



Our Vision

Resilient and sustainable Pacific Island communities using climate information to manage risks and support practical decision-making about climate variability and change.

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Pacific RISA: Year Three

Completing a third successful year, Pacific RISA has broadened and deepened its interdisciplinary research and outreach to help Pacific Island communities understand and address the impacts of climate variability and change. During Year Three, the Pacific RISA program expanded its work throughout the Hawaiian archipelago and the US-Affiliated Pacific Islands using the 2012 Pacific Islands Regional Climate Assessment (PIRCA) as a springboard for diverse activities. PIRCA workshops facilitated a knowledge exchange with many groups, including the Hawai'i Commission on Water Resource Management (CWRM), regarding the adaptive management of freshwater resources. Networks and gaps of information flow about climate change throughout the region have been identified, allowing the Pacific RISA team to build on existing linkages and to focus resources on areas that are underserved. New work in American Sāmoa is laying the foundation for assessing the value of multiple legal and policy tools aimed at supporting climate adaptation efforts.

Pacific RISA Program Evaluation

In 2012, Dr. Susanne Moser completed a qualitative evaluation of Pacific RISA's progress through external partners' perspectives. The evaluation involved interviews with collaborators and direct quotes from the interviews are listed below. In the evaluation report, Dr. Moser concludes that Pacific RISA is indeed known, recognized, and appreciated for what it chooses to focus on, its approach, and what it sets out to achieve.

Pacific RISA's recognized and unique strengths

- "They focus on a politically and socially important topic [freshwater]."
- "They're really good with doing assessments. It helps us refine our products."
- "Very strong social science skills, often lacking elsewhere."
- "The expertise in the RISA team is unparalleled."

How the Pacific RISA works and becomes impactful/influential

- "RISA is involved with people in the sand and reef; they understand information needs and how to reach people."
- "They're exemplary in putting decision-making at the center of what they do – compared to us geeks who start with scientific problems... So we learn from them."
- "They're the 'boots on the ground.' They can validate forecasts, and document what impacts people are experiencing. ... They help us achieve end-to-end goals, i.e., ensure that climate forecasts get used. So that increases preparedness."

Quality of work

- "They're always there, always engaged, here to help."
- "They make sure the job gets done."
- "We hear good things about them in communities."

Leadership and partnership

- "Leadership is collaborative, communicative, passionate, focused, shared vision and actions, engaged, and caring."
- "A very effective partner."
- "They [RISA team members] come to us."
- "I wish there was three of them."

Specific projects or achievements mentioned

- "I really liked RISA's videos. Really well done on timely, good topics. We need more of these."
- "...its role in drafting the state climate change adaptation policy was a huge success."
- "I learned a lot at their water and climate change workshop."

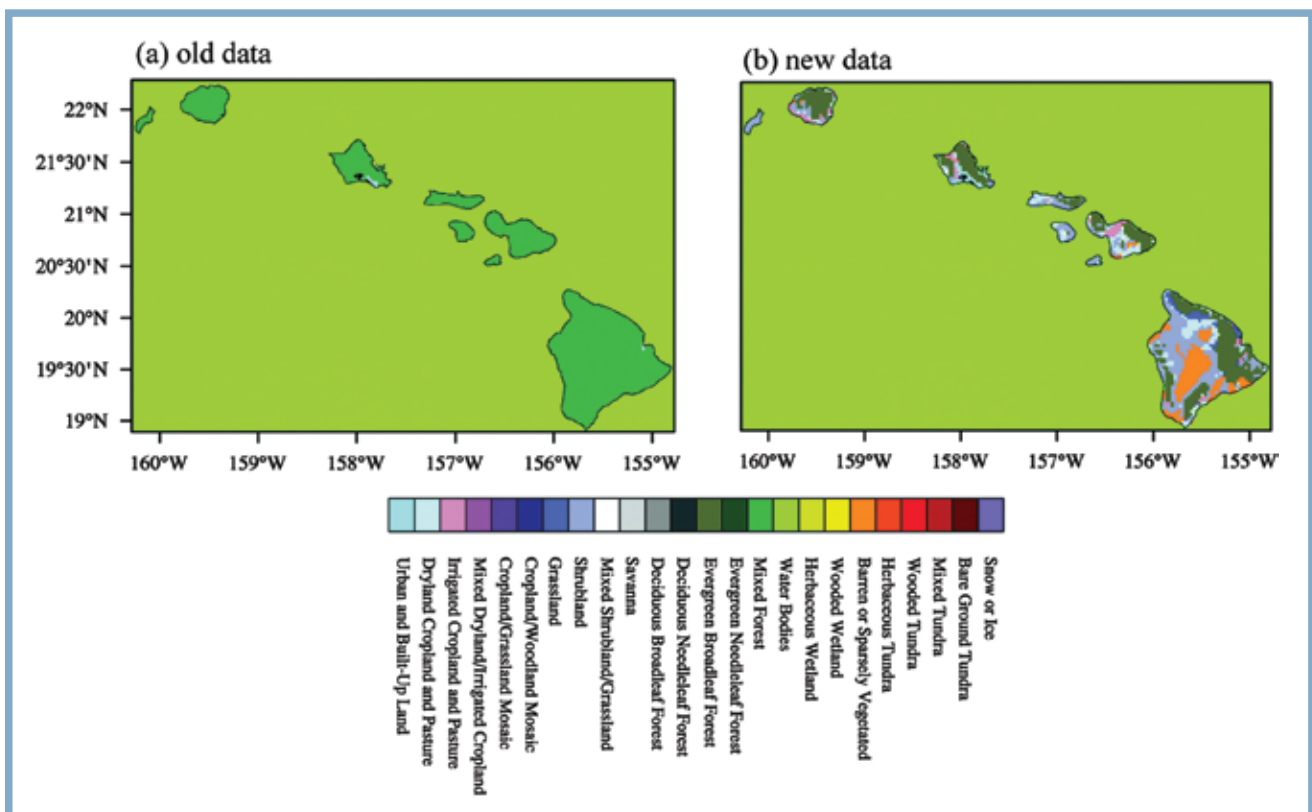
Additionally, the evaluation suggests a number of opportunities for promoting and strengthening Pacific RISA's position in Hawai'i and the Pacific. For example, we need to: (1) broaden partners' familiarity with Pacific RISA's goals and strengths to ensure they are recognized at every level among partner organizations; (2) intensify outreach, communication, and stakeholder engagement; and (3) explore new collaborative opportunities such as building online portals and data management tools for the Pacific region.

