

Pacific Research on Island Solutions for Adaptation

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Aerial view of Palau outside Koror. (Credit: Lighting Strike Pro/Adobe Stock)

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Introduction

About Pacific RISA

The *Pacific Research on Island Solutions for Adaptation* (Pacific RISA) program supports Pacific Island and coastal communities in adapting to the impacts of climate variability and change. As one of 12 NOAA CAP/RISA programs, Pacific RISA emphasizes the engagement of communities, governments, and businesses in developing effective strategies to build resilience in key sectors such as water resource management, coastal and marine resources, fisheries, agriculture, tourism, disaster management, and public health. This is the first Annual Report reflecting our name change from the Pacific Regional Integrated Sciences and Assessments program. We believe that the new name captures both the science-based nature of our work, as well as the fact that Pacific Islands are global leaders in climate adaptation solutions.

The Core Office of the Pacific RISA program is led by the Arizona State University (ASU) Global Institute of Sustainability and Innovation (GIOSI), in partnership with and located at the East-West Center. Researchers are from the University of Hawai'i's Water Resources Research Center, Natural Resources and Environmental Management, Richardson School of Law, and Sea Level Center, and Clark University Department of Geography. Collaborators are at the USGS-Pacific Islands Water Science Center, the University of Guam, and the Micronesia Conservation Trust.

During this second year of our Phase IV funding, the Pacific RISA established a new project-focused Advisory Committee, consisting of eight experts from across the Pacific Islands region that represent high-level State, County, and island-scale natural resources governance, international environmental security and policy, environmental and climate justice and equity, regional/global climate partnerships, and place-based expertise.

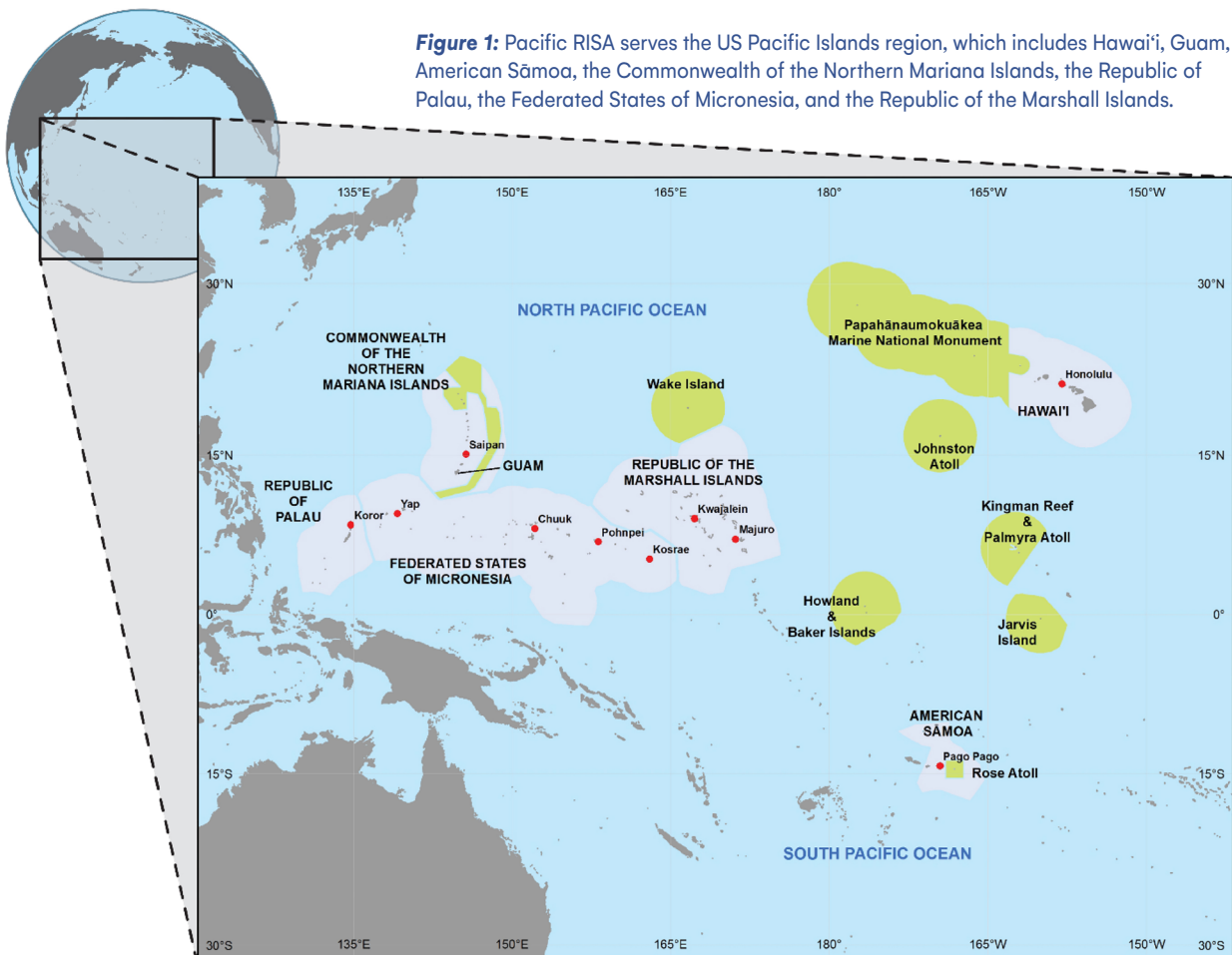


Figure 1: Pacific RISA serves the US Pacific Islands region, which includes Hawai'i, Guam, American Sāmoa, the Commonwealth of the Northern Mariana Islands, the Republic of Palau, the Federated States of Micronesia, and the Republic of the Marshall Islands.



Image 1: Participants at the PESC represented 14 Pacific Island Countries and Territories and eight high-level delegations from the region and international partners such as the United States, Australia, and Taiwan. (Credit: The Pacific Community)

Accomplishments

Featured Accomplishment: The Pacific Ecological Security Conference

Native biodiversity and ecosystems have deep cultural significance to the people of the Pacific Islands, whose identities and livelihoods are often tied closely to the land and sea. Non-native, invasive species pose critical threats to these island systems and communities that are already at risk from a changing climate, and can even exacerbate the harmful impacts of climate change. In response to requests by Pacific Islands Countries and Territories (PICTs) for a coordinated, whole-of-Pacific approach to invasive species management, PI Dr. Laura Brewington led preparations and organized the inaugural Pacific Ecological Security Conference (PESC) in the Republic of Palau, which took place in October 2022. Hosted by the Government of Palau and sponsored by the East-West Center, the Nature Conservancy, the Pacific Community (SPC), and the US Office of Insular Affairs, the PESC brought together Pacific Island leaders, development partners, regional organizations, agriculture and food security experts, and natural resource managers to develop Pacific-wide, scientifically-based Strategic Action Plans that address critical invasive species issues facing the

region. As the organizer, PI Brewington delivered a keynote presentation on the intersection of invasive species with climate change.

