Canopy Interception of Native Versus Invaded Mesic Forest in Mākaha Valley, O`ahu: A Comparative Study

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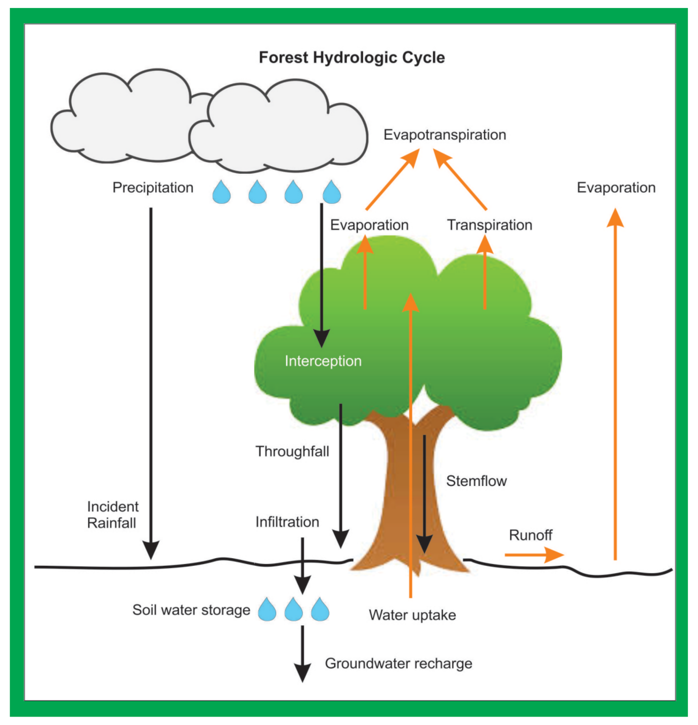
(as of September 2018)

Background



A primary goal of the Honolulu Board of Water Supply (BWS) and its Watershed Program is to ensure an adequate supply of fresh water for current and future generations.

In this regard, the capacity of O`ahu's watersheds to capture and store precipitation is critical: it is the sole natural source of fresh water supply for the island.

Our BWS Canopy Interception Study attempts to quantify differences in rainfall capture between native and invasive forests found in the Wai`anae Mountains.

This aspect of the water budget of O`ahu's watersheds (and of watersheds in general) has not been well-studied. Until recently, the only similar research in Hawai`i was located in high-elevation "cloud forest" terrain on the island of Hawai`i, where fog drip is a primary component of precipitation.

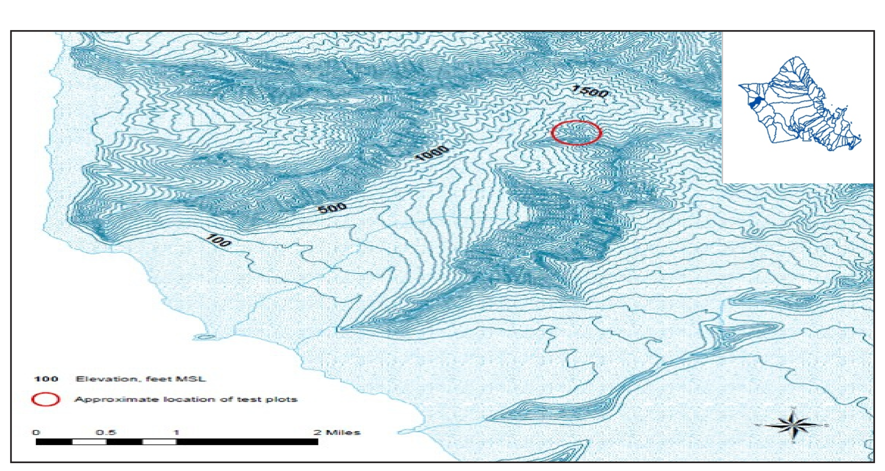
Because that research was not representative of the majority of forested areas on O`ahu, this study was established as a first step to address O`ahu's forests.