Research Updates

Hawai'i Regional Climate Model with New Land Surface Dataset Shows Improved Simulations

Activities. Researchers at the University of Hawai'i's International Pacific Research Center (IPRC) and Department of Meteorology have dynamically downscaled the Weather Research and Forecasting (WRF) model to fit the Hawaiian Islands, known as the Hawai'i Regional Climate Model (HRCM). The HRCM facilitates climate simulations in the Hawai'i region and has been updated with a new land surface dataset and a convective parameterization scheme. The researchers validated the model against data received from nine surface climatological stations and a dense network of precipitation stations.

Findings. The HRCM captures the basic features of Hawai'i's seasonal mean large-scale circulation, with some biases for cold and wet conditions in the simulated lower troposphere. Model results obtained with the new land surface dataset also showed improved simulations at most of the climatological and precipitation stations, with realistic representations of the magnitude and geographic distribution of mean rainfall and heavy rainfall. Comparing the results of the downscaled HRCM with results obtained using the land surface dataset from the official release of the WRF model confirmed that the new surface generally improved the simulation of all surface variables.

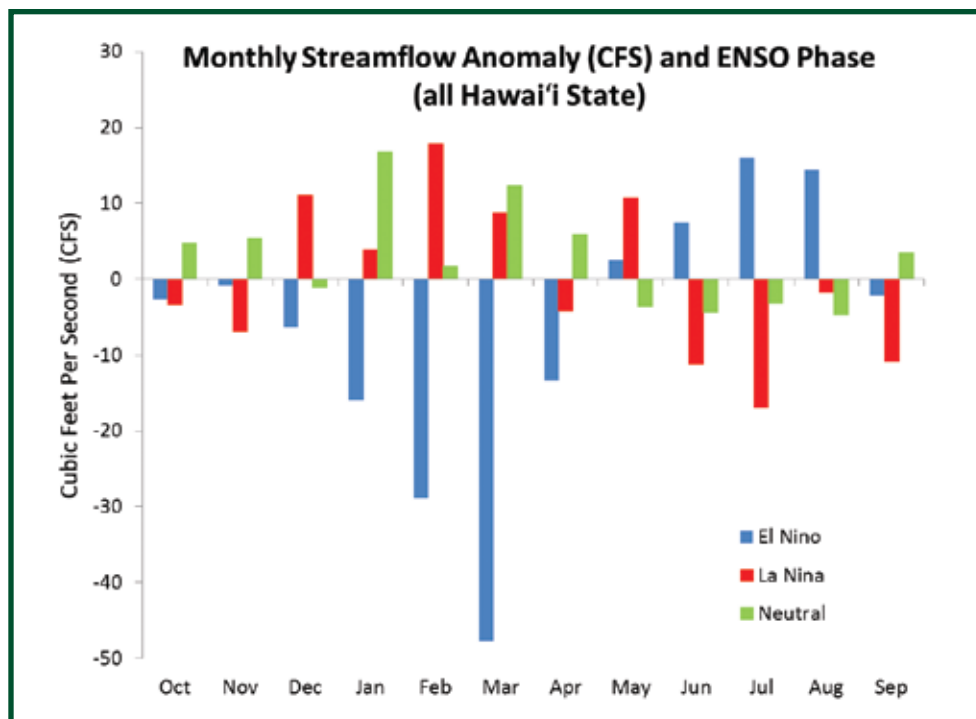


The (a) old and (b) new land surface dataset in the Hawai'i Region.

Dry Season Flows Significantly Lower; Potential for Increased Winter Drought in Hawai'i

Activities. Building on work by Pacific RISA Lead Principal Investigator Dr. Victoria Keener and the US Geological Survey (USGS) Pacific Islands Water Science Center (PI-WSC) concerning the effects of seasonal climate variability on streamflow and precipitation at sites throughout the Pacific Island region, research has focused on the identification of post-1990 streamflow anomalies within the entire state of Hawai'i. Dr. Keener and PI-WSC collaborators also continue to investigate how El Niño-Southern Oscillation (ENSO) has historically affected trends in streamflow, and how those effects may be shifting with climate change and the potential advent of new ENSO regimes.

Findings. The current research finds that the majority of decreasing streamflow trends between 1978 and 2008 occurred during the dry-season summer months (May through August). In addition, the shift in large atmospheric circulation patterns over the mid-latitude and tropical North Pacific result in fewer weather disturbances reaching the islands during the rainy season months of November and December. At most sites on O'ahu and Kaua'i, and half on Maui, dry season flows post-1990 have significantly decreased. The analysis of flow trends with ENSO indices show a potential for increased winter drought, especially in La Niña years. Finally, a shift in the character of average, maximum, and minimum flow distributions across all sites post-1990 to higher frequencies of low flows may be associated with central Pacific warming (El Niño Modoki) events. The hydroclimatic effects of these Modoki events are largely undefined in the Pacific Islands.

