

# Climate Change Issues of Hawaii



**Kyle Dittmer**

*Hydrologist – Meteorologist*

Columbia River Inter-Tribal Fish Commission  
Portland, Oregon, USA

*Professor – Earth Science*

PCC – Southeast Campus, Portland, Oregon

January 23, 2018 Oregon-AMS meeting



# Columbia River Inter-Tribal Fish Commission - CRITFC




# PURPOSE?

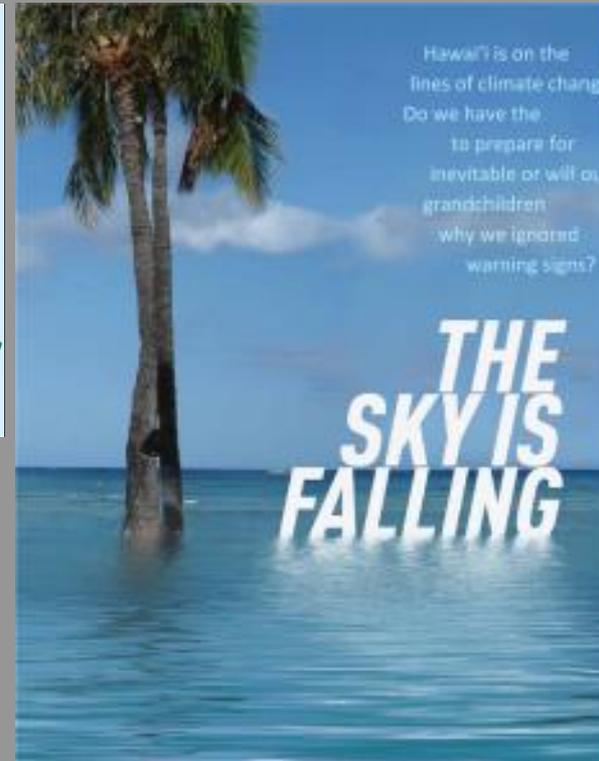
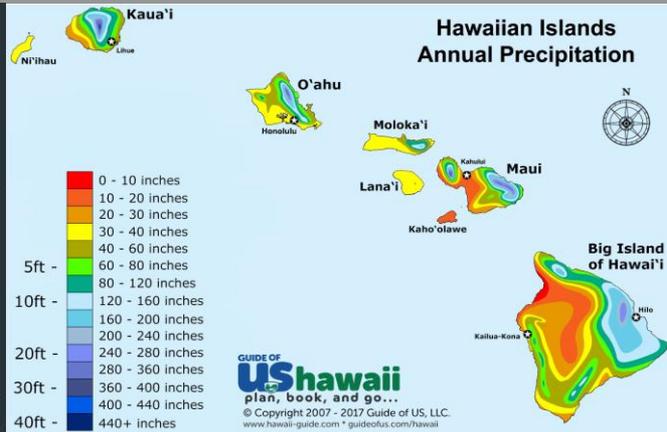


WHAT DO YOU HOPE TO LEARN TODAY?

#1 – Learn about the Climate Change issues of Hawaii.

#2 – Specific sectors: water, natural resources, society impacts.

#3 – Compare the issue-lists: Hawaii vs. the Pacific Northwest.



# COMPARE HAWAII vs. PNW



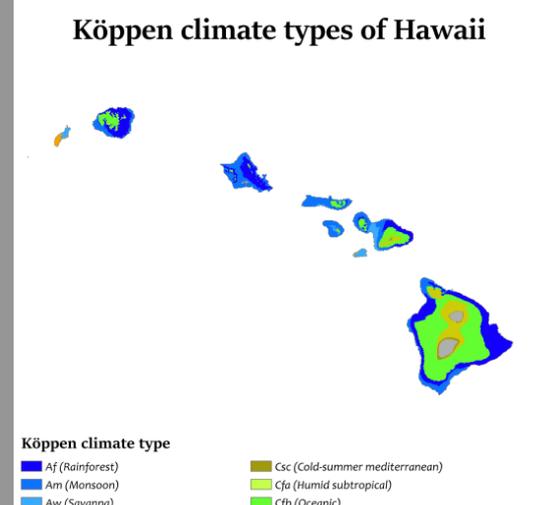
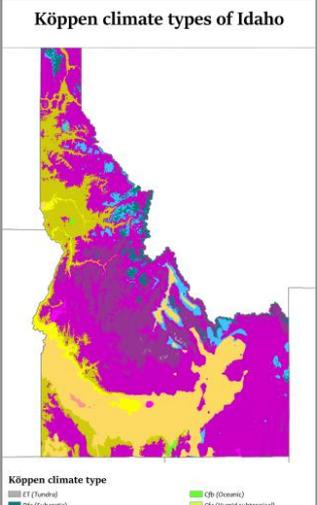
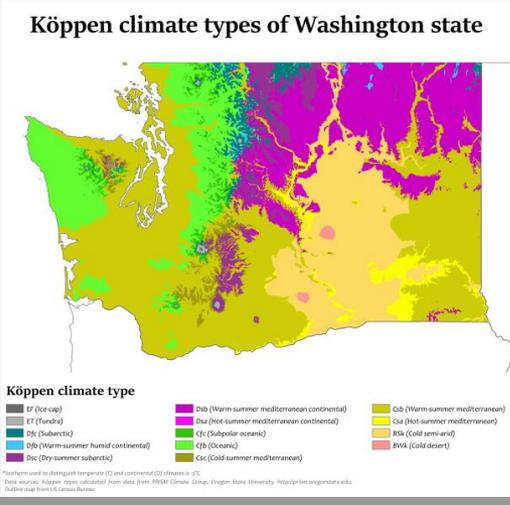
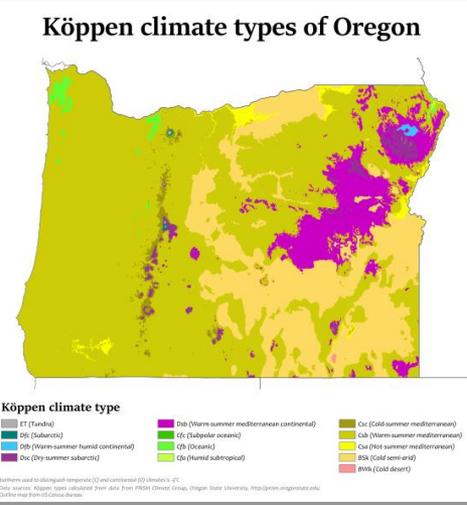
## HOW DOES EACH STATE DIFFER?