During the conference, working groups developed three Strategic Action Plans based on the conference themes: Strategic Action Plan for Coconut Rhinoceros Beetle, Pacific Biocontrol Strategic Action Plan, and Biosecurity Plan for Invasive Ants in the Pacific. Each plan highlights how the failure to adequately address invasive species in Pacific Island ecosystems weakens the resilience of Pacific communities and ecosystems to cope with the impacts of climate change and ability to adapt to a changing world. The plans are already being used to drive legislative and policy outcomes, and are being referenced in regional and international calls for action and funding around invasive species (see **Societal Impact**).

Additional high-level outcomes of the PESC included final Outcome Statements, backed by conference participants, which recommended that the Pacific's two primary multilateral organizations (SPC and the Secretariat of the Pacific Regional Environment Programme [SPREP]) take on the PESC action plans, and the issue of invasive species itself, as a joint effort. PI Brewington has since co-authored a publication (in review) with the working group leads that serves as a roadmap for coordinated regional action and the next PESC.



Images 2 (left) & 3 (top): PESC attendees visited Kayangel Atoll in northern Palau. With a maximum elevation of 5 ft. above sea level, its five small villages are spread across four islets that are highly vulnerable to tropical storms, extreme tides, and sea level rise. Recent invasive mammal eradication programs have improved community resilience to climate change and food security. (Credit: left: Island Conservation; top: Laura Brewington)

PESC attendees also visited Kayangel atoll in Palau (Images 2 & 3) to better understand invasive species management needs and climate threats in some of the Pacific's most vulnerable communities. With a population of only 54, Kayangel is the northernmost state of Palau and was heavily damaged during Typhoon Haiyan (2013). Two rodent eradication projects have been conducted to protect the habitats,

endangered birds, and sustainable livelihoods of the Kayangel community. Today, three out of the four islets in Kayangel remain rat and cat free, providing a safe haven for biodiversity to flourish and ensuring food security. This is especially critical at a time when crop production on these low-lying islands is subjected to frequent typhoons and increased salinization due to sea level rise and storm surge.

New Focus Areas/Partnerships

Hawai'i Youth Climate Summit

In tandem with Hawai'i Climate Week (see Outreach & Engagement), PI Dr. Victoria Keener organized a Youth Climate Summit that brought over 50 youth ages 12 to 27 together to focus on identifying key levers for accelerating climate actions around topics such as legislative action, growing a circular economy, youth litigation and social justice, and local civic engagement. Participants provided lightning talks around current initiatives, identified implementation gaps, and formed networks that can amplify actions. This event was facilitated by PI Keener and run by a team of students and youth activists from the Hawai'i Youth Climate Coalition (HYCC) and Wipeout Crew, among others. A key climate resource and contacts sheet was generated for the HYCC from Summit discussions.

Community Flood Risk Modeling

PIs Dr. Chris Shuler, Matthew Widlansky, and Zena Grecni collaborated with researchers from the Carolinas Collaborative on Climate, Health, and Equity (C3HE) at the University of North Carolina at Chapel Hill on a successful cross-CAP/RISA related proposal to the Climate Program Office (CPO) competition *"Assessing Tradeoffs and Co-Benefits for Complex Decision-Making in Communities Facing Coastal Inundation and/or Inland Flooding"*. The forthcoming project will enable equitable adaptation to changing coastal flood risks through community-engaged modeling in North Carolina and Hawai'i, and will support PI Shuler's graduate student, Brian Gorberg, through his PhD program at the University of Hawai'i.

North Kaua'i Hydrologic Modeling

Building on the connections established and the outcomes of the Kaua'i Peer-to-Peer Exchange project, and in response to the compound effects of the 2018 Hanalei floods,¹ PI Shuler's team is also developing new partnerships with stakeholders in Kaua'i. The County of Kaua'i Planning Department is interested in incorporating hydrologic model outputs into their planning framework to implement new cli-

¹ During the 2018 Hanalei floods, many transportation assets (bridges, roads, and foot trails) were made impassable thereby physically isolating the community for many months.



Image 4: Youth Participants at Hawai'i Climate Action Day.
(Credit: Krista Jaspers)



Image 5: Participants with PI Keener at the Youth Climate Summit.
(Credit: Victoria Keener)



mate-ready zoning and building policies. PI Shuler's team is working with the County and local community groups like the [Hanalei Initiative](#) and the [Hanalei Watershed Hui](#) to develop user-driven modeling scenarios to best inform local adaptation efforts. By co-producing flood modeling scenarios with Kaua'i County planners, the team is working to deepen partners' understanding of science and knowledge related to hydrology, climate, and adaptation options. Products will also include an interactive climate exposure viewer that will assist County offices as well as community organizations and other stakeholders in identifying the areas with higher or lower exposure to different climate related hazards. The viewer will also incorporate elements of social vulnerability indices, as climate exposure and vulnerability are

Images 6 & 7: The Oleson Lab visited the Island of Kaua'i where they learned about ecosystem-based adaptation from local communities. As part of a scoping trip, they helped clear man-groves with Mālama Hulē'ia at Alakoko Fishpond. (Credit: Kirsten Oleson)

controlled by social factors as well as environmental ones. This will allow users to map and better understand equity and social justice considerations as they relate to climate hazards.

Ecosystem-Based Adaptation on Kaua'i

PI Dr. Kirsten Oleson's team is currently developing and strengthening partnerships with the County of Kaua'i Planning Department and forging connections with local community groups. In May 2023, PI Olseon led a scoping trip to Kaua'i with University of Hawai'i MS students Ann Nyambega (NREM) and Brian Gorberg (Dept. of Earth Sciences) to gauge community groups' interest in co-producing knowledge about the outcomes of their ecosystem-based adaptation projects. Such projects can help people cope with or decrease the risk of climate change impacts, like sea level rise or increased precipitation. While on Kaua'i, the team also met with County adaptation planning officials, agricultural extension agents and community leaders, attended a climate adaptation public meeting for the community of Lihu'e, and worked alongside fishpond restoration groups to get first-hand knowledge to inform the project.

