# PI-CSC Student Research Symposium Abstracts

## Understanding changes in hydrology and primary productivity within three Hawaiian fishponds in Keaukaha, Hawai‘i.

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**Abstract:** Groundwater springs are fundamental in providing nutrients to coastal environments, yet are difficult systems to understand due to their complex interactions with hydrogeologic, oceanographic, and climatologic processes. In Hawai‘i groundwater plays a significant role in loko i‘a (Hawaiian fishponds) function and sustainability. Therefore, understanding the interactions between groundwater and seawater in loko i‘a environments is important. Keaukaha, HI, located on the east side of Moku o Keawe (Hawaii Island) is a stretch of coastline encompassing three loko i‘a that are undergoing restoration, creating invaluable estuarine habitats. To ensure sustainable restoration and productivity, fishpond managers need methodologies to quantify the variability of environmental changes through time and specific impacts of climate change, such as changes in rainfall and sea level. These factors will alter the hydrology of the loko i‘a, changing nutrient inputs and primary productivity. In collaboration with loko i‘a practitioners, coastal resource managers, Keaukaha community members, and University of Hawai‘i scientists, the objectives of this project are to: 1) examine relative groundwater flow within three loko i‘a; 2) quantify the spatial and temporal variability of chemical composition of major groundwater springs along the Keaukaha coastline, including in the loko i‘a; 3) identify the abundance of benthic primary productivity at varying salinities within the loko i‘a; 4) develop a model to predict changes in relative groundwater flow and chemical composition within loko i‘a based on various predicted climate change scenarios; and 5) understand various people’s perspectives on wai (freshwater) to develop a platform where different ways of knowing can be compiled and shared.

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## Groundwater percolation in northern Guam: Insights from Jinapsan Cave

Kaylyn Bautista; Water and Environmental Research Institute (WERI), Univ. of Guam
Co-Author/PI: John Jenson, Professor of Environmental Geology, WERI, Univ. of Guam

**Abstract:** Jinapsan Cave, on the Guam National Wildlife Refuge at the northern tip of the island, serves as an underground observatory of groundwater percolation. Research drawn from eight years of monthly observations and sampling of dripwaters in this cave have been consolidated into time-series data on drip rates and their correlations with storms and seasonal changes in rainfall, and their relationship to bedrock geology. The layout and geology of the cave, hydro-geological features of the bedrock as seen in the cave, the time-series, and statistical analyses of observed dripwater rates will be described. What these may tell us about the plumbing of the percolation routes will be of interest to everyone who would like to have a more thorough and precise understanding of the processes by which rainwater--and thus, potentially, some surface contaminants that could be carried by it--percolate through the 200- to 500-ft-thick section of limestone bedrock that stands above the freshwater lens in Guam's major aquifer.

**Presentation slides**

## Kilo Lani: Reconstructing climate patterns in Hawai‘i

Kilika Bennett; Kawaihuelani School of Hawaiian Language, Univ. of Hawai‘i at Mānoa
Co-Author/PI: Rosie Alegado; Asst. Researcher, Hawai‘i Sea Grant College Program, Univ. of Hawai‘i at Mānoa

**Abstract:** Understanding the forces shaping natural inter-annual rainfall variability is crucial to long-range resource planning and management. The El Niño Southern Oscillation (ENSO) is a long-term climate pattern that influences inter-annual rainfall. Assessing ENSO impacts in Hawai'i is hampered by the inherently unpredictable nature of high and low ENSO activity in the Pacific, deriving from limitations in the instrument record, which began in the 1880s. The repository of historical Hawaiian language materials is an invaluable cache of cultural and historical knowledge spanning multiple centuries, yet remains inaccessible to most audiences. We developed "fingerprints" of local climatological parameters correlating with potential pre-1880 ENSO events. Next, we performed targeted queries of the Hawaiian language newspapers to identify additional non-climate indicators of ENSO, specifically fish recruitment. Utilizing the Hawaiian language repository may inform current climate models and also enable a broader understanding of the societal effects climate events may have on Hawaiian society.

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## Developing resilience for small businesses affected by climate change

Phillip Cruz; School of Business &Public Administration

**Abstract:** Climate change is affecting societies and economies around the world. Small businesses are uniquely impacted due to their limited available resources. Research questions for this project include: 1. Are small business owners in Guam concerned with climate change? 2. Do they have contingency plans in the event of flooding, severe weather, lack of imports due to severe weather, etc. and 3.What steps can they take to be more resilient to climate change? I seek to answer these questions using research, surveys, interviews, and focus groups. Additionally, the results for this project will provide the foundation for an awareness campaign for small businesses in Guam about how climate change can affect their business and steps they can take to be more resilient.

