Kilo Lani: Reconstructing historical climate patterns in Hawai‘i using traditional knowledge and dendrology

PI: Rosie Alegado, Assistant Researcher, Oceanography/Sea Grant Program, UH Mānoa
Collaborators: Axel Timmermann, Professor, Oceanography/IPRC; Puakea Nogelmeier, Professor, Kawaihu’elani Center for Hawaiian Language

Background

Understanding the forces that shape natural variability in rainfall from year to year can be vital for long-range water resources planning and management. One long-term climate pattern that can have significant impacts on inter-annual rainfall is the El Niño Southern Oscillation (ENSO). ENSO is a global climate mode characterized by variations in sea surface temperatures in the Eastern Tropical Pacific that modulates the magnitude of our local seasonal weather patterns and changes large-scale ocean currents and atmospheric circulation patterns. For Hawai‘i, El Niño events typically displace the subtropical jet stream, leading to decreased precipitation in the winter and slightly enhanced rainfall in summer. In addition to causing changes in rainfall, ENSO may alter the frequency of extreme events such as flooding and tropical cyclone/hurricane activity but these linkages are statistically less robust than for rainfall. We assert that having a detailed understanding of the relationship between the dominant Pacific climate modes (such as ENSO, the Pacific Decadal Oscillation and the North Pacific Gyre Oscillation) and Hawai‘i’s weather/climate and surrounding environment can inform policies on hazard resilience (PI-CSC Themes 2 and 3).

However, assessing the impact of ENSO and its potential secular changes on Hawai‘i is hampered by the fact that periods of high and low ENSO activity are inherently unpredictable in the Pacific. Our current inability to determine change in ENSO frequency, magnitude and duration derive from limitations in the reliability of our instrumental records, which extend back less than 150 years. Reconstructing multi-century paleo-climates derived from annual tree rings, ice cores, lake sediments and coral can extend the global observational record. Collectively, these proxies from diverse geographical locales reduce any biases or weakness in any individual proxy.

Project summary

Here we propose two complementary strategies to develop a deeper understanding of how climate modes affect regional climates in Hawai‘i: introducing additional historical observations through Hawaiian language newspapers, and developing climate indicators specific to Hawai‘i using introduced tree species. The proposed work crosscuts several PI-CSC themes including predicting, detecting and tracking climate-related change through traditional ecological knowledge (Theme 1 and 4), modeling regional rainfall in response to climate anomalies (Theme 2, objective 2) and providing a window into traditional management practices during extreme climate modes (Theme 4). This project brings together individuals with expertise in climate science and Hawaiian language to compile details from a variety of high spatial resolution indices (ex. temperature, rainfall, pressure) whose data span the Hawaiian Islands and correlate with ENSO and other modes of North Pacific climate variability.
Focusing on Hawaiian language newspapers presents an unparalleled opportunity to query an archive of indigenous knowledge for climate data and related topics. Over the years 1834 to 1949, Native Hawaiian intellectuals, political and religious leaders, historians, cultural specialists and everyday kānaka (people) filled the pages of nearly one hundred different newspapers with over 125,000 pages of testimony about their lives, their lands, their lāhui (nation) and their environment. Hawaiian language newspapers likely represent the richest holding of indigenous knowledge in the United States. We are bringing on a graduate assistant with expertise in Hawaiian language translation to aid in this effort.

In addition, we are using dendrochronology to independently build a robust, spatially-stratified climate archive of rainfall and primary productivity across Hawai‘i. Trees native to tropical regions usually do not produce tree rings. However, introduced conifers (e.g. Cook Island and Norfolk pines), which are broadly distributed across the state, have visible, annual rings which can provide evidence for floods, droughts, insect attacks, and even lightning strikes that occurred during the lifespan of the tree. Thus far we have sampled Big Island trees spanning a wide range of temperatures and elevations, from sea level to 2,000 m. We have also developed image-processing methods that can be applied to each tree ring in order to correlate the ring widths to instrument time series records.

![Fig. 1. Global Environmental Science undergrad Ryan Ueunten coring an introduced pine (Big Island).](image1)

![Fig. 2. Example of tree ring core.](image2)