Climate Services and Sectoral Climate Early Warning Systems in Palau

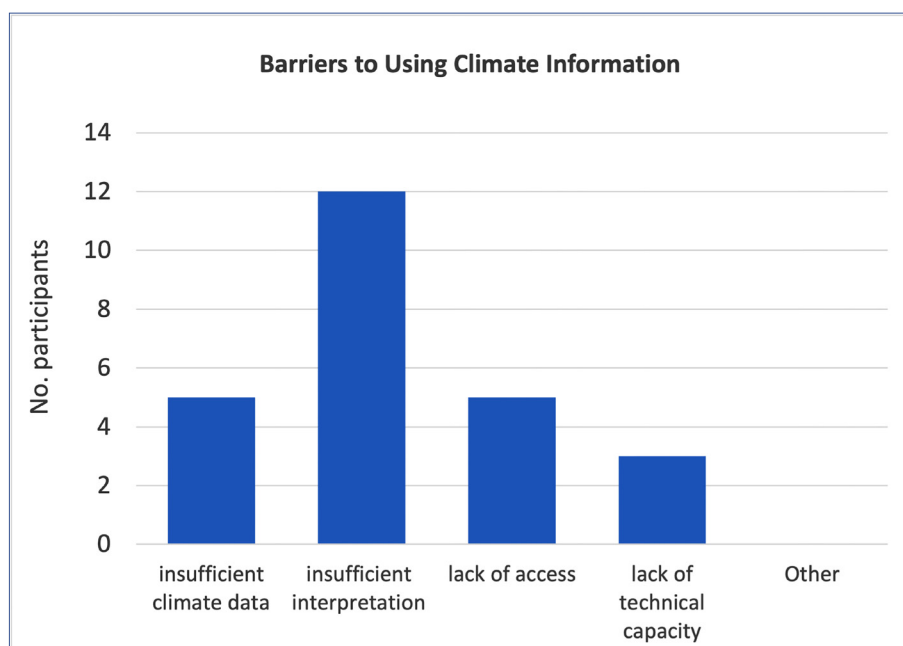
In April 2022, Project Specialists Paula Moehlenkamp and Chelsey Bryson attended the first Palau National Climate Outlook Forum (NCOF) led by the Palau Weather Service Office, and a National Framework for Climate Services (NFCS) workshop. During the meetings, Moehlenkamp and Bryson met with stakeholders to advance progress on sector-based climate early warning and climate indicator development. They also led an interactive group polling exercise around climate information services and priorities in Palau. To decrease redundancy and stakeholder fatigue, Pacific RISA is helping to

coordinate projects and align products between related climate services research, including climate indicators for the NOAA Pacific Islands Climate Change Monitor, UHSLC training, climate and oceanographic systems produced by the Pacific Islands Ocean Observing System (PacIOOS), the Pacific Islands Regional Climate Assessment (PIRCA), the Local2030 Island Network Sustainable Development Goal dashboards, and ocean portals and health and drought early warning systems for Pacific RISA's Green Climate Fund climate information systems program in Palau and the Republic of the Marshall Islands (RMI).



Image 8: Project Specialist Bryson facilitated a live polling survey with stakeholders during the National Framework for Climate Services workshop in Palau. (Credit: Paula Moehlenkamp)

Figure 2: A live poll result showing perceived barriers to using climate information for decision-making. (Credit: Chelsey Bryson)



Tracking Sea Level Conditions in Palau

PI Dr. Matthew Widlansky of the University of Hawai'i Sea Level Center (UHSLC) is leading a project to track and communicate sea level conditions for coastal disturbances in Palau. The team will monitor conditions and develop tracking metrics to support NOAA reporting activities while providing training on the use of sea level information. This project will improve the communication of sea level information with stakeholders in Palau, especially on seasonal variability scales, by developing enhanced sea level tracking products and a dashboard that contains sea level indicator products.

In addition to sea level tracking, this project will perform surveys of impact-based water level thresholds, which will be used to categorize extreme events. The information will be included in the tracking products. The primary deliverable will be a digital report card on sea level conditions in Palau, containing standardized indicators for tracking sea level variability that are automatically generated to provide current, quarterly, and annual updates for island locations. Training modules will accompany the reporting metrics, which will add value to information about sea level conditions and support capacity building for coastal communities.

Research Highlights

Fifth US National Climate Assessment

Pacific RISA PI and Lead Chapter author Dr. Abby Frazier, and PIs Grecni, Keener, Oleson, Shuler, as well as Pacific RISA Advisory Committee member Malia Nobrega-Olivera are members of the Hawai'i and Pacific Islands regional chapter author team for the Fifth US National Climate Assessment (NCA5). The team shaped the Hawai'i and Pacific Islands regional chapter through four drafts and responded to five rounds of review and comments from the public, federal agencies, and the National Academies of Sciences, Engineering, and Medicine. The PIRCA reports have figured prominently into determining key focal areas for the chapter, its key messages, and the examples of impacts and adaptation options. The regional chapter will synthesize the state-of-knowledge of climate change science and evaluate the impacts on populations and sectors, as well as adaptation responses underway in the region. With

U.S. Global Change Research Program



Image 9: In April 2023, the Hawai'i and Pacific Islands chapter author team traveled to Washington, DC, where they met with some of the other 800 scientists and experts that are involved in creating the NCA5. *From left to right:* PI Keener, Malia Nobrega-Olivera, PI Shuler, PI Oleson, PI Frazier, Ann Singeo, Romina King, and PI Grecni (Credit: Victoria Keener)

several Pacific RISA PIs that have authored multiple NCAs, the 14-author team prioritized transparency and regional engagement to choose key topics and held five technical meetings with participation from all US Pacific Island jurisdictions. The NCA is an authoritative source of climate information for the United States, covering all regions, and can inform actions and policies.

Pacific Ecological Security

PI Brewington continues to focus on expanding capacity to adapt to and manage the compounding threats of invasive species and climate change in Hawai'i and the Pacific Islands region. She co-founded the Pacific Regional Invasive Species and Climate Change (RISCC) management network, which has expanded to over 400 members just a few years after its inception. Pacific RISCC holds monthly webinars, has created literature summaries for managers to use in developing adaptive management programs, and has produced relevant publications that examine the interactions between invasive species and climate change in the region. In July 2022, she was also a keynote speaker at the World Summit on Island Sustainability in the Galapagos Islands, Ecuador, where she shared some of the bright spots and unique challenges surrounding these issues in Pacific Islands, featured in a blog post on the Pacific RISA website.



Figure 3: Climate change and invasive species have intersecting impacts on Pacific Island ecosystems and communities. (Credit: Brewington et al. 2023)

Several of Pacific RISCC’s Hawai‘i-based members also took part in a historic decision made by the Hawai‘i Board of Land and Natural Resources (BLNR) on March 24, 2023 in which the Board unanimously voted to approve an Environmental Assessment and issuing a finding of “No Significant Impact” for a mosquito suppression program that is planned for East Maui. This program, which uses a natural form of mosquito “birth control” that has been applied in more than 15 countries to fight mosquito-borne diseases, may be the last opportunity to save at least four of Hawai‘i’s critically endangered endemic forest birds. PI Brewington testified that given the dire projections for continued temperature increases in the islands, the only way to protect the birds from avian malaria is to eliminate the vector (mosquito) that carries it.

