The Future Climate of Pu'u Wa'awa'a

Hotter and drier conditions are projected across Pu'u Wa'awa'a by the end of the century

What is Climate Downscaling?

A wide variety of global climate models provide future rainfall and temperature projections for most of the Earth's surface. These models use mathematical equations to describe and predict how energy interacts with the ocean and atmosphere across large areas. Climate downscaling is a technique to translate global model projections for large areas to a finer resolution more useful for local scale management. Different downscaling methods with different strengths have been used to generate a range of future climate projections for rainfall and temperature in Hawai'i. These projections are influenced by two different greenhouse gas (GHG) scenarios: 1) a future where societies across planet Earth are successful in reducing GHG emissions to the atmosphere ("Low Emissions" scenario); and 2) a business as usual future where there is no change in effort to reduce GHG emissions ("High Emissions" scenario).

Understanding how climate is projected to change under these two different scenarios is critical to developing effective management responses including adaptation options for species, ecosystems, watersheds, and human communities. For example, novel translocation and reintroduction approaches, landscape restoration, reforestation projects, and community-led co-management initiatives may all be influenced by information about future climate, with impacts on the development of adaptation strategies.

Future Climate Change at Pu'u Wa'awa'a

Future rainfall for both the low and high emissions scenarios for Hawai'i Island are shown in Figure 1. For the low emissions scenario, Pu'u Wa'awa'a is projected to see a moderate, 6% (1 inch) decline in average annual rainfall by the end of the century. The biggest reductions in rainfall are projected for higher elevations. For the high emissions scenario, a 43% (9 inch) reduction in annual rainfall is projected. In this scenario, pronounced drying is projected across the entire area but is most pronounced at low elevations (<300 ft.). For temperature (Figure 2), accelerated warming is expected under both future scenarios. For the low emissions scenario, end-of-century temperatures across the area are

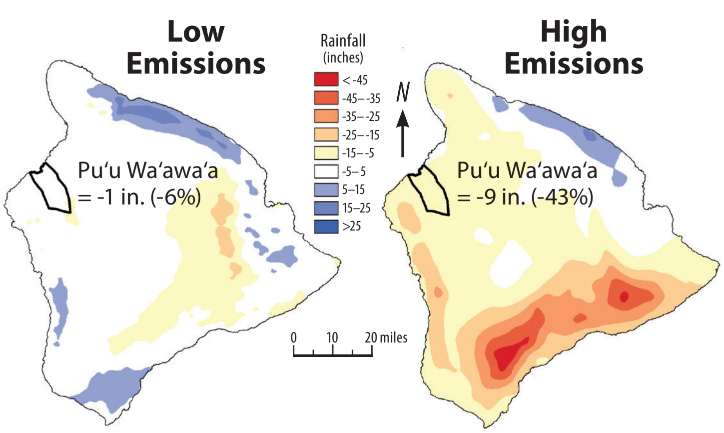

Figure 1: Future projected changes in rainfall on Hawai'i Island for year 2100, under a low[1] (left) and high[2] (right) emissions scenario.

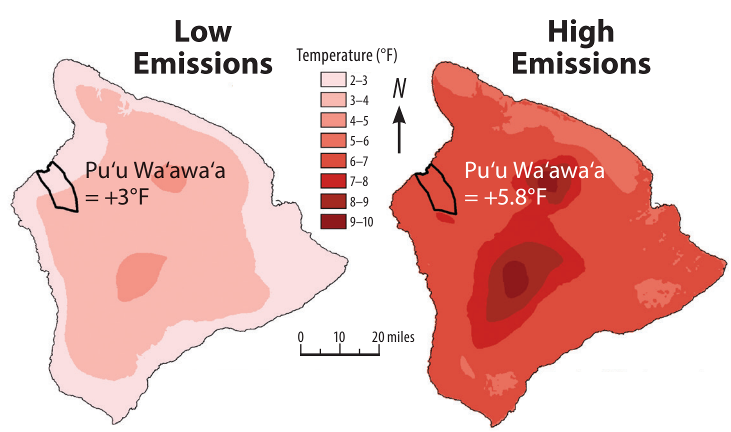

Figure 2: Future projected changes in temperature on Hawai'i Island for year 2100, under low[2] (left) and high[1] (right) emissions scenarios.

projected to average 3°F warmer than temperatures today. For the high emissions scenario, average temperatures across the area are projected to be 5.8°F warmer. For both scenarios, warming rates are relatively consistent across the 6,000 ft. elevation gradient, but the most pronounced warming is expected at the highest elevations.

Why is This Important?

A Range of Impacts Across the Area

Future changes in temperature and rainfall will undoubtedly affect the plant and animal species that reside in Puʻu Waʻawaʻa. As the climate becomes warmer and drier a range of impacts are expected including dramatic range shifts of native and non-native species, increased wildfire risk, expansion of disease and increased risk of extinction for the area's endemic species. It is also important to understand that climate change is not just a future scenario, as many of these impacts are being realized today.

The primary threat to native Hawaiian forest birds is avian malaria, which is transmitted by the bite of non-native mosquitoes. In the past, low temperatures at high elevations created disease free forest refuges. However, environmental warming allows the mosquitoes to move further up-slope thus reducing the area of safe habitat available, which leads to population declines. Current climate based population models predict most species of Hawaiian honeycreepers will lose more than 90% of their current range by 2080[3]. At Puʻu Waʻawaʻa, the iconic ʻIʻiwi (Figure 3) now persists only in the forested high elevations located above the mosquito range. In the absence of significant intervention, many native Hawaiian species like the ʻIʻiwi will suffer major population declines or extinction due to increasing risk from avian malaria during the 21st century.

Figure 3: **The endemic scarlet ʻIʻiwi [found at Puʻu Waʻawaʻa]. At present ʻIʻiwi are restricted to elevations above ~4,000 ft. where the southern house mosquito, *Culex quinquefasciatus*, (the primary vector of avian malaria and avian pox) is largely absent. As temperatures increase, mosquitos may move up-slope and expose ʻIʻiwi, to these deadly diseases.[4]**
Credit: Zach Pezzillo , DLNR-DOFAW

Understanding how climate is projected to change is critical to an effective management response that incorporates a wide range of adaptation options to promote healthy ecosystems. Land managers are working to build climate resilient native ecosystems by excluding invasive species, partnering with researchers to investigate strategies for reducing mosquitoes on a landscape scale, seed banking, and restoring native plant species across their ecological ranges. The past is no longer a guide for the future, and new innovative approaches will be required to perpetuate our natural and cultural resources in the long-term. In the face of projected changes in environmental conditions, the role of land managers has never been more important.

[1] Dynamical downscaling; Zhang et al. (2016) https://doi-org.eres.library.manoa.hawaii.edu/10.1175/JCLI-D-16-0038.1

[2] Statistical downscaling; Elison Timm et al. (2015) https://doi-org.eres.library.manoa.hawaii.edu/10.1002/2014JD022059

[3] Fortini et al. (2017) https://doi.org/10.1371/journal.pone.0140389

[4] Judge et al. (2017) https://irma.nps.gov/DataStore/Reference/Profile/2239426

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This work was funded by the Pacific Islands Climate Adaptation Science Center.

Design and layout: Brooks Bays (SOEST Publication Services)

June 2021