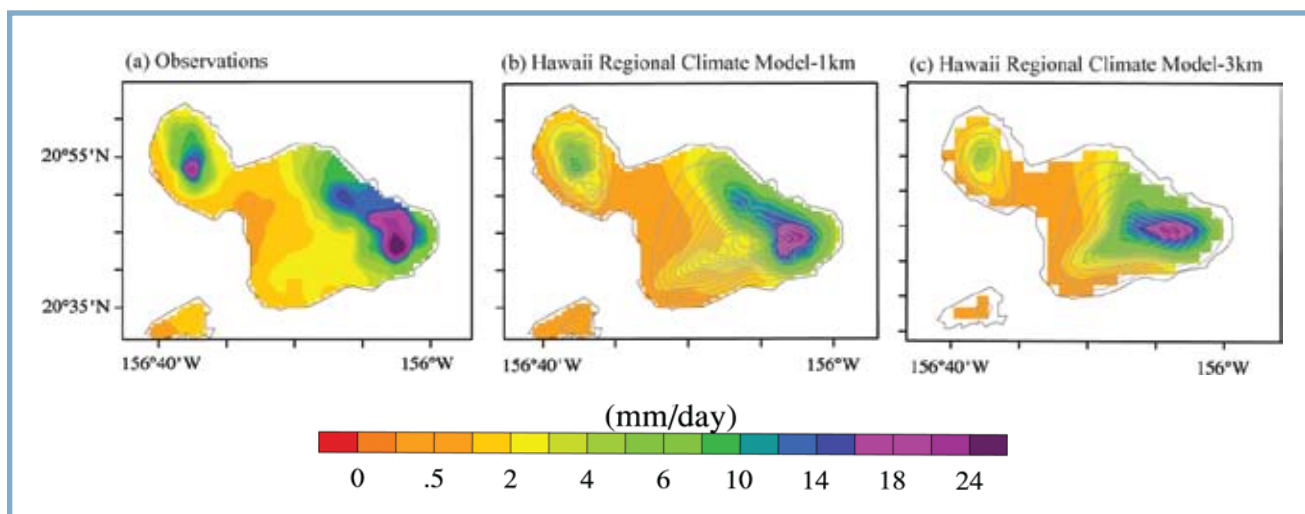


Patterns of monthly average streamflow emerge clearly when NINO 3.4 SST designations are used to separate El Niño, La Niña, and Neutral phases. ENSO patterns associated with rainfall are seen even more clearly in streamflow patterns: wet La Niña winters and dry El Niño winters. Also of interest is that Neutral winters may have high flow anomalies as well, and the clearer patterns in the summer of anomalously dry La Niñas and wet El Niños, while Neutral years by and large stay very close to average. (Source: Miller and Keener, forthcoming).

Rainfall Simulations Improved for Hawai'i at the Island Scale

Activities. In collaboration with IPRC, Pacific RISA researchers Dr. Kevin Hamilton and Dr. Chunxi Zhang are also studying detailed, 3 km resolution geographic patterns of air temperature, surface humidity, frequency of trade wind inversion, inversion height, cloud properties, and rainfall in Hawai'i. Their 20-year simulations have produced reasonably realistic results with the exception of rainfall, and they are working to improve simulations of mean rainfall distribution at an island-specific scale and finer resolutions.

Findings. Deficiencies in the IPRC's simulated rainfall distributions on Maui and O'ahu were hypothesized to be attributed to the 3 km topographic resolution in the models, and were tested for Maui by analyzing the 11-year simulation at 1 km resolution. The result was improved realistic distribution of mean rainfall on Maui. Comparison of the 3 km model resolution and the 1 km model resolution results from Maui also shows that employing the fine resolution version does significantly alter the projected rainfall changes as well as the mean rainfall in the base climate simulation. "We are just beginning to understand the details of how climate change will affect the Hawaiian Islands," said Dr. Henry Diaz, Senior Researcher at the University of Colorado.



Annual mean rainfall rate for the period 1994–2009: (a) derived using rain gauge observations, (b) from the 1 km simulation, and (c) from the 3 km simulation (mm/day). Contours show the model topography at 250 m intervals.

Social Network Analysis

Activities. Pacific RISA Postdoctoral Fellow Dr. Kati Corlew and Dr. Keener analyzed the professional and scientific networks of climate stakeholders in Hawai'i and the US-Affiliated Pacific Islands. Using network analysis methods, they tracked information flows, key hubs, and isolated groups to map out the strengths and gaps in the flow of climate information in the region. The project is supported by the National Oceanic and Atmospheric Administration (NOAA) and the US Department of Interior Pacific Islands Climate Science Center (PI-CSC), and addresses “the blind spot researchers and agencies currently have as to which communities and stakeholders may not be getting access to key knowledge,” said Dr. Keener.

Findings. More than 1,000 climate change professionals in the Pacific Islands were invited to complete a network analysis survey between December 2012 and March 2013. The survey solicited information about professional and personal demographics, network connectedness, climate change risk perception and resiliency, and sense of community. Email, phone, and face-to-face follow-up inquiries were conducted for the entire list of interviewees, and 340 surveys were completed. A network of 966 individuals was identified, with over 9,000 connections distributed among the Pacific Islands. The average distance across the network was three people, meaning that any single individual is only three connections away from all others. While Hawai'i contained the majority of network members (576), even small networks still proved to be highly connected: Palau, the smallest, had 30 survey respondents and a total of 50 networked individuals identified, with 245 connections.

Dr. Corlew has engaged with hundreds of climate change professionals across the region regarding the need for a network resource and support for increased collaboration, especially in remote areas in the Pacific. “The biggest takeaway is that we are connected throughout our region. We all know this—we are a series of islands connected by the ocean. But there is always room to build these connections. By mapping out how we communicate, we can find how best to strengthen our community,” said Dr. Corlew during a May 2013 interview.

Findings were presented by Dr. Corlew at the American Psychological Association (APA) annual meeting held in Honolulu from July 31 to August 4, 2013, fostering discussions of how to apply this research to future analyses examining why people become connected to a network and how national and international colleagues can contribute to climate change research and communication at a global level.



Dr. Kati Corlew distributes surveys and fact sheets about the network analysis project to participants of the 2013 Pacific Islands Climate Services Forum in Suva, Fiji.