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## Planning for sea level rise: Increasing rural O‘ahu coastal community resilience by addressing on-site wastewater management

Theresa Dean; Department of Urban and Regional Planning, Univ. of Hawai‘i at Mānoa
Co-author/PI: Daniele Spirandelli; Asst. Professor of Coastal Policy & Community Development, Univ. of Hawai‘i at Mānoa

**Abstract:** The goal of this research is to examine the current laws and policies that manage on-site wastewater systems and evaluate how these regulations could be adapted to make wastewater systems more resilient to climate change stressors. On O‘ahu, a large number of on-site sewage disposal systems (OSDS) are located close to the shoreline, which is problematic with the advent of sea level rise. Regulatory agencies at different levels are responsible for permitting on-site systems, establishing watershed scale land use plans, and monitoring and mitigating nonpoint source pollution. This research seeks to answer whether coordination between individual site assessments and watershed scale land use plans are required in order to ensure that these systems are managed properly. An evaluation of land use implications of future OSDS site suitability and a policy gap analysis will be conducted to understand how coordinating land use planning and infrastructure regulation can increase the resilience of on-site wastewater management.

**Presentation slides**

## Econometric modeling of the maximum sustainable yield of the Pearl Harbor aquifer

Nathan DeMaagd; Economics Department, Univ. of Hawai‘i at Mānoa
Co-Author/PI: Michael J. Roberts; Assoc. Professor of Economics, Univ. of Hawai‘i at Mānoa

**Abstract:** Determining the quantity of fresh water that can be drawn from O‘ahu’s aquifers is of crucial importance for the sustainable management of our water system. Of particular interest is the maximum sustainable yield (MSY) of the aquifers, or the maximum possible consumption rate that does not deplete the aquifer. Previous literature on the topic uses geological composition and water flow models in order to estimate an aquifer’s MSY. Although these efforts have aided geologists in their understandings of the aquifer systems of Hawai‘i, the complexity of the models make them somewhat cumbersome. This study instead applies a resource economics approach, borrowing concepts such as resource stock and growth. Using an econometric model that incorporates available pumping and aquifer head level data, we suggest a means to estimate the MSY of the Pearl Harbor aquifer in a simpler manner without a need to rely on geological models.

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## Rainfall driven shifts in *Staphylococcus aureus* in Hilo Bay, Hawai‘i

Louise Economy; Tropical Conservation Biology and Environmental Sciences Program, University of Hawai‘i at Hilo
Co-author/PI: Tracy Wiegner; Assoc. Professor of Marine Sciences, Univ. of Hawai‘i at Hilo

**Abstract:** *Staphylococcus aureus* is a human pathogen that may persist in watersheds and be transported from the landscape to coastal waters following rainfall. Therefore, the concentrations of these bacteria in the coastal ocean may be impacted by anticipated climatic changes, including shifting rainfall and stream flow patterns. To assess such fluctuations, a study was conducted in Hilo Bay, Hawai‘i. Analyses of *S. aureus* and fecal indicator bacteria (FIB) concentrations were conducted. Significant positive correlations were observed between *S. aureus* and rainfall, as well as with stream flow. Significant positive correlations were also found between *S. aureus* and FIB during high rainfall, but not low rainfall conditions. A predictive model of *S. aureus* loading to coastal waters with rainfall/stream flow changes will be created for land managers and public health agencies. Additionally, data will be disseminated to local communities, informing water users of *S. aureus* infection risks related to climate change.

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## Culturally relevant educational resources and lesson plans on climate science in Guam

Cassandra Flores-Hughes; Department of Geography, Univ. of Guam
Co-author/PI: Romina King, Asst. Professor of Geography, Univ. of Guam

**Abstract:** This research strives to unearth educational resources for individuals who seek knowledge on climate science which is culturally relevant to Guam. Locally produced and authored educational resources and lesson plans on climate science in Guahan are available, yet not always easily accessible in a central database. Efforts to acquire and utilize such resources, integrated with eleventh and twelfth grade Common Core State Standards, Next Generation Science Standards, and Guam Teaching Professional Standards, are crucial for all educators, students, and individuals to learn about climate science through a Pacific lens.