Canopy Interception

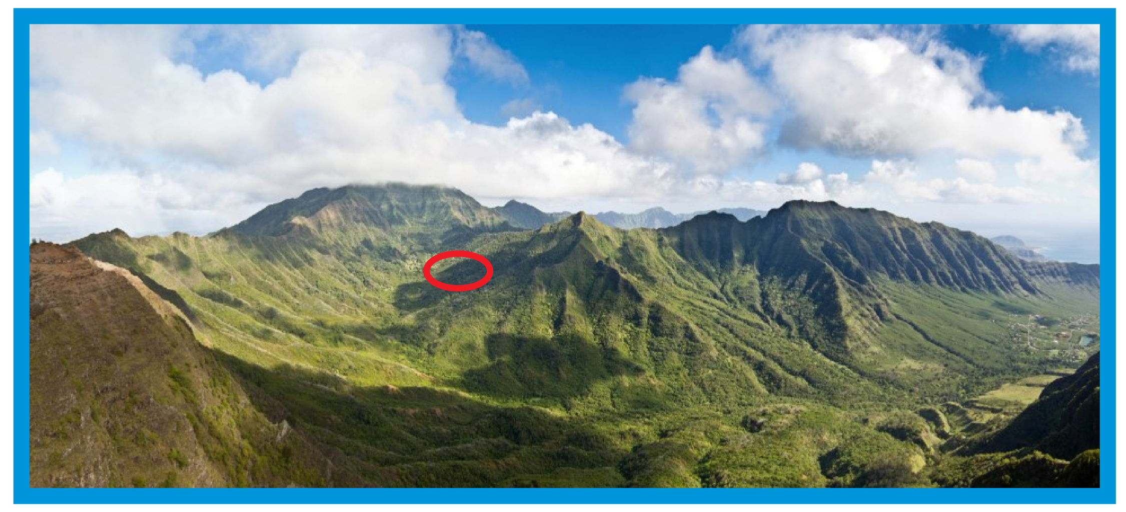
RF = TF + SF + CI → CI = RF – TF - SF

where
RF = gross rainfall TF = throughfall
SF = stemflow CI = canopy interception

By measuring gross rainfall, throughfall and stemflow in the field at native and invaded forest sites, the canopy interception of native and invaded sites can be calculated and compared.



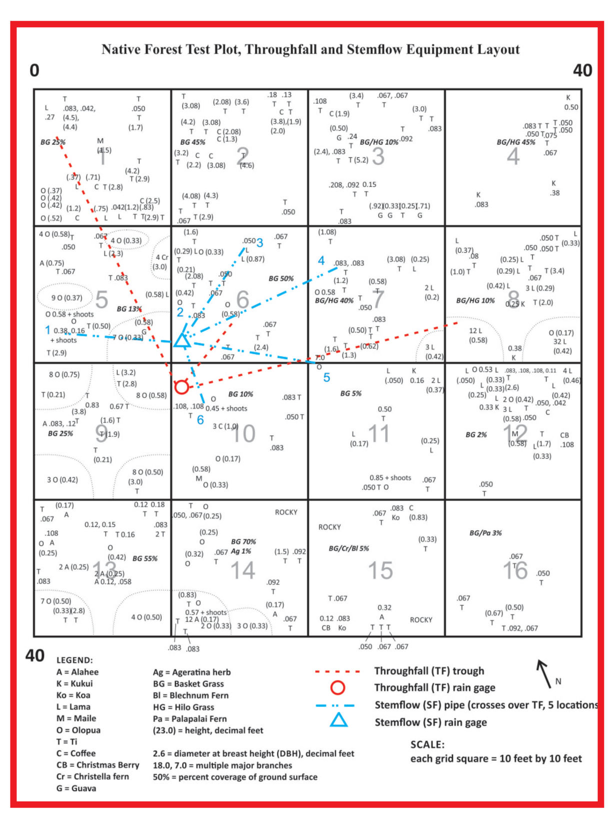
CI Study Watershed

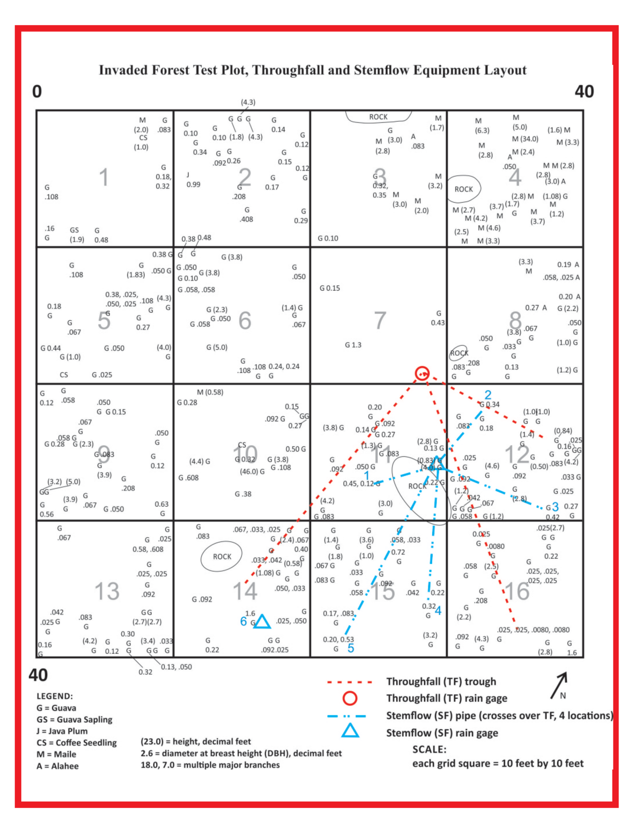


For this study, the native and invaded forest test plots are located in the Mākaha watershed of O`ahu, part of the Wai`anae Mountains. This is considered a high-priority watershed by BWS in terms of watershed protection and restoration efforts, ranking high with respect to groundwater recharge and groundwater production.