Policy-Related Research: Adaptive Tools Assessment

Activities. At workshops hosted by the Center for Island Climate Adaptation and Policy (ICAP), participants examined the 12 adaptive tools recommended in the 2012 ICAP white paper, *Water Resources and Climate Change Adaptation in Hawai'i: Adaptive Tools in the Current Law and Policy Framework*. The goal of the assessment was three-fold: (1) to identify priorities and barriers for implementing the recommended adaptive tools, in specific regard to each island setting; (2) to identify the most efficient and advantageous support that Pacific RISA can lend to the next steps of implementation; and (3) to educate regarding the existing findings and recommendations.

The outreach workshops convened water resource decision-makers from state, county, and federal agencies, as well as businesses and non-profit organizations. A written questionnaire circulated toward the end of each session asked participants to prioritize and rank the tools according to their importance and potential for implementation within the existing legal structure. The adaptive tools have also been the subject of several presentations made to legal experts and scientists, with useful feedback about potential implications and implementation.

Findings. ICAP found that more than half of the respondents selected a market-based measure among the top three-to-five tools they thought would be most effective for addressing climate change impacts on water resources. "Relate water commission fees more closely to the cost of water management and watershed protection" was selected by 18 respondents (51%). Fifteen respondents (42%) selected "Adopt a public goods charge for water use." Those tools were the subject of substantial discussion at the workshops, suggesting that the best opportunities to lend support might be through further development and implementation of these market-based strategies. Additionally, stakeholders' discussion at the three outreach workshops held in 2012 revealed several major themes:

- Funding for implementation and enforcement is critically needed. Fees charged in conjunction with providing water and permits should relate more closely to the actual cost of managing water. Also, after resource managers are educated on adaptive concepts and needs, they are more likely to identify opportunities for implementing adaptive concepts into existing (and already-funded) management strategies.
- Enhanced scientific monitoring, water-use reporting, and data on water availability are needed to support adaptive water management. Decision-makers also need better access to existing data from the University of Hawai'i and other groups.
- Long-term, integrated planning (incorporating agriculture, energy generation, infrastructure repair, and conservation efforts) could improve water resource management as a whole, while also potentially creating cost savings.
- Water conservation and recycling can improve Hawai'i's ability to adapt to decreasing freshwater availability; however, water conservation alone cannot ensure resource sustainability.

Policy-Related Research: Adaptive Tools Assessment

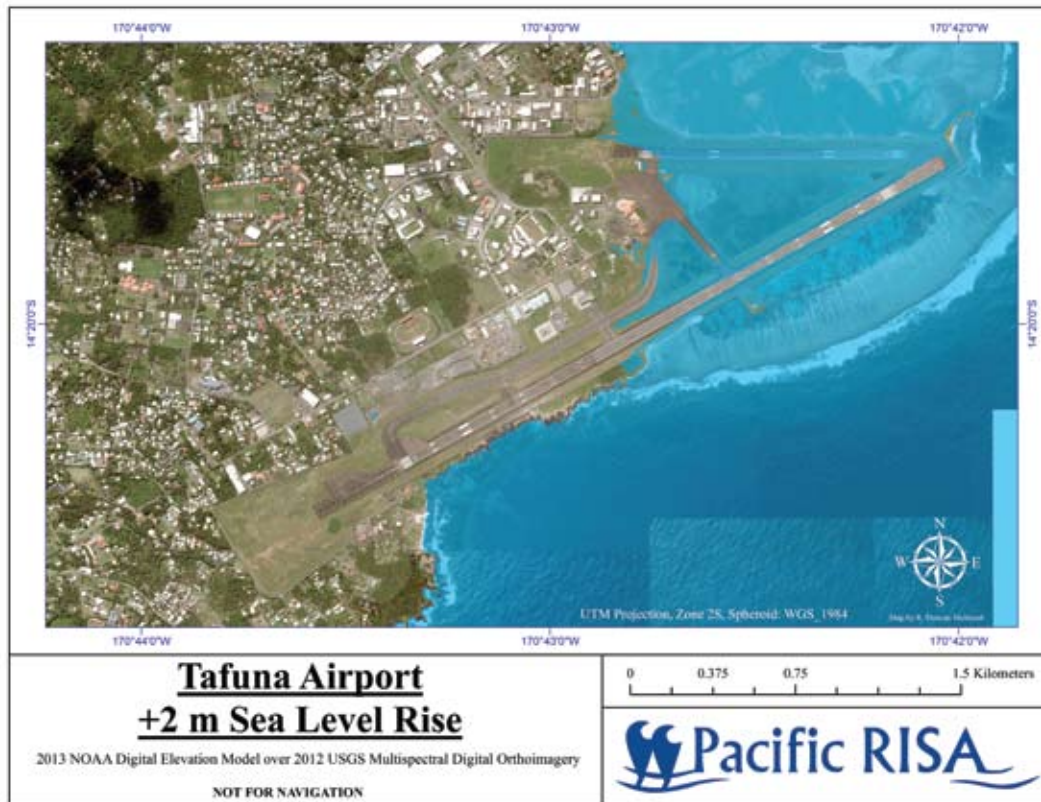
Spatial Analysis

A remotely-sensed, GIS-based assessment of projected sea-level rise in American Sāmoa is being conducted with Pacific RISA Project Assistant Mr. R. Duncan McIntosh. Mr. McIntosh is focusing on meeting select needs of the National Marine Sanctuary of American Sāmoa (NMSAS, formerly the Fagatele Bay NMS) that were published by the Office of National Marine Sanctuaries (ONMS) in the 2011 Science Needs Assessment (<http://sanctuaries.noaa.gov/science/assessment/fbnms.html>). A series of maps depicting incrementally elevated sea levels will be produced for all coastal areas of the NMSAS (excluding Swain's Island), as management support products. Additionally, maps will be produced for the islands of Tutuila, Aunu'u, Ofu, Olosega, Taū, and Rose Atoll (Motu o Manu), highlighting areas, populations, and infrastructure vulnerable to inundation.

