Modeling the response of Hawai'i streams to future rainfall conditions

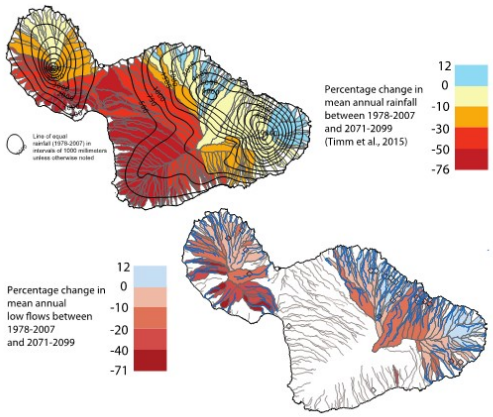
Maoya Bassiouni, USGS Pacific Islands Water Science Center, currently at Water Resources Engineering, Oregon State University

Wahinepe'e stream, Maui. Photo courtesy Forest and Kim Starr/ CC BY 3.0

The Hawaiian Islands are surrounded by saltwater, but freshwater from rainfall is what allows life to thrive on them. Each island has a limited number of intermittent and perennial streams that provide water for drinking and agriculture as well as habitat for several endemic species. Hawaiian streams are generally fairly short and often quite steep, which combined with heavy rains can cause frequent flash flooding and large variation in streamflow generally, both over time for a single stream and between streams at the same time. The wide differences in stream characteristics make it difficult to predict the response of streamflows to changing climate.

We developed a method to estimate annual stream low-flow discharge volumes based on basin physical characteristics, rainfall records, and historical streamflow data. Once we created the model using information from streams with flow gages, we are able to estimate flows in unmonitored streams. In addition, we are able to determine which streams are more or less sensitive to changes in rainfall. We then used this model to predict flow changes in Maui streams under two possible end-of-century future climate scenarios.

Results indicate that in areas where rainfall is projected to decrease in the future, stream low flows may decrease by more than 50 percent in some areas (see figure to left) and stream habitat for native species may decrease by more than 25 percent in some streams. In areas where rainfall is projected to increase, stream low flows and habitat increase. Model results for Maui under the two end-of-century climate-change scenarios reflect uncertainty in the climate projections. More research needs to be done to further improve our ability to model streamflows through time and space. However, our hydrologic models are able to provide regional-level information that is especially important given the relatively small number of Hawaiian streams where flows are monitored and the increasing demands on freshwater resources.



Projected rainfall (derived using CMIP5 and RCP 8.5) and associated low-flow changes by 2100. Image courtesy M. Bassiouni.

Quick Summary

- Each Hawaiian island has limited streamflow resources to support human needs for water as well as habitat for native species. It is important to be able to predict how these streams will be impacted by shifts in rainfall due to climate change. However, limited data and uncertain effects of climate change hinder regional or island-wide predictions.
- Our model provides a way to categorize streams at a state-wide level based on physical characteristics, so that we can estimate the response of streams to rainfall.
- Streamflow modeling can help provide estimates of future water availability that are required for equitable allocation of freshwater for household needs as well as agriculture and industrial use, and allow long-term adaptive management so that the limited freshwater supplies in Hawai‘i are managed in a sustainable way.

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