Lastly, PI Brewington mentored East-West Center Graduate Student Intern Perry Arrasmith in his review of the 2015 Regional Biosecurity Plan for Micronesia and Hawai‘i (RBP), which was as an initial step toward coordinated regional action on invasive species prevention and control. The Hawai‘i Invasive Species Council and the Coordinating Group on Alien Pest Species have been asked to update the State of Hawai‘i’s Biosecurity Plan priorities to better align with regional efforts that build resilience to climate change by reducing invasive species risks.

Perry’s internship compiled a set of recommendations for implementation that were delivered to State of Hawai‘i partners and agencies, and concluded that stakeholders like Hawai‘i Green Growth should be consulted for incorporating the RBP mechanisms into their dashboard tracking procedures.

Hydrologic Modeling and Compound Events

PI Shuler and Pacific RISA graduate student Brian Gorberg are leading data collection efforts for the development and parameterization of watershed models of the Northern Kaua‘i region, which is designated as underserved by the Climate & Economic Justice Screening Tool (CEJST). Gorberg finished gathering initial parameters for the Gridded Surface Subsurface Hydrologic Analysis (GSSHA) model and streamlined the process by creating shapefiles and writing code to input tables into the model. An example of some of the useful modeling data obtained thus far is contained in a “*Kaua‘i Flood Events Dashboard*” developed by Gorberg. The dashboard is based on NOAA data and publicly available to stakeholders [online](#). The goal of the project is to compare current extreme event flood maps to future scenario flood maps, which will be derived from climate change induced extreme precipitation, sea level rise, and storm surge. More information on progress can be found in Gorberg’s [online video presentation](#).



Figure 4: Screenshot from a preliminary 2D flood model simulation of the Hanalei watershed in North Kaua'i produced with the GSSHA model. (Credit: Brian Gorberg)

Compound Extreme Events in the Pacific Islands

The Pacific Islands region experiences high and often underestimated direct and indirect consequences from compound disasters, including tropical cyclones (Figure 5), land and ocean heat waves, wildfire, extreme rainfall and flooding, ENSO and drought, and changing sea levels. PIs Marra, Frazier, Widlansky, Keener, and Brewington are preparing a publication that will elucidate mechanisms by which both climate and non-climate compound extreme events are occurring in the region and how these physical mechanisms

have impacted island communities with different adaptive capacities. This analysis will help Pacific RISA and partners inform regional adaptation policies and advance coordinated preparation and response given changing future climate conditions. Analysis methods include both literature and policy review, interviews, and network analysis.

Hawai'i All-County Climate Adaptation Planning & Implementation Peer Exchange

As part of Hawai'i Climate Week in January 2023, Pacific RISA and the County of Kaua'i Planning Department hosted 30 state and county long-range planners, sustainability staff, and coastal zone managers who met at the East-West Center for a half-day workshop. They exchanged experiences to better understand the status of climate adaptation planning in the counties and the state framework. This Hawai'i All-County Climate Adaptation Planning & Implementation Peer Exchange, convened at the request of the County of Kaua'i, built upon successful previous Peer-to-Peer Exchanges but brought together a larger group to test the approach at a statewide scale. Participants learned how peers are using existing planning, policy, and regulatory tools; exchanged experiences around managed retreat; and began to bridge the disconnect between climate planning and implementation priorities. Key outcomes for decision-makers to consider included that incentivizing collaboration and planning across multiple agencies can accelerate climate action, and that pipeline programs and training are needed to prepare the County and State workforce to take jobs in climate adaptation and increase capacity to meet regular plan update cycles. (See **Outreach & Engagement** for more on this Peer Exchange.)

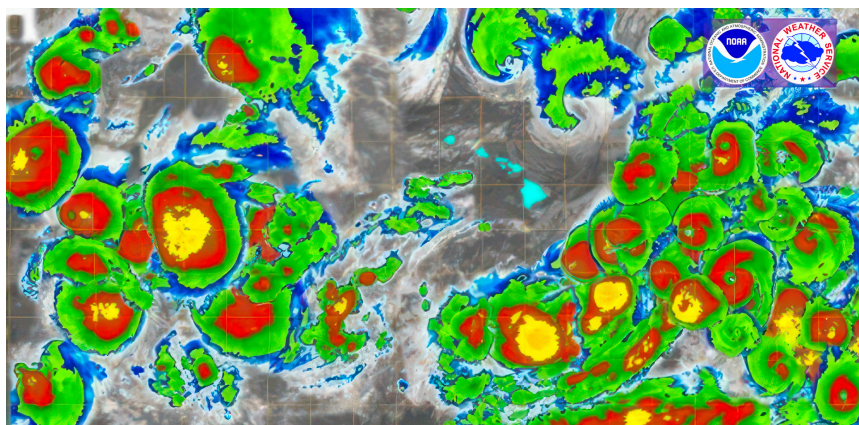


Figure 5: The changing frequency and intensity of climate extremes such as tropical cyclones interact with regional and local sociopolitical conditions to worsen negative impacts in different sectors. This figure is a mosaic of infrared satellite images showing fifteen tropical storms that reached or formed in the Central Pacific Basin in 2015. (Credit: Kevin Kodama/National Weather Service, Honolulu Office)



Image 10: Pacific RISA Program Manager Gwen Sisior representing Palau at the Convention on Biodiversity COP15 in Montreal, Canada. (Credit: SPREP)

Outreach & Engagement

International

- Fourteen of the 22 PICTs were represented at the 2022 PESC in Palau, along with eight high-level delegations from PICTs and international partners such as the United States, Australia, and Taiwan. The PESC was covered extensively in the media, with posts from Al Jazeera, the Pacific Island Times, the Sāmoa Observer, SCOOP, and the East-West Center, among others. Highlights were also featured in a [blog](#) on the Pacific RISA website. Final Outcome Statements and Strategic Action Plans from the conference were incorporated into high-level international negotiations at UNFCCC COP27 in Sharm El-Sheikh, Egypt by SPREP Director-General Sefanaia Nawadra on behalf of the PICTs. Meanwhile, at the 25th Micronesia Islands Forum (MIF) held in February 2023, PI Brewington provided briefing materials to the Micronesia Regional Invasive Species Council—one of the two official groups at the Forum—summarizing outcomes and priority next steps for Micronesia. The leaders endorsed all recommendations by the Regional Invasive Species Council to fund and support PESC outcomes and Strategic Action Plans. The full text of the 25th MIF Communique can be found [here](#).
- Program Manager Gwen Sisior attended UNFCCC COP27 as part of the Palau Delegation following the Adaptation negotiations. Within the Adaptation negotiations were discussions on the Global

Goal on Adaptation, which looks at enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to impacts of climate change. Also significant were the discussions on National Adaptation Plans that many small island states (SIDS), including Palau, have struggled to develop. Ms. Sisior also attended the Convention on Biodiversity COP15 in Montreal, Canada (Image 10), where she engaged in discussions specifically on the guidance of the Global Environment Facility (GEF), the world's largest funder of biodiversity protection, nature restoration, and climate change response in developing countries, as finance is critical for SIDS to enable implementation of adaptation work.

