MAUKA TO *MAKAI:* FROM THE MOUNTAINS TO THE SEA

Reducing Stormwater Runoff Pollution in Maunalua Bay, O'ahu, Hawai'i

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Background

Urbanization

Urban development has severely altered the natural hydrology of many watersheds globally. A topic of contemporary interest in watershed management is reducing the amount of polluted stormwater runoff that enters streams and oceans. This phenomenon is worsened in watersheds with short and steep drainage basins and flashy precipitation, such as those in the Hawaiian Islands.

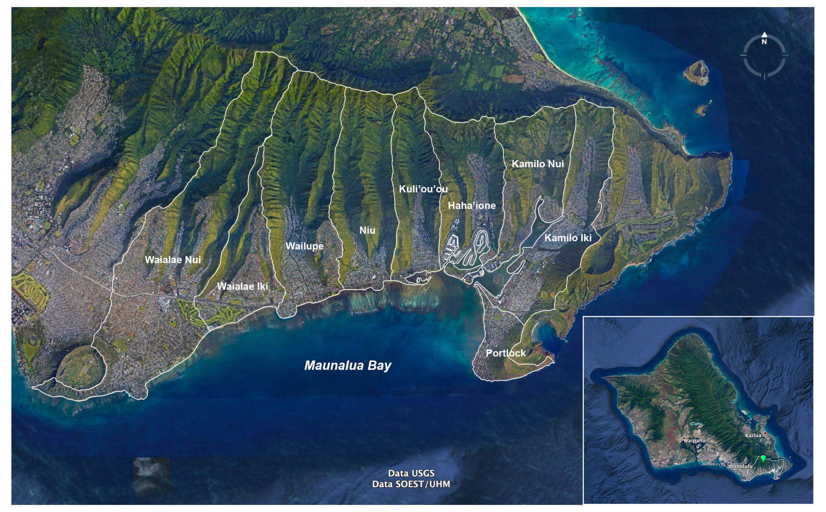

Figure 1. The Maunalua Bay Region, O'ahu, Hawai'i, U.S.A.

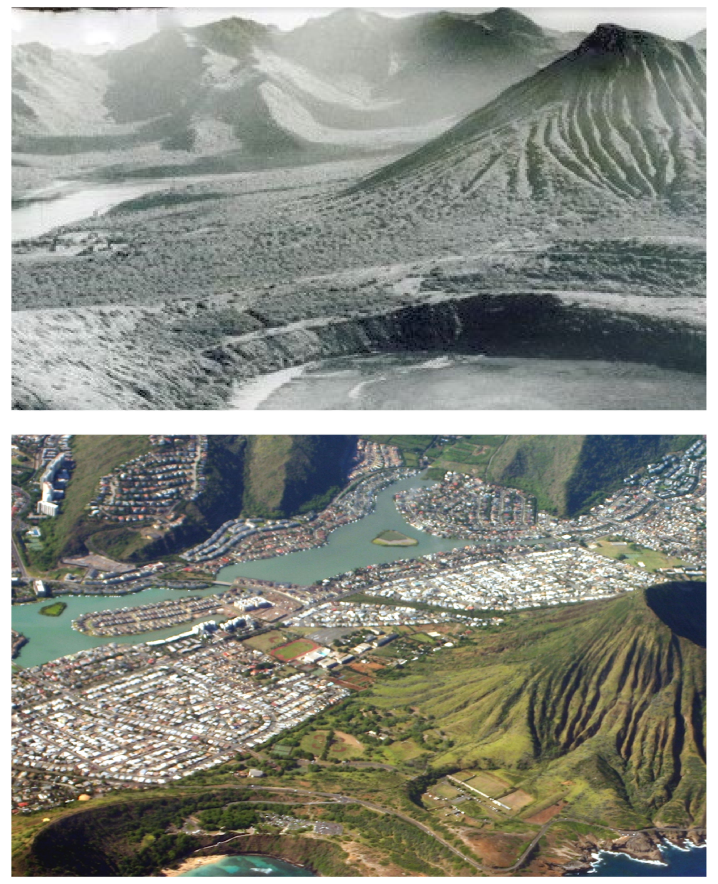

Figure 2. Hawai'i Kai 1920, Maunalua Fishpond Heritage Center (top), Hawai'i Kai Present, Brocken Inaglort (bottom)

Coastal Ecosystem Impacts

Stressors such as polluted stormwater runoff have negatively impacted the ecosystems of Maunalua Bay [1] (Figure 1). Fine sediments are particularly damaging to coral reefs [1, 2] as they are carried with high peak flows of stormwater from erosion of the upper watershed [3, 4].

