Using Circuits to Promote Water Sustainability and ʻĀina-Based Learning

Authors: Jenny Brown
Faculty Advisor: Aaron Hanai, Ph.D. and Jacob Tyler, MS
Kapiʻolani Community College, Honolulu, HI

Motivation

The goal is to create an electric circuit representation of the streams in a particular watershed or ahupuaʻa. The behavior of water flowing down a slope can be mathematically analogous to the electric current flowing through a circuit. Circuit simulations can then predict water flow, based on changes in weather or changes in engineered water diversions.

Process

- Get the terrain map of a particular watershed or ahupuaʻa, and select a few streams
- Research about said area (cultural, geographical, and linguistic significance)
- Determine the elevation of a few points along each stream using databases
- Design an analogous circuit representation (voltage ↔ elevation)
- Run a circuit simulation to determine the current through each circuit branch (current ↔ water flow)

1. To represent this project, the streams in ahupuaʻa in Waikīkī are going to be Waiʻalaenui, Waiʻalaeiki, Wailupe, and Pia.

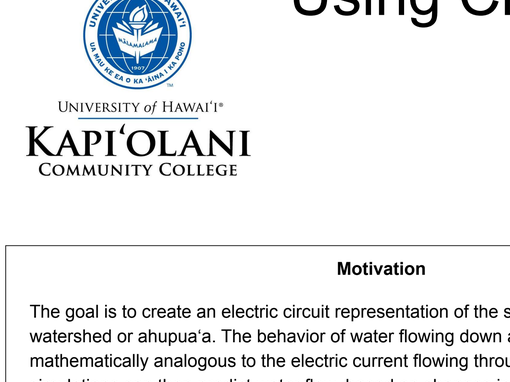

Fig. 1 Streams on Oahu via Hawaii Statewide GIS Program

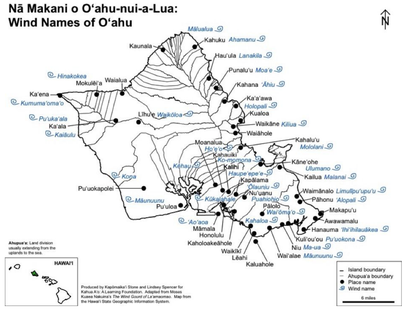

Fig. 2 Wind names of areas

2. Research your area of interest!

Māunuunu (Wind of Waiʻalae) - māunu: to molt; to change skin;

Honolulu, Kona, Waikiki Wind names: Kukalahale (general Honolulu)
Rain names: *Waikiki: Leikokoʻula
General Honolulu: Kūkalahale

2. To determine the geological elevation of the various points of the streams, as the elevations at certain points of the map.

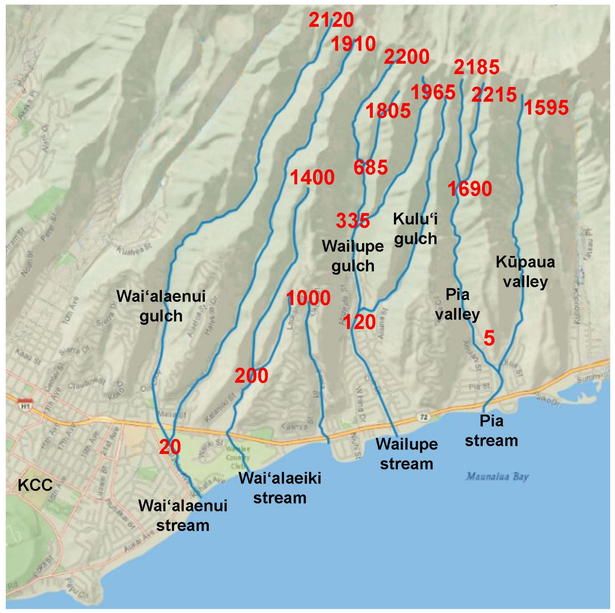

Fig 3. The a(Waiʻalaenui), b(Waiʻalaeiki), c(Wailupe), and d(Pia) are shown with their elevation (in feet) with its respective cross sections.

3. **What we assume before drawing the streams as the a circuit board:**

- ohm. [ōm] **The SI derived unit used to measure the electrical resistance of a material or an electrical device**. One ohm is equal to the resistance of a conductor through which a current of one ampere flows when a potential difference of one volt is applied to it.
- **Elevations are DC voltage:** The elevations of the source of the streams will be considered as a DC voltage and the ocean as the ground. Between the voltage and the node (cross section) will be resistors that represent the rocks or trees that changes the current of the river. Since the voltage at each node can be determined by the help of elevation, Kirchhoff's Current Law plays an important role in finding the ohms in the resistors.
- **Resistors closer to the ground is 1k Ohms and current is ½ node:** Assuming the current closer to the ground is half of either the current that connects to the node and the resistor closer the ground is 1k ohms.
- **Use Multisim… voltages and elevation are the same means it's correct:** For redundancy, a simulation in Multisim is made to examine if the resistors are correct by checking the voltages at the node are similar to the elevation, since the elevations determines the voltages.