Regional

- The development of the [2023 PIRCA report for the Federated States of Micronesia \(FSM\)](#) involved stakeholders across a wide range of sectors. Approximately 15 contributors from the FSM national government and research institutions were engaged in reviewing and editing or commenting on initial drafts of the assessment report. In July 2022, the PIRCA coordinating team held a virtual workshop specifically for FSM state governments and in-country NGO participants, who contributed their knowledge to the report's key focal areas, and relayed how they have experienced and dealt with climate-related impacts. Participants also specified areas where further research is needed. Meetings with FSM



Image 11: PI Brewington joined a panel of island sustainability experts moderated by Lieutenant Governor of Guam Josh Tenorio. Also pictured, left to right: Kate Brown (Executive Director of the Global Island Partnership), Bob Underwood (former University of Guam President and Guam Congressional Delegate), and Kristin Wilson-Grimes (Research Assistant Professor of Watershed Ecology at the University of the Virgin Islands). (Credit: Trina Leberer)



Image 12: Conference participants planted trees as part of watershed restoration efforts by the University of Guam GROW Initiative. (Credit: Laura Brewington)

Department of Environment, Climate Change and Emergency Management (DECEM) Assistant Secretary of Climate Change, Lucille Apis-Overhoff, along with her in-draft edits, enabled the report to reflect the status of national climate change action and priority needs for information and research.

- PI Grecni also presented on the PIRCA process by invitation at the FSM Joint Risk Management Network Meeting in January 2023. Members of the network in attendance included representatives from DECEM, Pohnpei Department of Education, Micronesian Red Cross Society, FSM Department of Public Safety, FSM Department of Health and Human Services–Disability Program, Conservation Society of Pohnpei, Madolenihmw Municipal Government, USAID, and other development partners.
- PI Shuler led a *Stream Gauging, Climate Monitoring, and Precipitation Isotope Collection* workshop in American Sāmoa in August 2022 where he discussed and engaged in co-production of sea level rise-driven groundwater inundation maps with the American Sāmoa Power Authority (ASPA) staff. All census tracts in American Sāmoa are designated as disadvantaged by the CEJST tool, and thus

all work in the territory is co-produced with and benefits disadvantaged communities.

- In April 2023, PI Brewington attended the 14th University of Guam Conference on Island Sustainability, which asked participants to “*Rediscover the Depths of Our Island Abundance*.” She joined three notable island experts in a panel moderated by Lieutenant Governor of Guam Josh Tenorio to discuss sustainable alliances across oceans and share examples of action being taken to build more resilient island communities (Image 11). Conference attendees also had the chance to learn more about Guam’s southern ecosystems from the Guam Restoration of Watersheds (GROW) Initiative (Image 12), which is conducting essential conservation work to build climate resilience by protecting the island’s drinking water and coral reefs, and is in line with the Guam Green Growth Action Framework for sustainability.

State

- In January 2023, the Pacific RISA, the State of Hawai’i Climate Change Mitigation and Adaptation Commission, the University of Hawai’i Sea Grant Program, and the PI-CASC co-organized, sponsored, and participated in the first Hawai’i Climate Week 2023: Partnerships, Science, and

Policy to Build a Climate-Ready Hawai'i, which was inspired by the Hawai'i State Climate Conference that the Pacific RISA team has co-organized since 2019. Events for the week included State Climate Action Day, a Youth Climate Summit (see *New Focus Areas/Partnerships*), an Adaptation Science Summit, the Hawai'i County Planners Peer-to-Peer Exchange, a Pacific Island Women Leaders at COP27 Discussion, and an Energy Policy Forum. Hawai'i Climate Week demonstrates the cooperation and partnership between community, government, NGOs, and universities that is essential to addressing different aspects of the climate crisis and implement solutions. At the conference, Hawai'i Governor Josh Green pledged to dedi-

cate \$100 million of the state's \$1.9 billion budget surplus to address climate change, and voiced his support for the Hawai'i Green Fee.

- The Peer Exchange project has a major component focused on engagement with Kaua'i County as it continues to complete its first island-wide Climate Action Plan. In the lead-up to the All-County Peer Exchange, PIs Keener and Grecni held several meetings with the Kaua'i County Planning Department to set objectives and co-develop the agenda for the exchange, held in January 2023. Also, during the exchange, PI Grecni facilitated a guided discussion to begin scoping the Hawai'i Adaptation Implementation Assessment and identifying gaps and bottlenecks in county climate planning.

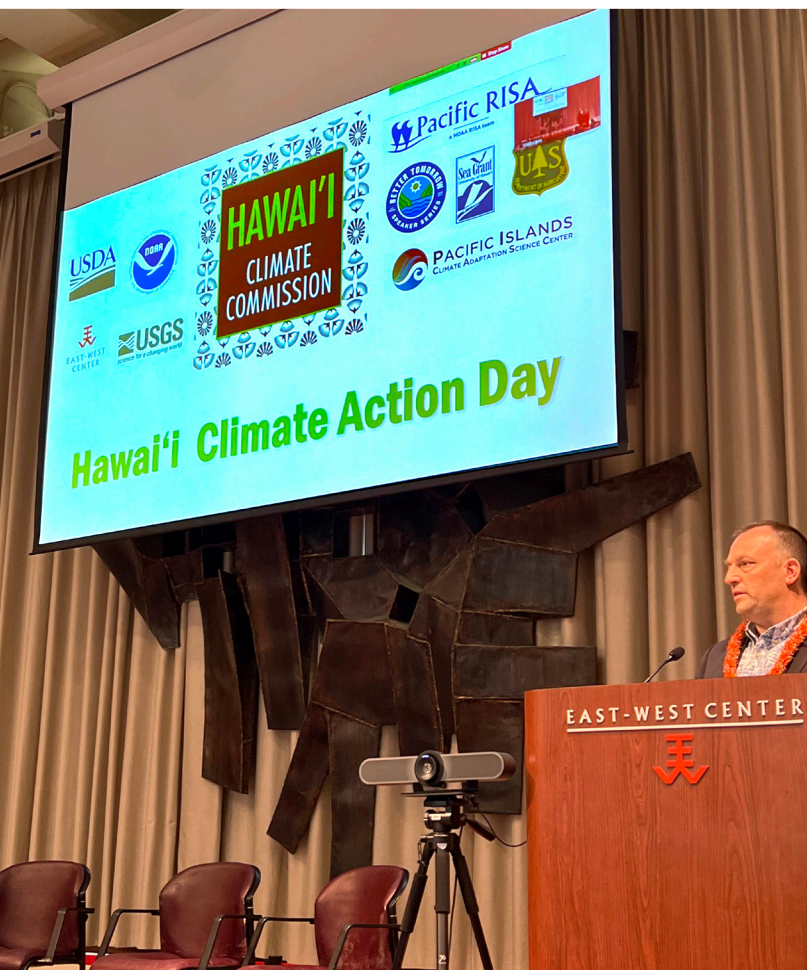


Image 13: Governor Josh Green announces his pledge to address climate change in Hawai'i. (Credit: Krista Jaspers)