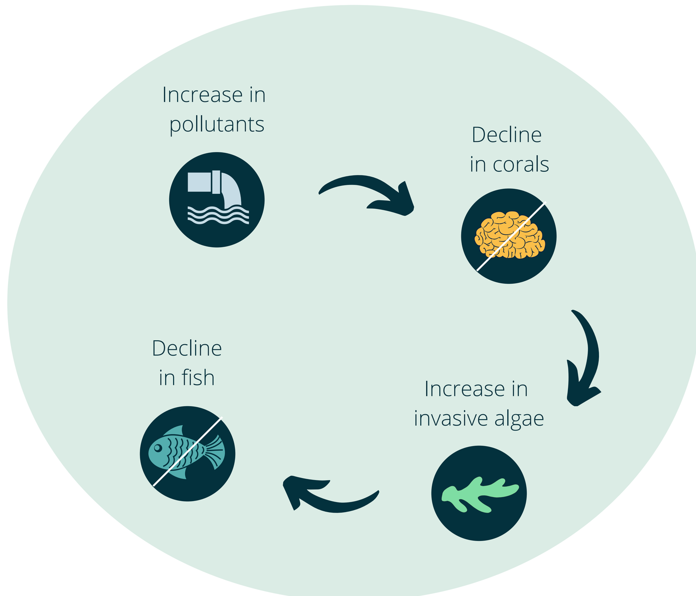

Figure 3. Diagram of ecological impact of stormwater pollutants

Project Objective

Develop a model using the Environmental Protection Agency's Storm Water Management Model 5.1 (SWMM) [5] to facilitate identification of "hotspot" areas that contribute higher stormwater pollution relative to surrounding areas in the Maunalua Bay Region

Approach

- Characterize data availability and limitations for each of the 10 watersheds in the region
- Delineate a representative watershed into areas called subcatchments using the heterogeneity of the natural and built environment
- Use a hydrologic model, SWMM 5.1, to obtain a baseline estimate of runoff pollutant loading in the chosen watershed
- Identify hotspot subcatchments that contribute higher total flow volume or peak flow relative to other subcatchments.

Main Findings

1 Model Results: Simulated vs. Observed Discharge

Our model is useful to identify spatial distributions of runoff and the associated hotspot locations. Figure 4 shows the timeseries of observed and simulated discharge.