**OREGON:**  
 "Purple" (50/50%)  
 Valley/mountain  
 Ocean/cont. climate  
 Economy: Agri./fish,  
 Timber/wood,  
 Technology,  
 Tourism/recreation

**WASHINGTON:**  
 "Purple" (55/45%)  
 Valley/mountain  
 Ocean/cont. climate  
 Economy: Aircraft,  
 software, retail-StarB,  
 Costco, REI, Eddie B.;  
 Real Estate; Agriculture &  
 wine; Tourism/recreation

**IDAHO:**  
 "Red" (35/65%)  
 Valley/mountain  
 Continental climate  
 Economy: Sci.&Tech,  
 Timber/wood/paper,  
 Agriculture-potatoes,  
 Tourism/recreation

**HAWAII:**  
 "Blue" (60/40%)  
 Valley/mountain  
 Trop./arid/temp  
 climate (4-8 zones!)  
 Economy:  
 Tourism/recreation,  
 Military,  
 Agriculture/seeds



\*Isotherm used to separate temperate (C) and continental (D) climates is 3°C.  
 Data source: Köppen types calculated from data from PRISM Climate Group, Oregon State University, <http://prism.oregonstate.edu>.  
 Outline map from US Census Bureau.

\*Isotherm used to separate temperate (C) and continental (D) climates is 3°C.  
 Data source: Köppen types calculated from data from PRISM Climate Group, Oregon State University, <http://prism.oregonstate.edu>.  
 Outline map from US Census Bureau.

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 Outline map from US Census Bureau.

\*Isotherm used to separate temperate (C) and continental (D) climates is 3°C.  
 Data source: Climate types calculated from data from WorldClim.org

# THE INTERVIEW



DR. **RYAN PERROY**, Associate Professor, University of Hawaii (at Hilo), Department of Geography

UNIVERSITY of HAWAII  
**HILO**

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## Phone Directory

UH Hilo Home > Phone Directory

Search

(search by name, title)

Unless otherwise specified, all phone numbers are within area

### Ryan Perroy

Associate Professor, Geography

Geography Department

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(808) 932-7098

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[Website for Ryan Perroy](#)

GEOGDEPT SSDIV TCBS

#### Ryan's Comments:

**Courses:** Remote Sensing, Advanced Geo-Spatial Techniques, Geostatistics, Field Methods.

**Research:** Exploring land degradation and recovery processes, invasive species, using lidar, remote sensing, X-ray fluorescence methods.



Spatial Data Analysis and Visualization Labs

University of Hawai'i at Hilo

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## People



### Ryan Perroy Ph.D.

Associate Professor  
Principle Investigator  
[rperroy@hawaii.edu](mailto:rperroy@hawaii.edu)

Specializations:  
Geographic Information Systems  
Remote Sensing  
Small Unmanned Aerial Systems  
Structure from Motion Analysis  
Soil Analysis



### Jon Price Ph.D.

Associate Professor  
Physical Geography  
[jpprice@hawaii.edu](mailto:jpprice@hawaii.edu)

Specializations:  
Geographic Information Systems  
Endemic and Native Flora  
Forest Dynamics  
Hawaii Ecosystems



# HAWAII CLIMATE ISSUES



Q#1: "What is the proportion of climate change research at the UH – academic/theoretical vs. practical/applied?"

UH/Manoa – more theoretical, UH/Hilo – more applied work

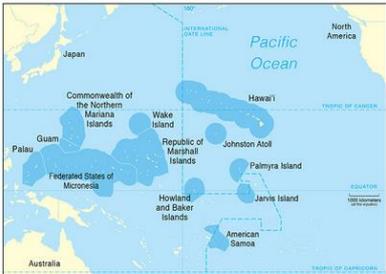


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## Welcome!