The maps will be created in collaboration with Dr. Charles Fletcher, Chairperson and Professor of Geology and Geophysics at the School of Ocean and Earth Science and Technology at the University of Hawai'i at Mānoa, who will generate high-resolution inundation layers for the NOAA Coastal Services Center Sea Level Rise and Coastal Flooding Impacts Viewer. The project will then employ spatial analysis to quantify land area likely to be affected under different inundation scenarios. For the NMSAS, the report will address the following published information needs:

- Which coastal areas will be affected by sea-level rise the soonest?
- How much coastline will be lost adjacent to the sanctuary as sea-level rises?





The report is also expected to produce the following requested management support products:

- Coastal inundation maps
- Sea-level rise models

Like global mean sea level, the local sea level in American Sāmoa has been rising as far as empirical evidence indicates, and though the instrumental record is limited in the Pacific Island region, the rate of rise also appears to be accelerating. As a result of the steep topography of the largest and most developed American Samoan island, Tutuila, the majority of the territory’s population, infrastructure, and arable land are found on low-lying coastal plains, leaving them vulnerable to inundation and increased erosion.

Law and Policy Analysis

The law and policy research team is analyzing water issues and policies in American Sāmoa more broadly, with the goal to evaluate adaptive tools in a US Pacific Island context beyond Hawai‘i. As new scientific information about water resources becomes available, researchers will need to know how that information can best be utilized in a policy and resource management context. A better understanding of the law and policy framework, cultural context, and local knowledge and information gaps can help partners such as the University of Hawai‘i’s Water Resources Research Center (WRRRC) set priorities for research and monitoring and also can inform the design and delivery of products and tools for water managers. Senior Attorney Richard Wallsgrove and Mr. McIntosh are investigating American Sāmoa’s water resource issues and policies. Steps to date include: (1) gathering existing information on America Sāmoa’s water resources, climate science, climate adaptation, and existing legal frameworks; and (2) holding informational meetings and conference calls with resource managers and other on-the-ground experts. After reviewing themes that emerge during this early scoping phase, researchers will compile a report identifying information needs and several options for potential next steps. This report will serve as the foundation for making decisions, in consultation with the Pacific RISA team, about the best research direction to pursue in response to stakeholder needs.

PIRCA Forum Analysis

Activities. Pacific RISA hosted the PIRCA Forum in partnership with the Pacific Islands Climate Change Cooperative (PICCC) and the Pacific Climate Information System (PaCIS), with support from the DOI PI-CSC December 10-12, 2012 in Honolulu at the East-West Center's Hawai'i Imin International Conference Center. The purpose of the forum was twofold: (1) to officially release the PIRCA reports; and (2) to gather a group of diverse stakeholders to disseminate the PIRCA information, discuss the usefulness and gaps in that information, and discuss the National Climate Assessment (NCA) process more generally.

The morning sessions on the first day were open to the public, and featured: a keynote speech by Hawai'i Lieutenant Governor (now US Senator) Brian Schatz; an overview presentation by Dr. Victoria Keener that summarized PIRCA findings across all sub-regions and technical areas; and a panel of high-level sector representatives from across Hawai'i and the Pacific region, who spoke about the importance of climate information to their specific sectors (education, security, agriculture, land management, urban planning, and international negotiations). Panel members included William Aila Jr., Chairperson, Hawai'i Department of Land and Natural Resources (DLNR); Russell Kokubun, Chairperson, Hawai'i Department of Agriculture; Jesse Souki, Director, Hawai'i State Office of Planning; Neil Hannahs, Director of Land Assets Division, Kamehameha Schools; J. Scott Hauger, Associate Professor, Asia-Pacific Center for Security Studies; Ngedikes Olai Uludong, incoming Alliance of Small Island States Lead Negotiator. There was also a public question-and-answer session. After the public forum, invited participants joined discussion sections divided according to the PIRCA technical areas (freshwater and drought, sea-level rise and coastal inundation, and terrestrial and marine ecosystems), and then by economic sector and areas covered in the example case studies.

Findings. The following points emerged from discussions generated by the PIRCA thematic groups:

- The importance of outreach to the wider community.
- Know your audience, not only other scientists and policy makers. Work with the community first to learn what information they need and what formats work best, and then provide that to them.
- Problems of communication: There is a lack of understanding of climate information because of language barriers, lack of trust, and difficult politics.
- The importance of trust in providing information to people. Trust enables people to actually listen to and act on the information. Find and utilize local "champions."
- Cost data: More information is needed on the costs and benefits of climate change adaptation measures.
- Natural disasters make people think about climate change.
- The importance of no-regrets and win-win planning.
- The importance of long-term monitoring.
- A need for government mandates: We must have a regulatory/policy framework to guide the planning process and direct climate change information incorporation.



Dr. Victoria Keener, Lead Editor of PIRCA report, at the opening of the PIRCA Forum in December, 2012 in Honolulu, Hawai'i.

Pacific RISA has received significant media coverage since the release of the PIRCA report, bringing climate change issues into focus for the public, through the *Honolulu Weekly*, the *Honolulu Star-Advertiser*, on *Honolulu Civil Beat's* website, and in *ClimateWire*. A news segment featuring interviews with the report's editors and contributors aired on the Hawai'i network KHON in December 2012, and a second news segment ran on Fiji TV in January 2013 following the Climate Services Forum in Fiji. On February 14, 2013, Dr. Keener was part of a panel discussion with Dr. Fletcher, DLNR Director William Aila Jr., and PICCC Cultural Adaptation Coordinator Stanton Enomoto on the PBS Hawai'i show *Insights*:

http://www.youtube.com/watch?feature=player_embedded&v=7ghy7ArhCvg.