Image 14: Pacific RISA's Chelsey Bryson, PI Keener, PI Grecni, Krista Jaspers, & PI Brewington at Hawai'i Climate Week. (Credit: Krista Jaspers)



Image 15: Participants at the Hawai'i County Planners Peer-to-Peer Exchange (Credit: Krista Jaspers)

Challenges

- All Pacific RISA Core Team members have taken on various aspects of program management in the absence of a full-time Program Manager for much of the past two years. To alleviate some of this burden, the team will soon hire for a new joint Hawai'i/Pacific program administrative position with the ASU Global Partnerships program, in collaboration with Pacific RISA Advisory Committee member and ASU GIOSI Asia-Pacific Executive Director, Amanda Ellis.
- Due to the ongoing COVID19 pandemic, both the RMI and FSM were closed to travel with only limited repatriation flights for the first quarter of the reporting period. The FSM lifted travel restrictions beginning in August 2022. Travel costs increased significantly while flight options decreased as compared with pre-pandemic times. PI Grecni and the PIRCA team continued to face challenges, therefore, in co-producing assessments for the FSM and RMI. However, assessment development processes gained momentum in recent months with travel now possible and productive virtual engagement efforts continuing.

- PI Widlansky faced logistical challenges related to limited flight schedules in the region, which delayed planned field work in Palau. The rescheduled field trip will occur in June 2023.
- PI Giambelluca faced delays on the development of a Climate Extreme Index time series for the Hawaiian Islands due to a reduced allocable effort/time for University at Albany collaborator Dr. Oliver Ellison Timm. Training for a student working with Python to analyze statistical data and generate maps and visualizations was slowed, resulting in fewer than expected meteorological maps and plots for analysis.

Next Steps

- PI Giambelluca and team will begin collaborating with the Hanalei Initiative to form on-the-ground connections with non-scientists that may be interested in an index time series for extreme events and future rainfall scenarios. There is an opportunity for two-way communication in which we can learn about local experiences with past rainfall extremes and gain insight about how to adjust our workflow to receive timely input of ideas and cri-

tiques from community members. The team would like to collaborate with the community to develop new procedures that could make research and products most usable to residents of Kaua'i.

- Following a positive outcome in funding for the cross-RISA proposal, PI Shuler's team will continue building on the Kaua'i flood work and to expand the scope of modeling to communities on the Island of O'ahu and State of North Carolina with the C3HE CAP/RISA team.
- The peer-to-peer exchange process has been successful in accelerating the uptake and use of climate information in policy-making in Hawai'i, and has the potential to accomplish similar climate adaptation planning and policy goals in other Pacific Islands, utilizing what has already been learned in the county exchanges and building peer-networks across the region. The near-term goals of the peer-to-peer exchange project that has been pioneered between the Counties of Kaua'i and Honolulu are to expand the exchange processes (1) outside of Hawai'i and between jurisdictions, and (2) advance the county/state climate information integration schematic resulting from the all-county planning exchange during Hawai'i Climate Week.
- The priority for PI Widlansky's project to track sea level impacts in Palau during the next year will be a planned field trip in June 2023. During this field trip, UHSLC technicians will meet with local stakeholders and survey local points of interest that are vulnerable to high sea levels.
- The FSM PIRCA report was developed in collaboration with partners from the PIRCA network and was released in July 2023. A PIRCA report for the

RMI was further developed through collaboration with and input from Kwajalein Atoll government and NGO representatives (release date TBA). These reports are highly anticipated by stakeholders, many of whom are also report contributors.

- In 2023, PI Brewington was appointed to the US Invasive Species Advisory Committee (ISAC), a two-year appointment that will advise the National Invasive Species Council (NISC) and member federal agencies on invasive species priorities. Over the next two years, ISAC will provide the conceptual frameworks for policy and action on the key topics of climate change, island biosecurity, underserved communities, early detection/rapid response, and promoting the Blue Economy. With PI Brewington's appointment to the ISAC, the committee will be able to elevate the many challenges islands face in preparing for and responding to invasive species impacts, while building climate resilience in communities that have been historically underserved by the US federal government.
- With continued momentum from the PESC, PI Brewington collaborated with SPC, Australia's Commonwealth Industrial and Scientific Organisation, and Australia's Queensland Department of Agriculture and Fisheries to submit an Expression of Interest proposal to the German government's International Climate Initiative (IKI). Titled "*Advancing biosecurity and management of invasive species to build climate resilience in the Pacific*", the proposed €17.4mn program will support strategic actions identified during the PESC to build climate resilience in Fiji, FSM, Palau, and Papua New Guinea.

Impact Evaluation

The annual evaluation conducted by Pacific RISA's external evaluator Dr. Susi Moser assessed how the ongoing PIRCA process is evolving and responding to expressed stakeholder needs. It used longitudinal evaluation that began over a decade ago to illustrate the need, development, and benefit of creating and sustaining a nuanced, collaborative, and deliberately inclusive climate assessment effort among researchers and practitioners in Hawai'i and the US-Affiliated Pacific Islands.

In this project year, the Pacific RISA program held two meetings to discuss and integrate equity and justice metrics into annual program and project evaluations. In the first, we discussed findings from a set of journal articles and reports and brainstormed applicability to our program. Next, Dr. Moser led us through an exercise that mapped equity metrics to our programmatic theory of impact, resulting in a set of metrics that will better capture equity in climate adaptation work within the Pacific RISA and the Pacific Islands region. Dr. Moser is currently engaging small groups

of research teams on a project-by-project basis, which will ultimately be analyzed and shared with Pacific RISA leadership. The next steps will be synthesizing what was learned in a report including recommendations to the team, followed by a team meeting in which findings and recommendations on approach to working and tracking equity dimensions of the Pacific RISA's work will be implemented.