The Pacific Islands Climate Science Center was established by the Department of the Interior on October 7, 2011, as a consortium hosted by the University of Hawai'i at Mānoa, the University of Hawai'i at Hilo, and the University of Guam. The Pacific Islands Climate Science Center is part of a network of eight regional centers established by the DOI. Its mission is to provide natural resource managers and cultural stewards in federal, state, and local agencies access to the best science available on climate change and other landscape-scale stressors that are impacting the nation's natural and cultural resources.

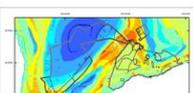
*Mahalo!*



Explore the geographic and thematic diversity of our Center projects in our new **Story Map!** Learn more about the climate change impacts facing the Pacific Islands region, the stakeholder-driven climate science funded by our center, and our efforts to work with under-represented communities threatened by the changing climate.



Explore and utilize a wide range of **Data Products** generated from our projects and



## Research

### University Consortium Project Summaries

#### Funded FY2016

**Kilo Lani: Reconstructing historical climate patterns in Hawai'i using traditional knowledge and dendrology**  
Technical narrative

PI - **Rosie Alegado**, Assistant Researcher, Hawai'i Sea Grant College Program, UH Mānoa

Co-Is - **Axel Timmermann**, Professor, Oceanography, UH Mānoa/IPRC  
**Pukea Nogelmeier**, Professor, Kawaihu'elani Center for Hawaiian Language



**Impacts of climate change in loko i'a (traditional Hawaiian fishponds) management I**

General summary

Technical narrative

PI - **Steven Colbert**, Assoc. Professor of Marine Science, UH Hilo  
Co-PI - **Cherie Kauahi**, Tropical Conservation Biology & Environmental Science, UH Hilo



**Impacts of climate change in loko i'a (traditional Hawaiian fishponds) management II**

General summary

Technical narrative

PI - **Steven Colbert**, Assoc. Professor of Marine Science, UH Hilo



PI-CSC: <http://pi-csc.soest.hawaii.edu/>

# HAWAII CLIMATE ISSUES



Q#2: "What climate change issues have the State of Hawaii deemed a priority for UH study?"

Priority issues: Sea-Level Rise, climate vulnerability, carbon emissions

Hawaii Ocean Science & Technology Park  
Administered by the Natural Energy Laboratory of Hawaii Authority

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### ENERGY PORTFOLIO

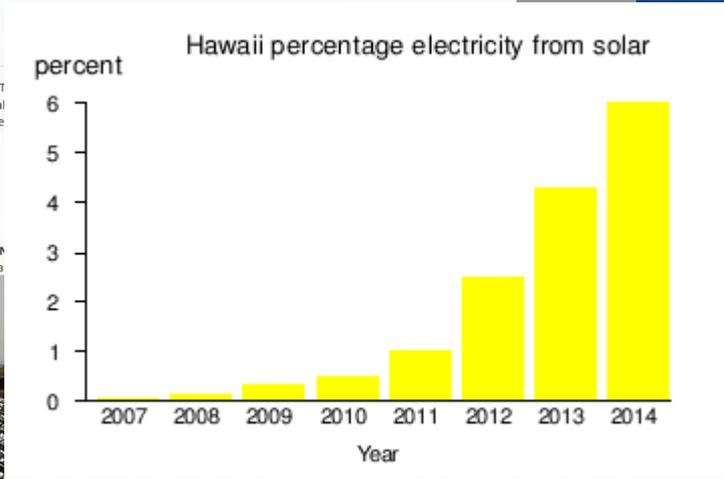
**ENERGY DISTRIBUTION (kW)**

OTEC CSP PV Storage

**OCEAN THERMAL ENERGY CONVERSION**  
technology since 1974. Closed a electricity usir by various gro Projects have (ONR), the Pac State of Hawa operated a 25 a heat exchan the HOST Park research campus mi

**CONCENTRATED SOLAR POWER**  
which the mate ma lot plant storms a

**PHOTOVOLTAIC**  
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MAKAI OCEAN ENGINEERING  
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RENEWABLE ENERGY SUBMARINE CABLE GIS SERVICES PIPELINES DESIGN NEWS ABOUT

## Ocean Thermal Energy Conversion

Makai has a long and intense involvement with OTEC dating back to the world's first net-power producing plant in 1979. See what we are currently doing to improve island communities. [Learn More >](#)

**Leaders in Our Field**  
Makai is dedicated to providing world-class solutions to difficult engineering problems for our international network of clientele. [Read More >](#)

**MakaiLay Lease Options**  
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Solutions: green energy (2050 goal), NE Lab work – ocean energy, biofuels, solar (active & passive).