Outreach Activities

US National Climate Assessment. The PIRCA report provided the basis for a draft chapter about Hawai'i and the US-Affiliated Pacific Islands region for the US National Climate Assessment. Lead Convening Authors of the chapter are Drs. JoAnn Leong and John Marra. Dr. Melissa Finucane contributed as a Lead Author. Over 4,000 comments on the report were received during the public review period. The draft report can still be accessed at: <http://ncadac.globalchange.gov/>. The final report is expected to be released in early 2014.

Pacific Islands Drought Monitor. The US Drought Monitor is a national program that tracks indicators and impacts of drought in localities across the US. The US Drought Monitor website contains a drought map that has been refined over time to reflect the needs of decision-makers and those who use the information (<http://droughtmonitor.unl.edu/>). Drought Monitor authors synthesize many drought

indicators into this single map that identifies areas of the country that are abnormally dry, in moderate drought, in severe drought, extreme drought, and exceptional drought. While the Drought Monitor already covers the 48 contiguous states, Hawai'i, Alaska, and Puerto Rico, several federal partners are now working to bring a US Drought Monitor-style system to the US-Affiliated Pacific Islands region. The tool is being designed to report the specific conditions of the Pacific Islands on a weekly basis. Important next steps include moving the monthly scientific consensus discussions about Pacific Island drought levels and impacts to weekly reporting, which will put them in line with the US Drought Monitor.

Implementing Adaptive Tools. Following the ICAP adaptive tools assessment based on the policy white paper *Water Resources and Climate Change Adaptation in Hawai'i: Adaptive Tools in the Current Law and Policy Framework*, Pacific RISA has maintained regular communication with key stakeholders and deepened the partnerships that began to take shape at the workshops. Primarily, that dialogue has centered on assisting policy makers and agency staff to identify opportunities to implement adaptive tools, and also on understanding and eliminating perceived legal and technical barriers to implementation. In addition, the research team is currently analyzing how climate adaptation concepts were integrated into a recent decision by the State of Hawai'i's Commission on Water Resource Management concerning water banking and sustainable yield accounting.

Developing Scenarios of Groundwater Availability. On the island of Maui, the Pacific RISA team is taking a place-based approach to stakeholder outreach and assessment. The focus is on the 'Iao Waihe'e watershed in central and west Maui, where researchers have been engaging stakeholders in initial meetings to facilitate discussion of the project's purpose and methods, and to elicit input on potential variables to include in hydrological models. Over 50 representatives of various Maui water management groups have provided excellent information on key factors for assessing changes in groundwater availability under changing climate and management conditions. Additionally, the WRRC is converting their 1 km and 3 km resolution climate simulation data into formats that can be used as an additional input for the water budget model in the study area, according to stipulations by researchers at IPRC. In addition, test scenarios for groundwater availability under climate and land use changes have been developed.

Pacific RISA Blog. An integral part of the new Pacific RISA website, launched in September 2012, is the news blog: www.PacificRISA.org/news. The blog is updated regularly with content ranging from decision-support tools, to climate-related events and news articles, and provides a space where users can share content and select options to receive Pacific RISA's updates via email, RSS feed, or social media.

Social Media. Pacific RISA took steps to develop its social media outreach and strengthen communication platforms, such as Facebook and Twitter, by diversifying updates throughout the course of the past three months. In general, these platforms are used to display the work of Pacific RISA and its collaborators, but they have also been used to share and tweet up-to-the-minute information on local, national, and international conferences, workshops, and events, along with news stories from around the world related to climate change and its linked human and natural effects.

To access the Pacific RISA Facebook page, please visit <https://www.facebook.com/PacificRISA>

To access the Pacific RISA Twitter account, please visit <https://twitter.com/PacificRISA>

You can also use Twitter to follow Dr. Finucane at <https://twitter.com/MelissaFinucane>

New Initiatives and Collaborations

Hawai'i Commission on Water Resource Management (CWRM). Pacific RISA is continuing outreach and meetings with CWRM to support their adaptation-related efforts. Dr. Keener was invited to present findings from the 2012 PIRCA to CWRM at their March 2013 public meeting, and researchers Drs. Finucane, Keener, and Alan Mair presented background information and discussed a potential climate scenario framework to a group of 10 CWRM staff.

American Sāmoa Water Resources. Pacific RISA is developing more in-depth studies of freshwater resources in American Sāmoa, building on interest that partners and the Pacific RISA Advisory Committee expressed during workshops on climate change impacts and freshwater resources in July 2011 and at the December 2012 Advisory Committee meeting. An important consideration is the recent designation of the WRRC as the USGS research institute for American Sāmoa. While every US state has a water resources research institute or a center, as a US territory, American Sāmoa had not previously received support from this USGS national program. Pacific RISA Principal Investigator Dr. Aly El-Kadi has started American Sāmoa's inaugural research project dealing with assessing ground water sustainability for the island of Tutuila. Data for water quality and levels compiled through modeling and fieldwork will support Pacific RISA's efforts in American Sāmoa.

In August, 2013 the WRRC research team completed a two week sampling excursion on the island of Tutuila to collect groundwater samples and data from public water supply wells. Samples were transported back to labs at University of Hawai'i at Mānoa for geochemical analysis. Since very little chemical data for the territory's groundwater has been published to date, this new data set will be an important component of the team's modeling efforts. Work is currently underway in the development and calibration of new groundwater models which should prove invaluable to policy makers in decisions regarding future water development in the face of a changing climate.



WRRC researcher Joe Jackrell (University of Hawaii) involving local children in groundwater science on the beach while collecting a coastal spring sample. Photograph by Chris Shuler.



American Sāmoa Community College student and the American Sāmoa Power Authority worker collecting water samples at a well with Joe Fackrell (UH). Photograph by Chris Shuler.

In addition, a number of partnerships were initiated between the WRRC and water management agencies in American Sāmoa including the American Sāmoa Power Authority (ASPA), the American Sāmoa EPA (ASEPA), and the American Sāmoa Community College (ASCC). ASCC student interns, led by Dr. Randy DeWees, Chair of the Science Department at ASCC, will keep making instrumental contributions to the project with the continued collection of data and water samples throughout the year.