Delivered Product

The make or break moment is if our calculations of the resistors match the voltages in the Multisim. The numbers should match up as seen in figure 4. If it's wrong, your Ohms are off.

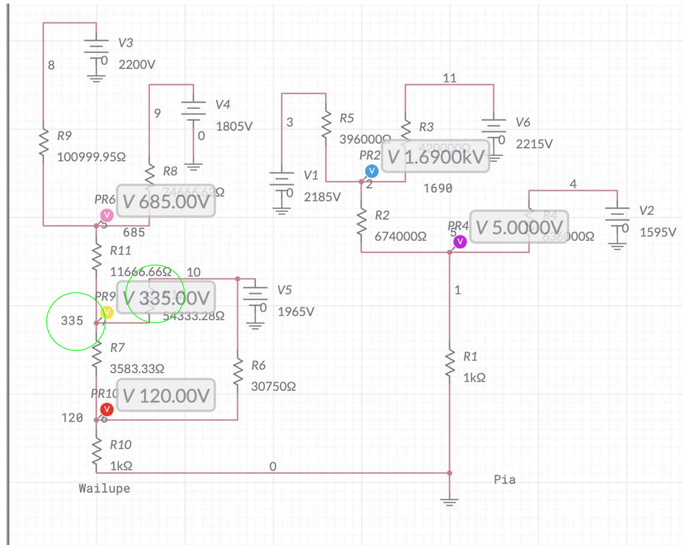

Fig. 4 Multisim with correct resistance (Voltages and numbers should match)

Significance

This project is a way to predict the behavior of water flows based on human interventions (such as water diversions), so the community can better know HOW to take actions that sustain the watershed in a responsible manner and promote resilience.This pilot project will also can serve as the template for a series of ʻāina-based learning class assignments in the EE 211 course on Circuit Analysis.

Lessons Learned

- Utilize all your resources: Google Scholar, Campus Resources, etc
- Talk to people who know more than you for background information
- Recheck your arithmetic

Acknowledgements

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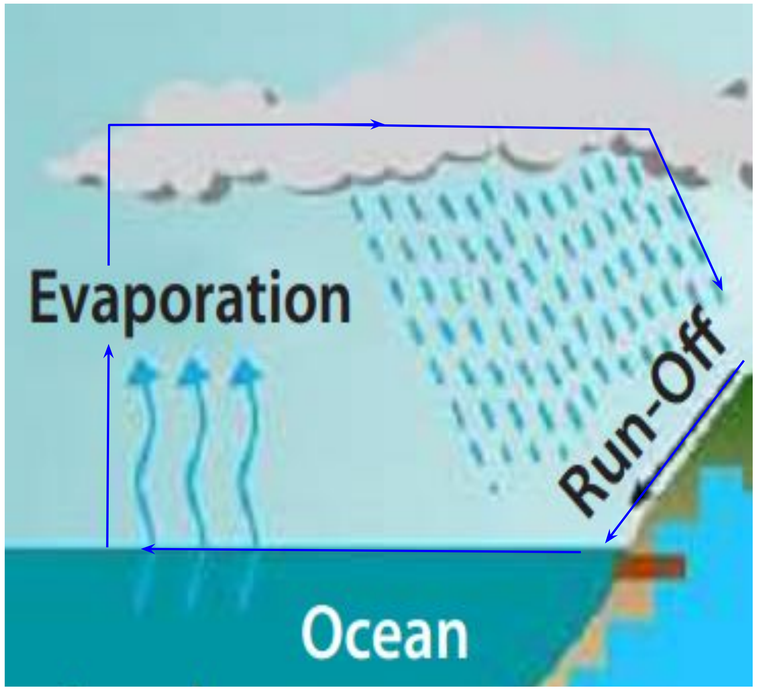
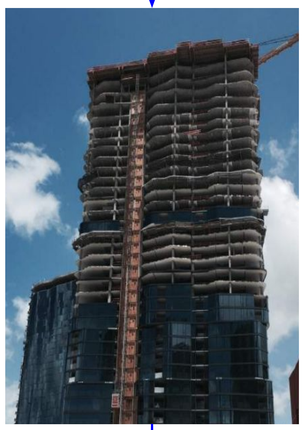
Analogous Systems



Natural water cycle



volume flow

higher elevation

pump

resistance to flow

reservoir

lower elevation

Engineered water supply network

current

higher voltage

battery

resistor

ground

lower voltage

Electric circuit

Makiki sustainability: its efforts across disciplines

Before

After

Resources

Resources

Hawaiian Place Names. (n.d.). Retrieved April 21, 2022, from https://ulukau.org/cgi-bin/hpn?e=d-0mahele--00-0-0--010---4------0-0l--1en-Zz-1---20-about---00031-001-10escapewin-00&a=d&c=mahele&cl=CL1.11.pr#CL1.11

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