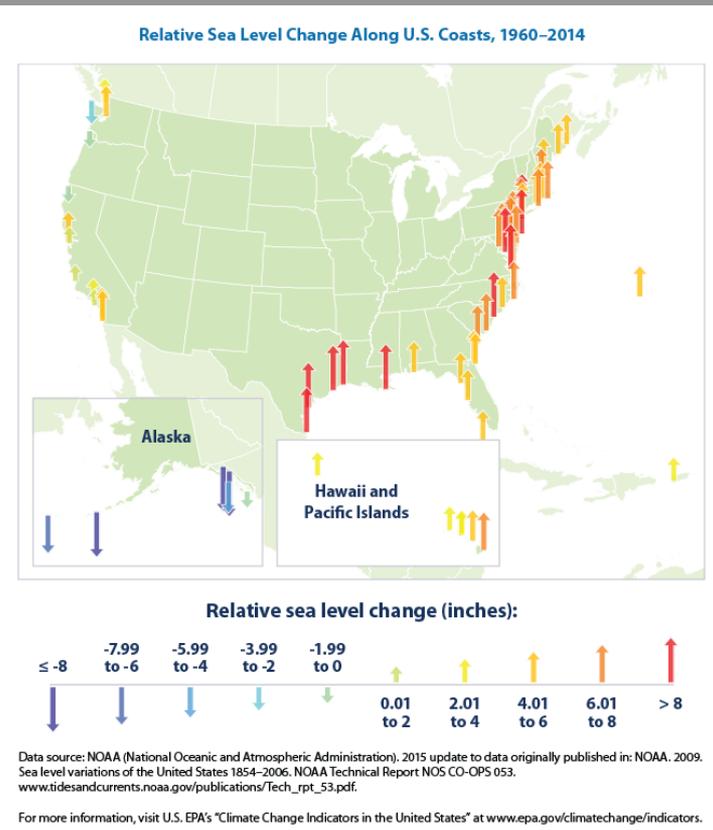
<http://nelha.hawaii.gov/energy-portfolio>  
<https://www.makai.com>

# HAWAII CLIMATE ISSUES



Q#3: "What climate change issues are UH *students* concerned about?"

Top issues: Eroding coastlines, sea-level inundation, salt-water intrusions



Context: local island specific

<http://www.soest.hawaii.edu/coasts/erosion>  
<https://www.sciencedaily.com/releases/2012/05/120507165601.htm>

# HAWAII CLIMATE ISSUES



Q#3: "What climate change issues are UH students concerned about?"