Pacific RISA Researchers Awarded Funding for Research on the Impact of Climate Change on Water Resources in Guam. A grant to the USGS (Principal Investigator: Dr. Stephen Gingerich) from the DoD Strategic Environmental Research and Development Program (SERDP) will support a four-year evaluation of potential adverse climate change impacts on DoD installations that rely on Guam's surface water and groundwater resources. Pacific RISA researchers Drs. Finucane, Keener, and Hamilton, will be members of a diverse team of investigators from multiple institutions including the USGS, the IPRC, the University of Texas, and the University of Guam, concerned with the following questions:

1. How will streamflow, sediment loads, and turbidity be modified and how will this affect surface water availability?
2. How will groundwater recharge and salinity be modified?
3. What are climate change impacts to DoD infrastructure supplying surface water and groundwater, and what are the adaptive strategies to maximize the water resources?
4. How will information about potential climate change impacts be communicated to water managers evaluating and implementing adaptive strategies?

Following quantitative assessments of groundwater recharge and the evaluation of climate change-induced modifications, Pacific RISA team members will link climate change information generated by the IPRC to water resource managers in Guam and support the development and evaluation of hydroclimatology information tailored to stakeholders. They will also consider the range of possible future scenarios so that an appropriate adaptive management strategy can be implemented as information on climate change is refined in the future.

Information generated by this research will yield practical benefits to the DoD by characterizing the efficacy of different management strategies and adaptations to projected climate change on Guam. Furthermore, the approach used for this study can be transferred to other islands where water resources are critical for military operations.

Secretariat of the Pacific Regional Environment Programme (SPREP). Based out of Apia, Sāmoa, SPREP is one of the most recognized regional and international institutions on environment and sustainable resource management. In mid-August 2013, the Pacific RISA team had the opportunity to meet with Ms. Seema Deo, Communications and Outreach Adviser of SPREP, to share experiences and lessons learned from climate change projects in the region. Future projects and possible collaboration were also discussed as both organizations are unique and essential to research and on-the-ground implementation. Building and maintaining such strategic partnerships was seen as highly beneficial for both teams.



Ms. Seema Deo, SPREP, and Drs. Victoria Keener and Kati Corlew, Pacific RISA.

Key Presentations and Meetings Attended

Finucane, M.L. & Keener, V. **Climate Change Impacts in the Pacific: Implications for US Environmental and Human Security**. Congressional Briefing sponsored by the East-West Center and the Pacific Islands Regional Climate Assessment, Washington, DC. September 17, 2013.

Corlew, K. **Network Analysis of Climate Change Professionals in Hawai'i and the US-Affiliated Pacific Islands**. Poster presented at the Annual Meeting of the American Psychological Association, Honolulu, HI. July 31-August 4, 2013.

Keener, V. & Wallsgrove, R. **Key Solutions for Climate Change Adaptation in the Context of Water Sustainability for Hawai'i**. Presentation at Forum on Water Sustainability Convened by US Senator Brian Schatz. Honolulu, HI August 2013)

Wallsgrove, R. **Cross-Sector Law and Policy Options to Adapt to Climate Change**. Presentation at the Hawai'i Conservation Conference. Followed by a panel discussion joined by representatives from the Honolulu Board of Water Supply, State of Hawai'i Commission on Water Resource Management, and University of Hawai'i at Mānoa Geography Department. Honolulu, HI July 2013.

Keener, V. **Pacific Islands Regional Climate Assessment**. Presentation for the Hawai'i American Water Works Association, Honolulu, HI. May 8, 2013.

Finucane, M.L., Keener, V., Marra, J., Spooner, D. **Climate Change in the Pacific Islands: Indicators and Impacts**. Presentation at the NOAA One Seminar (online). May 1, 2013.

Finucane, M.L. **Bridging the (Climate) Science-Society Gap**. Lecture presented at the Geography Department, University of Hawai'i at Mānoa, Honolulu, HI. April 29, 2013.

Keener, V. **Pacific Islands Regional Climate Assessment**, Lecture presented at the Geography Department, University of Hawai'i at Mānoa, Honolulu, HI. April 22, 2013.

2013 United States Drought Monitor Forum, West Palm Beach, Florida. The forum serves as an international meeting place to compare drought impacts and monitoring efforts, as well as providing an opportunity for state and regional drought monitoring groups to come together to examine locally relevant issues. Dr. Kati Corlew attended the forum to share information and updates on the status of drought issues in the Pacific Islands. April 16-18, 2013.

Keener, V. **Climate Change in the Pacific Islands: Indicators and Impacts**. Presentation for the US Green Building Council Hawai'i Chapter, Kaka'ako, HI. April 16, 2013.

Finucane, M.L. & Marra, J. **Pacific Islands Regional Climate Assessment**. Presentation at the UH Center for Pacific Islands Studies, Waves of Change Conference, Honolulu, HI. April 5, 2013.

Keener, V. **Pacific Islands Regional Climate Assessment**. Presentation for the Hawai'i Commission on Water Resource Management (CWRM), Honolulu, HI. March 20, 2013.

Keener, V. **Pacific Islands Regional Climate Assessment**. Presentation at the 2013 Pacific Risk Management 'Ohana (PRiMO) Conference, Honolulu, HI. March 13, 2013.

Keener, V. & Finucane, M.L. **Indicators and Impacts of Climate Change in the Pacific Islands**. Presentation at the University of Hawai'i at Mānoa Center for Pacific Island Studies, Waves of Change Tok Stori Session, Honolulu, HI. February 22, 2013.

Keener, V. **Pacific Islands Regional Climate Assessment**. Presentation for the Pacific Islands Climate Change Cooperative (PICCC) webinar. February 21, 2013.