Societal Impact

PESC Outcomes

The inaugural PESC in Palau produced Pacific-wide, fully vetted, scientifically-based Strategic Action Plans that address critical invasive species issues that erode the region's resilience to climate change. The impacts of the meeting and its outcomes are far reaching and ongoing: stakeholders and end users include all 22 Pacific Island Countries and Territories (PICTs), Ministries of Environment, Fisheries, Agriculture, and Trade/Finance, natural resource managers, land and marine resource planning agencies, the scientific research community, and funding entities. Below are several testimonials about the PESC from attendees and representatives of various Ministries and multilateral organizations within the region:

"It's important to recognize the vulnerabilities of our region and how invasive species exacerbate existing issues. For example, the Pacific is at the frontline of the climate crisis, and invasive species only further undermine the resilience of our ecosystems. Now more than ever, addressing invasive species should be at the forefront of our priorities and this meeting was a positive step forward to jointly ensure there is a strong regional coordinated approach to these critical threats." Gibson Susumu, Programme Lead for Sustainable Agriculture, SPC

"At this meeting, we have the opportunity to hear North Pacific stories. There are issues and work that we, in the South, may not be aware of and this meeting helped fill in the gaps and identify areas to work together for a truly regional approach to address invasive species. This also reinforces the need and the ongoing effort for CROP agencies to coordinate and build on their collaborative work." Sefanaia Nawadra, Director-General, SPREP

"Invasive species threaten our food systems through degradation, threaten our food security, economies, and our environment, so finding solutions should be a priority! Commitments and partnerships strengthen the response to invasive species. Our response towards preventing and mitigating invasive species should be actionable both locally and at a regional scale." Minister Steven Victor, Palau Ministry of Fisheries, Agriculture, and Environment

Immediately after the PESC, Resolution 39-GA-15 was passed at the Association of Pacific Island Legislatures (APIL) meeting in the FSM, which endorsed and supported invasive species management, control, and eradication in Micronesia. PI Brewington subsequently initiated the hiring of an invasive species and climate change research coordinator, in partnership with and housed within the Micronesia Conservation Trust (MCT). The creation of this position will promote equitable representation of Micronesian jurisdictions within the invasive species and climate research space, which is currently dominated by efforts from the State of Hawai'i. It also directly responds to needs that were identified during the PESC and meets the goals set out under Pacific RISA's Phase IV International Capacity Building Activities. Research conducted under this initiative will be used to refine the goals/objectives, targets and milestone for the invasive species and climate components of the Micronesia Challenge.

Owing to the momentum from the PESC, several other regional workshops have been or will be held in 2023: In May 2023, the US Office of Insular Affairs hosted its second annual Territorial Climate and Infrastructure Workshop in Honolulu with representatives from all US insular territories and the federal agencies charged with providing funding opportunities under the Bipartisan Infrastructure Law and the Inflation Reduction Act. Dedicated sessions were held on how invasive species pose threats to island infrastructure and climate resilience. PI Brewington is also collaborating with US INDOPACOM to organize a July 2023 Invasive Species Forum conference in Guam that will build off of the PESC and focus on research and development needs, and the State of Hawai'i is holding a workshop on Little Fire Ant in late 2023 to address state-level priorities that were outlined in the PESC Strategic Action Plan for invasive ants.

Design, Adaptation Planning, and Policy Impacts

- PI Shuler and his team improved and maintained weather station and stream gauging assets, including physical infrastructure and managed data in American Sāmoa. These products are both financially supported and used by operational and engineering staff at the territory's only water and power utility. Engineering staff at ASPA have used the rainfall, wind, and solar radiation data as design parameters in infrastructure projects, and operations staff have used the data for assessment of water shortages and future climate planning.
- The PIRCA reports continue to be referenced in the development of legislation in the region: Palau's National Office of Climate Change is using the Palau PIRCA report as the scientific basis for a current update to their national Climate Change Policy. Pacific SIDS delegations are using the PIRCA reports in climate change negotiations under the UNFCCC. Palau delegates to the UN reported referring to the PIRCA products in negotiations to quickly pull facts and data to support their block's positions. In Hawai'i, The City and County of Honolulu Climate Change Commission looked to the format of the PIRCA reports for inspiration in developing their 2023 Climate Change Brief.
- As a US-Affiliated Pacific Island nation, the FSM is marginalized in national policymaking and has limited access to resources. Citizens of the FSM do not have access to the same benefits as do citizens of US states and territories, and the FSM lacks the quantity and quality of climate information and data that is available to the United States for use in planning. The PIRCA report for FSM (July 2023) will provide data visualizations for historical climate and synthesize information on risks in key sectors, helping to fill those gaps. Building of knowledge power for the public and decision-makers in the FSM is a key benefit from the assessment co-production process.
- Kaua'i Mayor Derek Kawakami signed legislation in October 2022 that made Kaua'i one of the first counties in the nation to regulate construction based on the future sea level rise impacts of passive flooding and annual high-wave run up. This legislation built on knowledge and relationships from the peer-to-peer exchange led by the Pacific RISA with the City of Boston in 2021, which focused on the development of Boston's sea level rise zoning overlay district.
- Much of the focus of Pacific RISA projects on Kaua'i is around the North Kaua'i/Hanalei area, which is a rural area disproportionately impacted by extreme rainfall and flooding over the last several years. PI Shuler's North Kaua'i modeling

project is producing actionable climate-related hazards information for the underserved community within Wainiha, Hawai‘i. PI Oleson’s natural capital project also plans to partner with community organizations within disadvantaged areas. By co-producing climate knowledge and products with Kaua‘i County Planners, the Pacific RISA is improving partners’ understanding of science and knowledge related to hydrology, climate, and adaptation options.

- In June 2022, PIs Keener, Brewington, Grecni, Shuler, Oleson, and Giambelluca submitted written testimony with technical information supporting aquifer designation in West Maui. PIs Keener and Giambelluca offered additional oral testimony to answer the Commission’s questions. After hearing hours of testimony, the Commission on Water Resource Management (CWRM) unanimously voted to designate the entire aquifer as both a Surface Water and Groundwater Management Area, effectively the first time that projections of future climate have been used to proactively protect freshwater resources in the state.
- The Pacific RISA was cited in [Hawai‘i State Bill SB1588 SD2](#) relating to food safety, in which the

legislature concluded that Hawai‘i is the most geographically isolated state in the country and imports approximately ninety-two percent of its food. Each food product imported to Hawai‘i is a lost opportunity for building economic growth in the local agricultural sector, increasing resiliency in the face of future supply chain disruptions, and attaining state goals for local food production, including benchmarks for Hawai‘i’s farm-to-school program, food purchasing by state agencies, and food hubs.

Sustained Assessment Specialist

Sustained Assessment Specialist PI Grecni coordinates the PIRCA network and has led the development of climate change science and adaptation assessments for the FSM and the RMI (reports are under final development or in press; see *Outreach & Engagement and Societal Impact*). PIs Grecni and Keener also contributed new scholarship that improves understanding of the impact of regional climate assessments through a peer reviewed article published in June 2022.

