

GROUNDWATER SUSTAINABILITY FOR SMALL FARMERS OF O'AHU

Geoscience problem: Is there enough clean water to sustain our island needs, including diversified agriculture?

Hawai'i depends exclusively on local water, of which 89% is derived from groundwater sources. Increasing population, agricultural use, and climate change contribute to concerns over water quality and quantity. A huge challenge for the state of Hawai'i in the future is addressing clean water sustainability [Hawai'i Fresh Water Initiative, 2015].

Over the last 150 years there have been widespread land-use changes in the collection area of the Pearl Harbor groundwater aquifer. The area went from being dominated by pastureland in the mid-1800s, to farms and plantation cultivation with the advent of artesian wells in the late 1880s, [Nellist, 1953], to urban housing lots and large-scale military and retail complexes that characterize the area today. [Giambelluca, 1986; Giambelluca et al., 1996]. This landuse change has altered groundwater recharge and withdrawal rates. When land is irrigated for agriculture, more than half of this water returns to the basalt aquifer by infiltrating through the highly permeable soils [Mink, 1962]. Urbanized landscapes, in contrast, tend to increase runoff, which mostly goes directly into the ocean, reducing recharge rates.

In addition, between 1901- 1980, increasing groundwater withdrawals in southern O'ahu caused the water levels in the volcanic-rock aquifer to decline (Figure 1, [Oki, 1998], [Hunt Jr., 1996]). This resulted in a decline of natural spring discharge from 800,000 m³/d to 300,000 m³/d between pre-1980s and 2011 [Kelly et al., 2013], with implications for local ecosystems and agriculture. Decisions related to future infrastructure development and alternate sources of fresh water, including desalinization, will depend on the long-term sustainability of the groundwater resources in the Pearl Harbor aquifer [Oki, 2016].

One of the biggest contamination threats to the Pearl Harbor freshwater aquifer is saltwater intrusion. This problem is due to the fact that freshwater floats on top of the saltwater in the aquifer, where it is confined by impermeable caprock along the coastline (Figure 2, [Liu et al., 2005]). Groundwater withdrawals induce upward and landward movement of saltwater. Wells in the freshwater lens near the coast, such as the Pearl Harbor area, are particularly likely to induce brackish water or saltwater to move into the well as pumping continues [Oki, 2005]. This problem can be seen in the increased salinity occurring in the Pearl Harbor Aquifer [Oki, 2016].

Hawai'i is the most food insecure state in the nation, importing 90% of all food sold [Woody, 2015]. Scott Enright, Chairperson of the Hawai'i Board of Agriculture say "...we are working to lay a foundation for measuring our progress toward increasing agricultural production statewide... in the planning and promoting of new agricultural investment to increase our food security" [Melrose et al., 2015]. Of the land in use for agricultural production in 2015, the majority was still used for crops for export (sugar, seed production, and macadamia nuts). Diversified crops are now grown on just 16,900 acres statewide. This category includes a wide variety of leaf, root and melon crops, most of which is consumed locally. More than half of all diversified crops in the state are grown on O'ahu [Melrose et al., 2015]. There has been a shift in the center of local food production in the state to O'ahu where the market is the largest and transportation costs are the lowest, but this growing area depends entirely on water from the Pearl Harbor aquifer, which also supports the state's largest population center (O'ahu's southern coast).

Rationale for using the MWG approach to implement participatory research

The “virtuous exchange” [Deloria Jr. and Wildcat, 2001] model of the Mobile Working Group approach is ideally suited to the multi-cultural perspectives and wide-ranging skillsets and life experiences of our project collaborators. Sustainable water use, stewardship, and vision will not arise without the contributions of diverse stakeholders from around the state, including geoscientists, social scientists, policy-makers, farmers, cultural practitioners, and educators. Our working group consists of members of all these groups, and 7 of our 10 MWG members were either born or raised on O’ahu, giving them a vested interest in the outcome of this place-based research for themselves and their home communities. The MWG will support the professional development of each member through exposure to new communities and ways of thinking, while at the same time building a cohort of leaders for the future.

The goals of the MWG for the Pearl Harbor Aquifer Sumida Farms Case study are as follows:

Goal 1: Create an interactive outreach tool for visualizing land use and cultural resources related to the Pearl Harbor aquifer that incorporates historical information gained from translations of Hawaiian language newspapers, well and spring locations, oral histories, and traditional Hawaiian land divisions.

Goal 2: Provide support to Sumida Farms in their request for monthly water quality monitoring through one calendar year to track changes in temperature and salinity that may affect their crop productivity. Use these sampling opportunities to additionally collect microbial and chemical samples that will detect agricultural and human sources of contamination in the area that may clarify subsurface geologic connectivity in the Pearl Harbor aquifer.

Goal 3: Use data collected to create a springwater protection case study to identify more sustainable pumping rates for the aquifer that Sumida Farms can use to advocate for controls on groundwater pumping with local and federal agencies (BWS, USGS, HDOA, KS, etc.)

Goal 4: Build a community of mutual respect and trust related to topics of water governance and sustainability in the Pearl Harbor aquifer that supports the professional development of its members.