Top issue: Eroding coastlines...a big problem for most Pacific islands

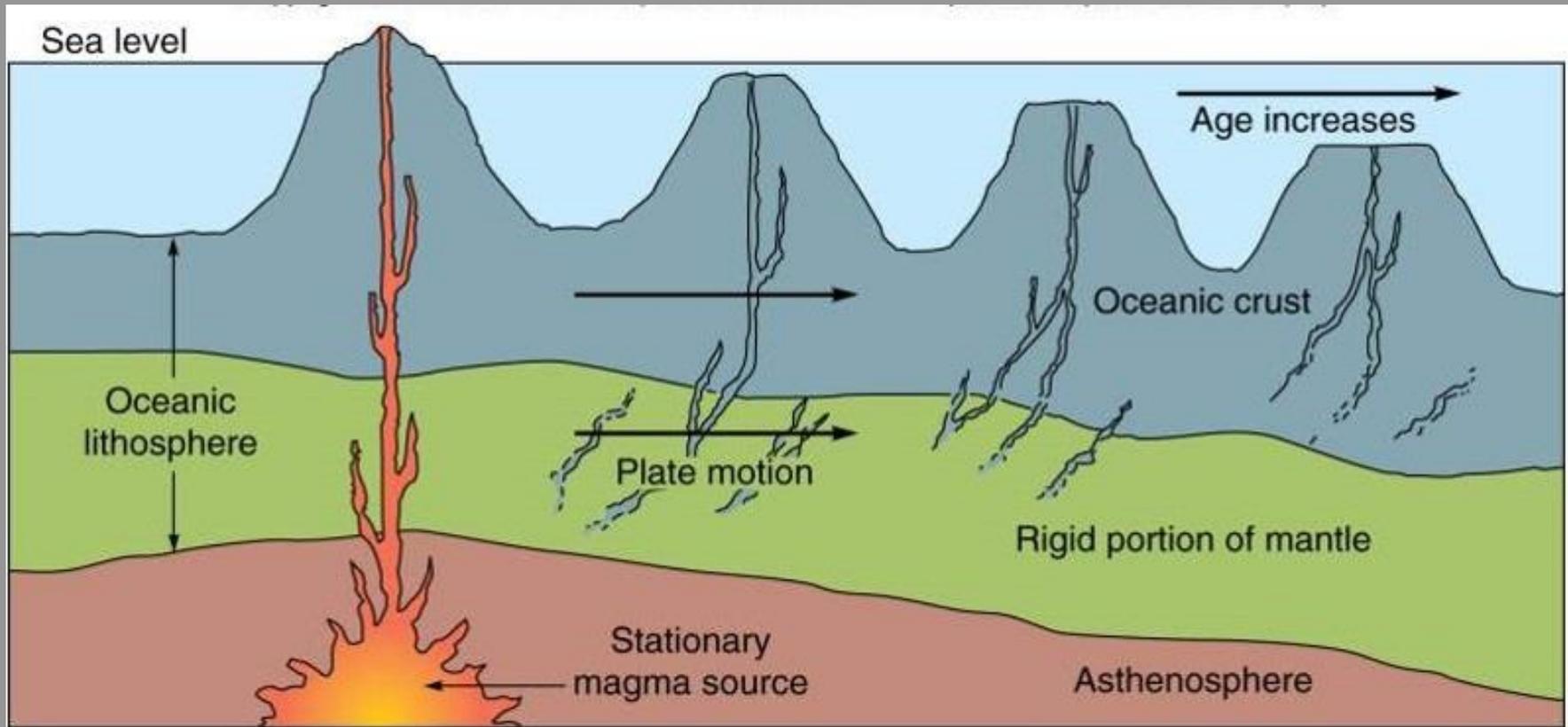


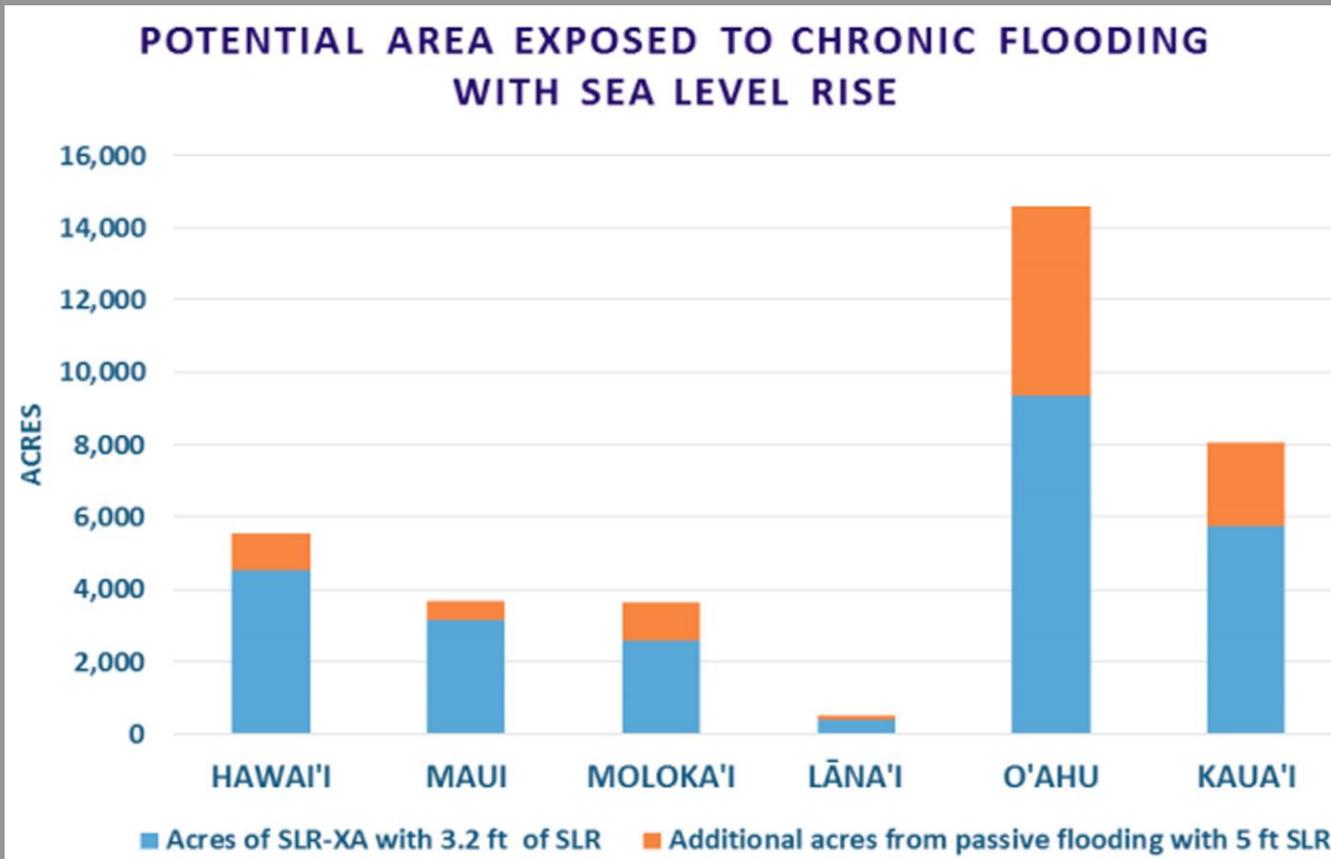
Plate Tectonic Subsidence – local impacts?

# HAWAII CLIMATE ISSUES



Q#3: "What climate change issues are UH students concerned about?"

Top issues: Sea-level Rise and coastal flooding – specific island impacts?



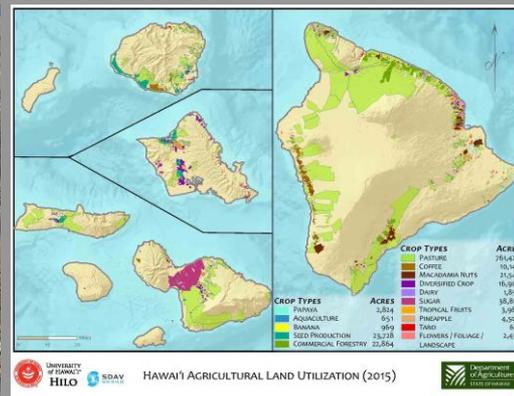
# HAWAII CLIMATE ISSUES



Q#4: "What climate change issues and projects are you and your students working on?"

Top issues: coasts, Sea-Level Rise. *Interface with Hawaiian ideas.* Projects:

- Hawaii County Planning Office – land permits- beach set-back limits (40-ft).
- Fish Ponds – restore worn-out ones, build new ones, build food security.
- Agriculture – how to deal with drought periods, intense rainfall events.
- Invasive species – potential impacts.
- Cesspools – Sea-Level Rise, water quality, and F&W habitat impacts.