PI Grecni’s activities have integrated closely with the work of others across the Pacific RISA team,

Image 16: During the NCA5 All-Author Meeting, the cross-CAP/RISA Sustained Assessment Network met in-person for the first time. Members attending were from the Southern Climate Impacts Planning Program (SCIPP, Darrian Bertrand), Pacific RISA (PI Grecni), the Caribbean Climate Adaptation Network (CCAN, Wanda Crespo-Acevedo), and Alaska Center for Climate Assessment and Policy (ACCAP, Danielle Meeker). (Credit: Mark Shafer, SCIPP)



including through new partnerships to expand Pacific RISA's activities and link to other regions. For example, PI Grecni partnered with PI Shuler and Widlansky and the C3HE team to expand flood modeling to communities on the Island of O'ahu and the State of North Carolina. PI Grecni helped shape and coordinate the Hawai'i County Planners Peer-to-Peer Exchange, with plans to support the expansion of this successful peer exchange model by offering it to USAPI partners within the PIRCA network.

PI Grecni is a chapter author for the Hawai'i and Pacific Islands regional chapter of NCA5. With her expertise in regional climate assessment, PI Grecni made unique contributions to the chapter which has integrated knowledge synthesized through the

PIRCA reports and engagement processes into the chapter key messages, narrative, and key figures. She took the lead in developing three figures for the chapter, and meaningfully contributed to two others, all illustrating regional key messages about climate risks and impacts, challenges, and adaptation options. PI Grecni attended author meetings, including the NCA5 All Authors Meeting in April 2023, and liaised with authors from other chapters in the assessment, especially those on physical climate science and the Caribbean region. Since fall 2022, PI Grecni has coordinated meetings between the NOAA CAP/RISA Sustained Assessment network (comprising eight members from CAP/RISA regions) and the USGCRP NCA5 leadership to brainstorm and coordinate around public engagement pre- and post-release.



As sea level rise accelerates, flooding will continue to negatively impact infrastructure in Palau, seen here, and across the Pacific Islands. (Credit: Lighting Strike Pro/Adobe Stock)

Publications

[Andreozzi, P., Quitugua, R., Ero, M., & Brewington, L.] Pacific Ecological Security Conference. (2022). Strategic Action Plan for Coconut Rhinoceros Beetle. Pacific Ecological Security Conference (PESC), Koror, Palau: Zenodo. <https://doi.org/10.5281/zenodo.7683206>.

Brewington, L., Eichelberger, B., Reed, N., Parsons, E., Kerkering, H., Martin, C., Miles, W., Idechong, J., & Burgett, J. (2023). Pacific Island perspectives on invasive species and climate change. In S.J. Walsh, C.F. Mena, J.R. Stewart, J.P. Muñoz Pérez (Eds): Island Ecosystems. Social and Ecological Interactions in the Galapagos Islands. Cham: Springer, pp. 59–78. https://link.springer.com/chapter/10.1007/978-3-031-28089-4_5.

[Day, M., Martin, C., Brewington, L.] Pacific Ecological Security Conference. (2022). Pacific Biocontrol Strategic Action Plan. Pacific Ecological Security Conference (PESC), Koror, Palau: Zenodo. <https://doi.org/10.5281/zenodo.7683179>.

Dusek, G., Sweet, W. V., Widlansky, M. J., Thompson, P. R., & Marra, J. J. (2022) A novel statistical approach to predict seasonal high tide flooding. *Frontiers in Marine Science*, 9: 1073792. <https://doi.org/10.3389/fmars.2022.1073792>.

Fandrich, K. M., Elison Timm, O., Zhang, C., & Giambelluca, T. (2022). Dynamical downscaling of near-term (2026-2035) climate variability and change for the main Hawaiian Islands. *Journal of Geophysical Research Atmospheres*, 127(2). <https://doi.org/10.1029/2021JD035684>.

Frazier, A.G., Giardina, C.P., Giambelluca, T.W., Brewington, L., Chen, Y-L., Chu, P-S., Fortini, L.B., Hall, D., Helweg, D.A., Keener, V.W., Longman, R.J., Lucas, M.P., Mair, A., Oki, D.S., Reyes, J.J., Yelenik, S.G., & Trauernicht, C. (2022). A century of spatial and temporal patterns of drought in Hawai'i across hydrological, ecological, and socioeconomic scales. *Sustainability*, 14(19): 12023. <https://doi.org/10.3390/su141912023>.

Grecni, Z., Bryson, C., & Chugen, E. (2023). Climate Change in the Federated States of Micronesia: Indicators and Considerations for Key Sectors. Report for the Pacific Islands Regional Climate Assessment. Honolulu, HI: East-West Center. <https://eastwestcenter.org/PIRCA-FSM>.

[Hoffmann, B., Boudjelas, S., Montgomery, M., & Brewington, L.] Pacific Ecological Security Conference. (2022). Biosecurity Plan for Invasive Ants in the Pacific. Pacific Ecological Security Conference (PESC), Koror, Palau: Zenodo. <https://doi.org/10.5281/zenodo.7683199>.

Keener, V. W., Grecni, Z. N., & Moser, S. C. (2022). Accelerating climate change adaptive capacity through regional sustained assessment and evaluation in Hawai'i and the U.S. Affiliated Pacific Islands. *Frontiers in Climate*, 4. <https://doi.org/10.3389/fclim.2022.869760>.

[Keener, V., Islam, M., Alegado, R., Coffman, M., & Fletcher, C.] City and County of Honolulu Climate Change Commission, (Adopted: July 29, 2022). Reducing Greenhouse Gas Emissions from Building Operations Guidance.

Krzesni, D. & Brewington, L. (2022). What do climate impacts, health, and migration reveal about vulnerability and adaptation in the Republic of the Marshall Islands? *Climate Action*, 1(22). <https://doi.org/10.1007/s44168-022-00023-4>.

Mezzacapo, M., & Shuler C. K. (2022). 2022 Hawai'i Cesspool Hazard Assessment & Prioritization Tool – 2022 Update Report & Technical Appendices. Report to the State of Hawai'i Department of Health Wastewater Branch. WRRRC Special Report SR-2022-02. <https://health.hawaii.gov/wastewater/files/2022/11/prioritizationtoolreport.pdf>.

[Romine, B., Keener, V., Alegado, R., Islam, M., Otsuka, K.] City and County of Honolulu Climate Change Commission, (Adopted: March 31, 2023). Climate Change Brief 2023.

Widlansky, M. J., Long, X., Balmaseda, M.A., Spillman, C.M., Smith, G., Zuo, H., Yin, Y., Alves, O., & Kumar, A. (2023) Quantifying the benefits of altimetry assimilation in seasonal forecasts of the upper ocean. *Journal of Geophysical Research Oceans*, 128(5): e2022JC019342. <https://doi.org/10.1029/2022JC019342>.