Keener, V. **Climate Change in the Pacific Islands: Indicators and Impacts**. Presentation at the Future Leaders of the Pacific Conference, Pago Pago, American Sāmoa. February 6, 2013.

Keener, V. **Pacific Islands Regional Climate Assessment**. Presentation at the Pacific Islands Climate Services Forum, Suva, Fiji. January 23, 2013.

Corlew, K. **Human Dimensions of Climate Change in the Pacific**. Presentation at the New York University Faculty Resource Network Winter Professional Enrichment Seminar, Honolulu, HI. January 17, 2013.

Keener, V. **Pacific Islands Regional Climate Assessment**. Presentation at the Pacific Islands Regional Climate Assessment (PIRCA) Forum. The well-attended public forum drew over 200 participants, and served as the official release of the PIRCA. Honolulu, HI. December 10-11, 2012.

Finucane, M.L. **Responding to Risk in a Global Context**. Presentation to the Asia-Pacific Leadership Professionals class, East-West Center. Honolulu HI, September 19, 2012.

Burgett, J., Finucane, M.L., Keener, V., Marra, J., Spooner, D. **Pacific Islands Regional Climate Assessment (PIRCA)**. Presentation at the Hawai'i Conservation Conference. Honolulu HI. August 2, 2012.



US Senator Brian Schatz speaking at the Congressional Briefing, Climate Change Impacts in the Pacific: Implications for US Environmental and Human Security. Presented by Dr. Melissa Finucane and Dr. Victoria Keener.

Year-Three New Hires

In order to accomplish its research and outreach activities, the Pacific RISA program has hired six new employees in its third year. Reflecting the multidisciplinary nature of the research, the new hires span several different social and physical science fields. Furthermore, Dr. Victoria Keener is now Lead Principal Investigator in the Pacific RISA Program.



R. Duncan McIntosh, Pacific RISA Research Assistant (Meteorology and Physical Oceanography)



Rachel Nunn, Pacific RISA Communications Coordinator (Climate Science and Disaster Management)



Laura Brewington, PhD, Pacific RISA Program Manager (Conservation, Environmental Policy, and Geography)



Krista Jaspers, Pacific RISA Research Assistant (Geography and Environmental Studies)



Tazebe K. Beyene, Graduate Research Assistant (Civil and Environmental Engineering)



Christopher Schuler, Graduate Research Assistant (Hydrology and Coastal Groundwater Research Group)

Publication Highlights

Anderson, C.L. (2012a). **Overview of Climate Risk Reduction in the US Pacific Islands Freely Associated States**. Honolulu, HI: Hazards, Climate and Environment Program, University of Hawai'i at Mānoa Social Science Research Institute, Technical Report No. 201103B. Available at <http://www.pacificrisa.org/wp-content/uploads/2013/02/Anderson-Overview-of-Climate-Risk-Reduction-in-the-US-PI-FAS.pdf>

Anderson, C. L. (2012b). **Overview of Climate Risk Reduction in the US Pacific Islands Hazard Mitigation Planning Efforts**. Honolulu, HI: Hazards, Climate & Environment Program, University of Hawai'i at Mānoa Social Science Research Institute, Technical Report No. 201103A. Available at <http://www.pacificrisa.org/wp-content/uploads/2013/02/Anderson-Overview-of-Climate-Risk-Reduction-in-the-US-PI-Hazard-Mitigation-Planning.pdf>

Finucane, M.L., Miller, R., Corlew, K., Keener, V.W., Burkett, M., Grecni, Z. (2013). **Understanding the Climate-sensitive Decisions and Information Needs of Fresh Water Resource Managers in Hawai'i**. *Climate, Weather, Society*, 5(4): 293-308.

Keener, V., Marra, J.J., Finucane, M.L., Spooner, D., Smith, M.H. (Eds.) (2012). **Climate Change and Pacific Islands: Indicators and Impacts**. Report for the 2012 Pacific Islands Regional Climate Assessment. Washington, DC: Island Press. Available at www.pacificrisa.org/projects/pirca/

Keener, V., Hamilton, K., Izuka, S.K., Kunkel, K.E., Stevens, L.E., Sun, L. (2013). **Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 8**. *Climate of the Pacific Islands*. NOAA Technical Report NESDIS 142-8, Washington, DC.

Lauer, A., C.X. Zhang, O. Elison Timm, Y. Wang, K. Hamilton. **Downscaling of Climate Change in the Hawai'i Region using CMIP5 Results: On the Choice of the Forcing Fields**. *J. Climatol*, in press.

Leong, J., Marra, J.J., Finucane, M.L., Giambelluca, T., Merrifield, M., Miller, S.E., Polovina, J., Shea, E. (in press). **Hawai'i and US-Affiliated Islands. In the US Global Change Research Program National Climate Assessment**. Washington DC. <http://ncadac.globalchange.gov/download/NCAJan11-2013-publicreviewdraft-chap23-hawaii.pdf>

Safeeq, M., Mair, A., Fares, A. (2013). **Temporal and Spatial Trends in Air Temperature on the Island of Oahu, Hawaii**. *Int. J. Climatol*, 33: 2816–2835. doi: 10.1002/joc.3629

Wager, K. (2012). **Climate Change Law and Policy in Hawai'i, Briefing Sheet, 2012**. Center for Island Climate Adaptation and Policy, University of Hawai'i at Mānoa. Available at <http://icap.seagrant.soest.hawaii.edu/icap-publications>.

Zhang, C., Wang, Y., Lauer, A., & Hamilton, K. (2012a). **Configuration and Evaluation of the WRF Model for the Study of Hawaiian Regional Climate**. *Monthly Weather Review*, 140, 3259-3277.

Zhang, C., Wang, Y., Lauer, A., Hamilton, K., & Xie, F. (2012b). **Satellite and Ground-based Determinations of Cloud Base Height, Cloud Top Height and Cloud Thickness in the Hawaiian Region**. *Geophysical Research Letters*, 39, L15706, doi:10.1029/2012GL052355.



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