**Goal: self-sufficiency across all sectors of Hawaii society**

<https://www.livescience.com/39482-hawaii-beach-erosion-sea-level-rise.html>

# HAWAII CLIMATE ISSUES



Q#5: "What about Hawaii's fisheries, its management, and climate change?"

- Rebuild Fish Pond culture – major aspect of traditional Hawaii.
- Ocean Acidification – HI oyster farm hatcheries helping out WA farms!

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**Paepae o He'eia**  
He'eia Fishpond, He'eia Oahu

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### The Fishpond

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Hawaiian fishponds are unique and advanced forms of aquaculture found nowhere else in the world. The techniques of herding or trapping adult fish with rocks in shallow tidal areas is found elsewhere but the six styles of Hawaiian fishponds, especially large walled ponds, were technologically advanced and efficient as their purpose was to cultivate pua, baby fish, to maturity. Their invention was a result of the Hawaiians deep understanding of the environmental processes specific to our islands as well as their connection and observation of the food resources on the 'āina and in the kal.

Ocean fishing is dependent, to a great extent, upon conditions of the ocean and weather. High surf, storms, and other associated weather phenomenon influence and interrupt most fishing practices. Therefore, fishponds provided Hawaiians with a regular supply of fish when ocean fishing was not possible or did not yield sufficient supply (Kelly, 1976).

Located in He'eia Uli on the island of Oahu, He'eia Fishpond is a walled (kuapā) style fishpond enclosing 88 acres of brackish water. The kuapā is built on the Malauka 'a

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**Prof. Maria Haws: commercial shellfish hatchery research – mitigation tool**

<http://paepaeoheeia.org/thefishpond>

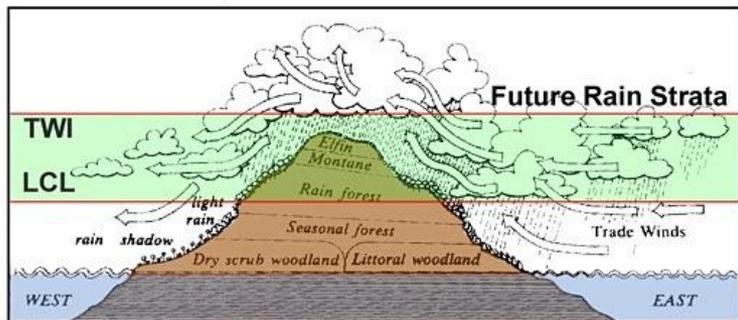
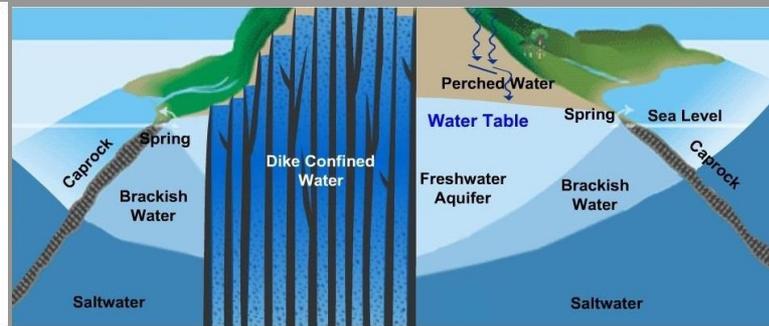
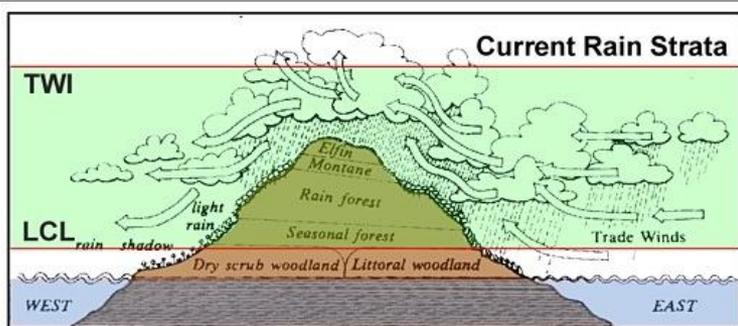
<http://hilo.hawaii.edu/keahou/2012/10/17/haws-aquaculture>

# HAWAII CLIMATE ISSUES



Q#6: "Has anyone looked at climate change impacts to Hawaii's streams?"

- New research trends: Lower streamflow (e.g., USGS retrospective studies).
- Flashier rainfall events and floods will become more common.
- Higher flow vulnerability, more water uncertainty – agriculture impacts?



<http://www.desdemonadespair.net/2015/02/researchers-climate-change-affecting.html>  
<http://geography.manoa.hawaii.edu/thomas-giambelluca/>

# HAWAII CLIMATE ISSUES



Q#7: "What about basic research on Climate Variability – ENSO and PDO?"

The UH School of Oceanography has been the lead entity: "Studies of the basic physics of tropical atmospheric and ocean coupled systems on seasonal and longer timescales, notably the El Niño phenomenon and the Asian monsoon circulations, and predicting future variability through advanced numerical modeling have a long and distinguished history within SOEST."