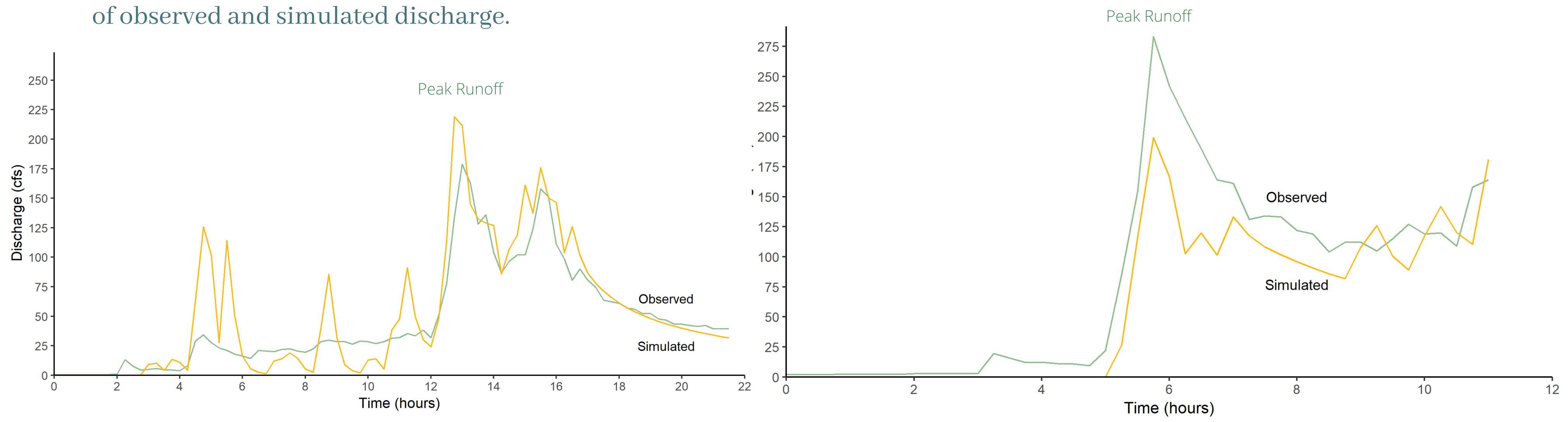

Figure 4. December 19, 2010 (left) abd March 14, 2009 (right) precipitation events [6] with a performance of: R2 (0.80); NSE (0.65); Peak simulated discharge (+13%), and R2 (0.89); NSE (0.80); Peak simulated discharge (-24%), respectively

2 Stormwater Volume and Peak Flow Identified Hotspots

Top 20 hotspot subcatchments were determined by overlaying subcatchments with high runoff ratios (0.64-0.80) for both storm events (Figure 5). The top 20 hotspot subcatchments for peak flow were determined by overlaying subcatchments with high peak flows (13 to 92 cfs) for both storm events (Figure 6).