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## Simulations of groundwater inundation induced by sea-level rise and high tides reveal widespread flooding in the Waikiki area on O‘ahu, Hawai‘i

Shellie Habel; Geology & Geophysics Department, Univ. of Hawai‘i at Mānoa
Co-author/PI: Charles H. Fletcher; Professor of Geology & Geophysics, Univ. of Hawai‘i at Mānoa

**Abstract:** According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), global mean sea level is expected to rise by as much as 0.98 m by the year 2100. However, global ice loss is currently exceeding researchers' expectations, indicating that rates of sea-level rise (SLR) will surpass IPCC projections. Hydraulic connectivity between the ocean and coastal groundwater, in conjunction with SLR, will produce flooding in low-lying areas regardless of surficial connection to the coastline as groundwater levels progressively breach the land surface. Such flooding will be exacerbated during spring-tide stages and diminished during neap-tide stages. Here, we describe a modeling approach that simulates narrowing of unsaturated space and flooding generated by SLR-induced lifting of coastal groundwater. The methodology combines terrain modeling, groundwater monitoring, estimation of tidal influence, and numerical groundwater-flow modeling to simulate future flood scenarios considering user-specified tide stages and magnitudes of SLR. We apply the methodology to the Waikiki area of Honolulu, Hawai‘i and find that SLR of nearly 1 m generates groundwater inundation across 23% of the 13 $km^2$ study area, threatening $5 billion of taxable real estate and 48 km of roadway.

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## Shoreline change analysis at three different coastal geomorphologies on Hawai‘i Island

Rose Hart; Tropical Conservation Biology and Environmental Sciences Program, Univ. of Hawai‘i at Hilo
Co-Author/PI: Ryan Perroy; Asst. Professor of Geography and Environmental Science, Univ. of Hawai‘i at Hilo

**Abstract:** Hawai'i Island, one of the most diverse and volcanically active islands in the world, is in a weak position for adapting to the potential impacts of sea-level rise (SLR) and coastal erosion due to a lack of comprehensive shoreline studies. This two-year project seeks to quantify historic and current coastal erosion rates for selected priority areas on Hawai‘i Island to better predict and manage changes due to SLR. Existing shoreline records, including historic aerial photographs and LIDAR coastal surveys, in combination with new imagery and three-dimensional datasets collected from unmanned aerial systems and other survey platforms will allow us to determine past and current shoreline change rates. These data will then be merged with SLR projections and other geospatial layers to estimate future impacts to coastal communities and natural and cultural resources. The priority areas of this study represent a variety of coastal environments at different stages of development, including sea cliffs (Hamakua Coast), low-lying and subsiding coastal lava fields (Kapoho Tide Pools), and calcareous beaches (Hapuna Beach). Erosion rates and SLR projections will be incorporated into the county's GIS database and made available to the public through the statewide GIS system. These data will provide a visualization tool for communities and county workers to understand local impacts of SLR and consider necessary adaptations.

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## Can albizia mulch be used on agricultural land to replace fertilizer, improve agroecosystem functioning, and provide climate change mitigation and resilience?

Joanna Norton; Tropical Conservation Biology and Environmental Sciences Program, Univ. of Hawai‘i at Hilo
Co-author/PI: Rebecca Ostertag; Professor of Biology, Univ. of Hawai‘i at Hilo

**Abstract:** This project investigates the potential benefits of composted albizia (*Falcataria moluccana*) mulch applied to agricultural land in East Hawai‘i. Albizia is a fast-growing, nitrogen-fixing tree that is highly invasive in East Hawai‘i, and so this material is in abundant supply and in need of eradication. Application of mulch to cropland can supply key nutrients, replacing the need for some synthetic fertilizers. This addition of organic matter to the soil can also sequester carbon, modulate the release of other nutrients, and decrease water stress on plants. If this approach is found to be economically viable, climate change mitigation or resilience could be a by-product of agricultural production and invasive species removal. This experiment will be conducted with cassava and corn in a randomized block design of agricultural plots, and will analyze yields, plant tissue nutrients, and soil nutrients to assess performance of this alternative treatment compared to status quo fertilization.

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## Managing for local stressors critical to coral reef ecosystem health and goods and services delivery

Lindsay Veazey; Department of Biology, Univ. of Hawai‘i at Mānoa
Co-Author/PI: Kirsten Oleson; Department of Natural Resources and Environmental Management, Univ. of Hawai‘i at Mānoa

**Abstract:** Coral reefs provide critical ecosystem goods and services (EGS) but are threatened by environmental and anthropogenic pressures. Ecosystem models can simulate the impacts of local-scale versus global-scale stresses and their cumulative effects. By simulating a range of management and climate change scenarios, we evaluated the effectiveness of the local management approaches in mitigating coral reef decline. We adapted a regional-scale model for Maui Nui, Hawai‘i and applied two ecological production functions to quantify changes in EGS over time. Coral loss was more stymied under high effort sediment mitigation, but the effects of management were largely lost under climate change pressures. Climate change did not directly impact fish biomass but indirectly increased herbivore biomass due to the abundance of algae that occupied space opened up by coral die-offs. This work provides insight into the relative influence of land-based versus marine stresses and local versus global pressures as drivers of reef health.

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