The screenshot shows the SOEST website interface. At the top, there is a navigation bar with links for 'ABOUT US', 'DIRECTORY', 'GIVING', 'JOBS & EMPLOYMENT', and 'CONTACT'. Below this is a secondary menu with categories: 'EXPLORE OUR SCHOOL', 'OCEAN', 'LIFE', 'CLIMATE', 'ENERGY', 'ATMOSPHERE', 'EARTH', and 'SPACE'. The main content area features a large image of clouds and the SOEST logo. On the left, there are sections for 'EDUCATION' and 'RESEARCH'. Under 'RESEARCH', there is a 'CLIMATE' section with sub-themes: 'Ocean Acidification & Chemistry', 'Climate Modeling & Forecasting', and 'Sea Level Rise & Coastal Hazards'. Below these are 'Associated Departments' for 'Department of Atmospheric Sciences' and 'Department of Oceanography'. At the bottom, there is a 'Recent Updates' section.

## ENSO in the Future

The figure contains two main graphs. The left graph, titled 'Collins et al, 2010', is a bar chart showing the change in standard deviation (s.d.) for various climate models. The y-axis is 'Change in s.d. (s.d.)' ranging from -0.4 to 0.4. The x-axis lists models: CCSM3, CGCM3.1(t47), CNRM-CM3, CSIRO-Mk3.0, ECHAM5/HR10, FGOALS-G1.0, GFDL-CM2.0, GISS-EH, IPSL-CM4.0, MIROC3.2(hires), MRI-CGCM2.3.2, PCM, UKMO-HadGEM1, and URM0-HadCM3. The chart is divided into 'Increased variability' (positive values) and 'Decreased variability' (negative values). The right graph, titled 'Cal et al, 2015', is a scatter plot of 'Standard deviation of Niño3 index' for 'CMIP5' models. The y-axis is 'Climate change' and the x-axis is 'Control period', both ranging from 0.2 to 1.8. A diagonal line represents a 1:1 relationship. Points above the line are labeled 'Increased variability (12)' and points below are labeled 'Decreased variability (9)'. A legend on the right lists various climate models with their corresponding symbols and colors.

**Collins et al, 2010**

**CMIP3**

**Cal et al, 2015**

**CMIP5**

**“ENSO variability is controlled by a delicate balance of amplifying and damping feedbacks.....that will probably be modified by climate change. Therefore...it is not yet possible to say whether ENSO activity will be enhanced or damped, or if the frequency of events will change.”**

**–Collins et al, 2010, Nat. Geosci.**

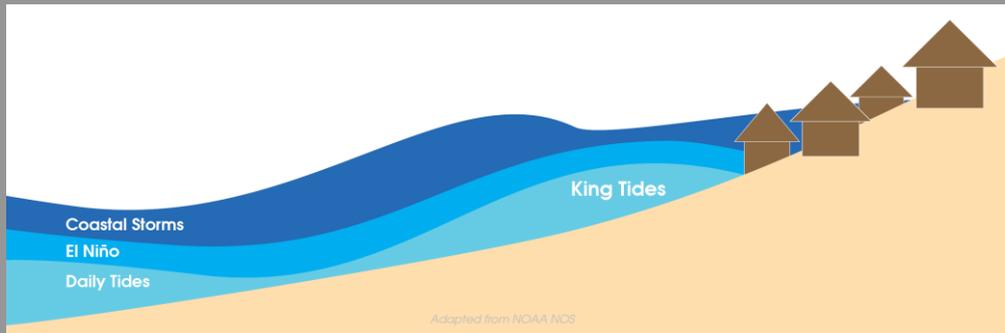
<https://www.soest.hawaii.edu/soestwp/research/themes/climate>

# HAWAII CLIMATE ISSUES



Q#8: "Climate change and native Hawaiians— their issues?"

Top: Eroding coastlines, sea-level inundation, salt-water intrusions, *King-tides*



<http://ccsr.seagrants.soest.hawaii.edu/king-tides>

# HAWAII CLIMATE ISSUES



“ What can be done for Hawaii?”

Solutions are scientific and political and local

**EPA** United States Environmental Protection Agency August 2016 EPA 430-F-16-013

## What Climate Change Means for Hawaii

Hawaii's climate is changing. In the last century, air temperatures have increased between one-half and one degree (F). Warming in the oceans around Hawaii has damaged coral reefs, and, in recent decades, increased ocean acidity has threatened reefs and other marine ecosystems. Average precipitation decreased in the last century, reducing freshwater availability on some islands and affecting delicate land-based ecosystems, often harming native species. In the last 50 years, sea level has risen along Hawaii's shores, increasing erosion and threatening coastal communities and infrastructure.

Climate is changing because the earth is warming. People have increased the amount of carbon dioxide in the air by 40 percent since the late 1700s. Other heat-trapping greenhouse gases are also increasing. These gases have warmed the surface and lower atmosphere of our planet about one degree during the last 50 years. Evaporation increases as the atmosphere warms, which increases humidity, average rainfall, and the frequency of heavy rainstorms in many places—but contributes to drought in others.

Greenhouse gases are also changing the world's oceans and ice cover. Carbon dioxide reacts with water to form carbonic acid, so the oceans are becoming more acidic. The surface of the ocean has warmed about one degree during the last 80 years. Warming is causing snow to melt earlier in spring, and mountain glaciers are retreating. Even the great ice sheets on Greenland and Antarctica are shrinking. Thus the sea is rising at an increasing rate.