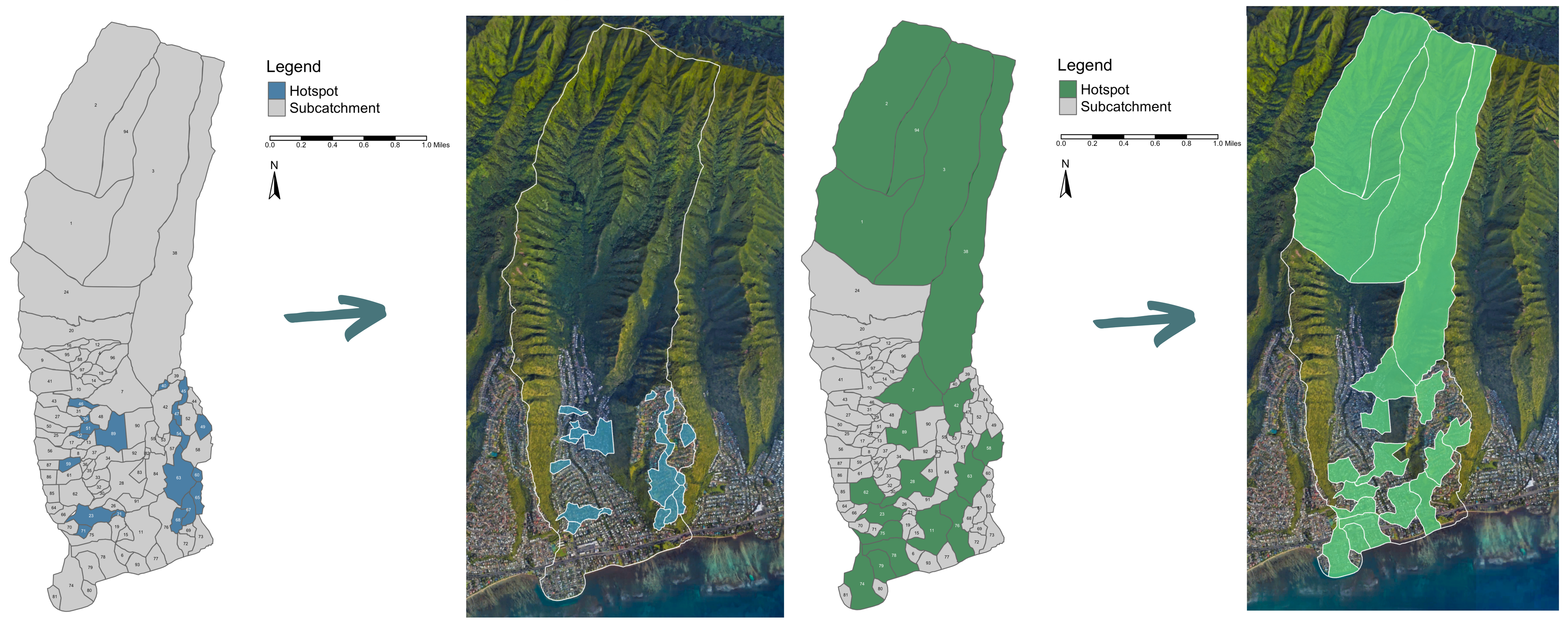

Figure 5. Top 20 Stormwater Volume Hotspots Within the Wailupe Watershed Figure 6. Top 20 Peak Flow Hotspots Within the Wailupe Watershed

3 Relationship Between Urbanization and Runoff

Figure 5 shows that higher percent of impervious surfaces from urban environments generates more runoff.

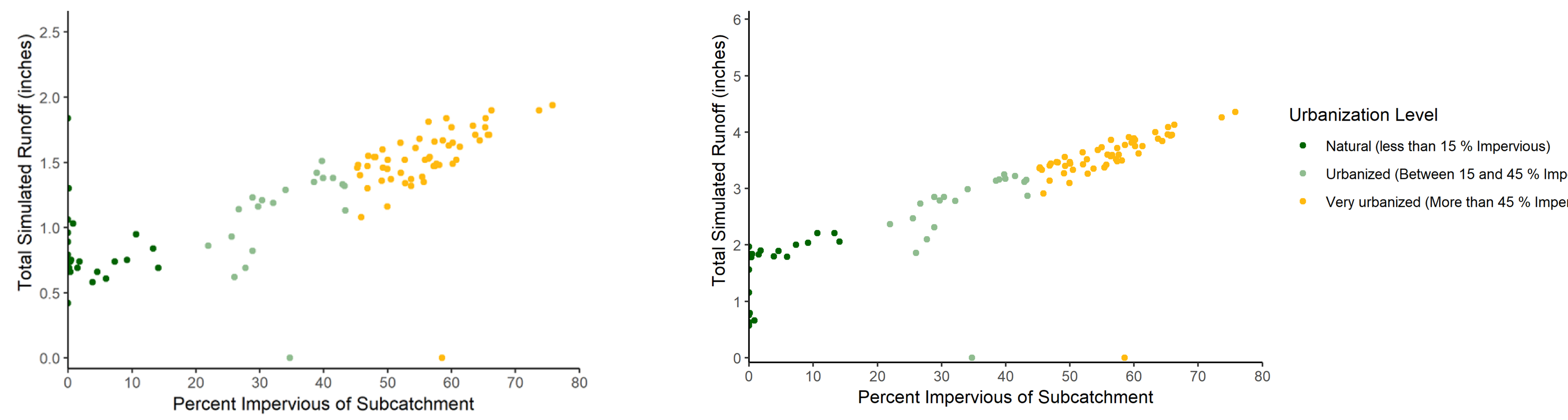

Figure 5. March 14, 2009 (left) and December 19, 2010 (right) precipitation events [6].

Recommendations

- Stormwater Volume (Runoff): Explore green infrastructure placement to increase infiltration of stormwater and pollutants to natural soils [7].
- Peak Flow (Sediment): Reduce sources of sediment with erosion control measures of mass wasting areas in upper watershed, and prioritize green and gray infrastructure that provides sediment controls in the lower watershed [8].
- Regional Strategy: Use the model as part of a regional strategy to prioritize hotspot subcatchments for the remaining watersheds with viable data in the bay. Involve the community and other stakeholders in an informed decision making process based on results from the model, tools, and ground truthing.

Example Hotspot Areas

Highly urbanized areas (Kuli'ou'ou watershed, top, and the Haha'ione Watershed, bottom)

Examples of heavy sediment erosion, called mass wasting areas, in the upper watershed. (both images, Niu Watershed).

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