The Mākaha watershed is largely undeveloped; land cover is generally shrubs and evergreen forest. Elevation across the watershed ranges from sea level to 4,025 feet at Mount Ka`ala, the highest point on O`ahu.

Historical rainfall patterns across the Mākaha watershed were reviewed. As expected, average annual rainfall is greater along the mountain slopes compared to lower elevations, reflecting the capacity of the higher mountain slopes to capture the predominant northeast tradewind-borne precipitation. The rainy season on O`ahu extends roughly from October through April.





CI Study Test Plots and Equipment

An effort was made to select test plots having similar characteristics except for vegetation type, to minimize any influences on canopy interception other than vegetation type.

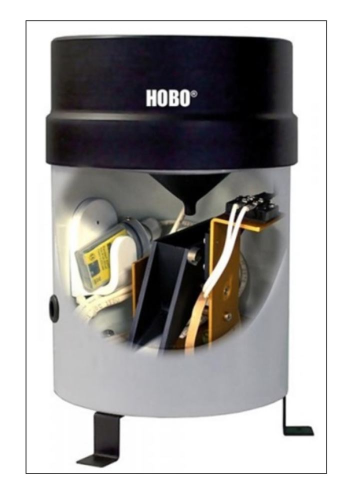
Elevation: About 80 percent of the Mākaha watershed lies below the the lower boundary of "cloud forest", where fog drip becomes a primary component of precipitation (~2,460 feet MSL). Therefore, test plot locations were selected below this elevation to represent the majority of the watershed area (~1,640 and 1,605 feet MSL).

Aspect: Aspect refers to the horizontal direction to which a slope faces; aspect can significantly influence local climate. To minimize this influence, test plot locations have minor slope (average ~10 degrees) and similar aspect (~northwest).

Gross rainfall: Test plot locations were selected close to one another (~200 feet apart), same range of historic rainfall (>65 inches annually).

Vegetation type: The native forest test plot was selected with an array of native trees and plants expected for a fairly intact forest at this elevation in the Wai`anae Mountain range. In contrast, the invaded forest test plot was selected with a classic monotypic character; in this case, *Psidium cattleianum* (strawberry guava), considered one of the most invasive plant species in Hawai`i.

Each of the two test plots is square-shaped, and 40 feet by 40 feet in extent. The plots were temporarily gridded into 10 foot by 10 foot sectors, and plant surveys were conducted to inventory all species within the test plots. The native test plot contained alahe`e, kukui, koa, lama, maile, olopua, ti, and palapalai fern. Minor amounts of nonnative species such as coffee, Christmas berry, and basket grass were also present. The invaded test plot contained almost exclusively strawberry guava.



Gross Rainfall Equipment: Because the test plots are located close to one another, a single tipping bucket rain gauge (standard 6-inch diameter, 0.01-inch / tip) installed near the plots collects gross rainfall data to represent both the plots.

Throughfall Equipment: For each test plot, a total of three troughs lead to a fabricated tipping bucket (150 mL / tip) rain gauge. The gauge is nested in a stainless steel can, levelled and anchored to the ground for stability. Troughs were installed under trees typical of the test plots (species, diameter, height) in configurations that represented the average canopy and gap proportions and minimized overlap of throughfall collection between troughs.

Stemflow Equipment: Stemflow collectors connected to a fabricated tipping bucket (150 mL / tip) rain gauge were used for each test plot. Trees selected for stemflow data collection represented the range of typical species, diameter and height found commonly on the test plots. Stemflow collectors were supported through lengths of 7/8-inch diameter poly tubing protected in 1-inch diameter HDPE pipe, leading toward the rain gauge, nested in a stainless steel can, levelled and anchored.

Preliminary Data and Future Work

Preliminary data for April 2017 through April 2018 show that native forest throughfall is significantly greater than invaded forest throughfall, while invaded forest stemflow is greater than native forest stemflow. Long-term data collection and quantification of results is expected, as well as ongoing collaboration with University of Hawaii, studying related water budget characteristics (evapotranspiration, soil moisture).

Finally, a CI Study is being established near the boundary of the Nuuanu / Manoa watersheds, to assess native versus invaded rainfall capture in the Ko`olau Mountains.