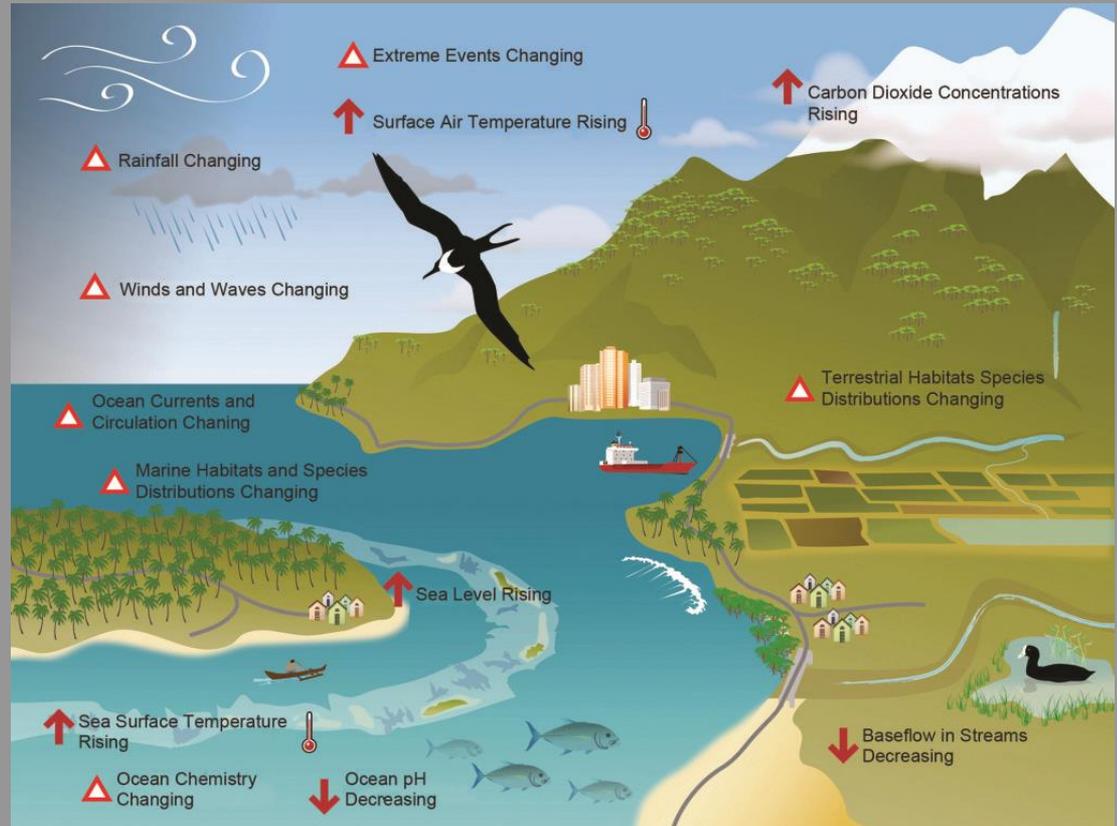
### Ocean Warming and Acidification

The waters around Hawaii are warming, which is harming Hawaii's coral reefs and marine ecosystems. The El Niño-Southern Oscillation ("El Niño") and other natural cycles cause ocean temperatures in the Pacific to fluctuate from year to year and from decade to decade. Even after accounting for these natural patterns, the waters around Hawaii have been warming since the 1950s, with temperatures rising by several degrees from the ocean surface down to at least 600 feet. Rising water temperatures can harm the algae that live inside corals. Because algae provide food for the coral, a loss of algae weakens corals and can eventually kill them. This process is commonly known as "coral bleaching," because the loss of the algae also causes the corals to turn white. Mass bleaching events are becoming more common, with documented cases in the north-western Hawaiian Islands in 1996 and 2002. Water temperature spikes in Hawaii have also been linked to coral disease outbreaks.

*Bleached corals in Kaneohe Bay, Oahu, in the fall of 2014. Credit: XL Catlin Seaview Survey*

Increasing ocean acidity can also damage corals, as well as shellfish and other organisms that depend on minerals in the water to build their skeletons and shells. The acidity of the Pacific Ocean has increased by about 25 percent in the past three centuries, and it is likely to increase another 40 to 50 percent by 2100.

Warming and acidification could result in widespread damage to the entire marine ecosystem in the waters off Hawaii. Hawaii's isolation in the Central Pacific makes it home to a wide range of fish species not found anywhere else in the world. Many of these fish rely on healthy coral reefs for habitat, and even with substan-



<https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-hi.pdf>  
<http://climateadaptation.hawaii.gov/climate-change/>

# HAWAII CLIMATE ISSUES



“ Climate Change issues: Hawaii vs. PNW?”

What are your Questions?

**HAWAII**

**Thank You...ALOHA!** 😊

**PACIFIC NORTHWEST**

- **Sea-Level Rise**
- Coastal erosion and flooding
- Climate vulnerability
- Water supply and management
- Carbon emissions

- **Shift in hydrologic regimes**
- Melting glaciers due to warming
- Water supply and management
- Forests, Agriculture, invasive sp.
- Extreme events – rain, drought

