

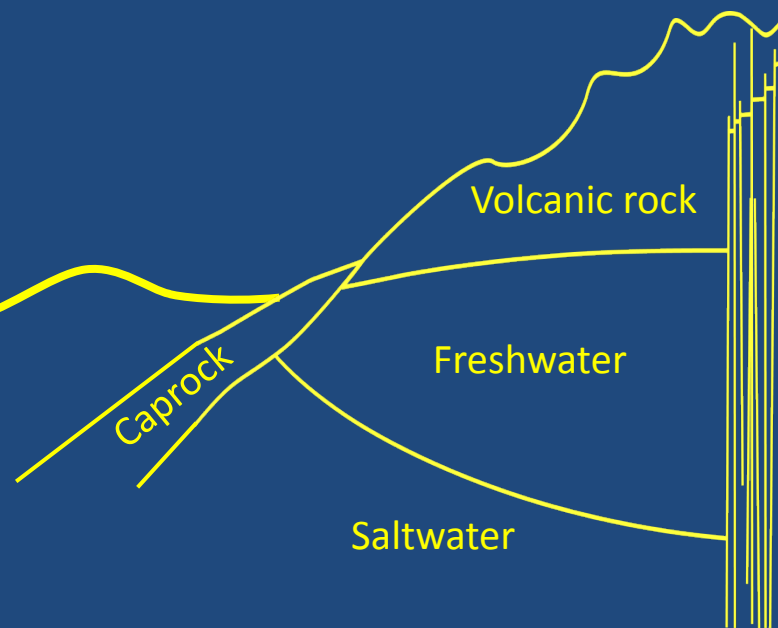
# Quantifying Effects of Humans and Climate on Groundwater Resources Through Modeling of Volcanic-Rock Aquifers of Hawaii



W.R.R.C.  
University  
of Hawaii



**Kolja Rotzoll,  
Scot K. Izuka, Tracy Nishikawa, Michael N. Fienen, and Aly I. El-Kadi**



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# USGS Water Availability & Use Science Program

## Hawaii Volcanic-Rock Aquifer Study

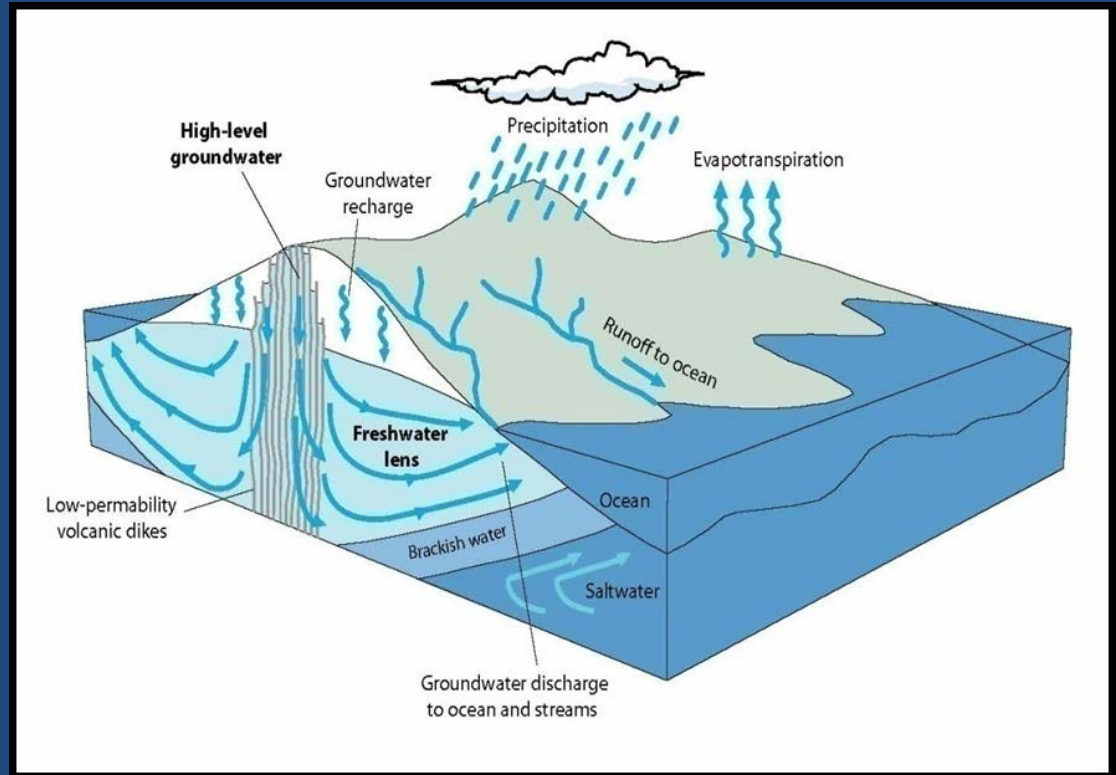
### Challenges

Limited capacity to store fresh groundwater

Sharp contrasts in climate, geology, and hydrology

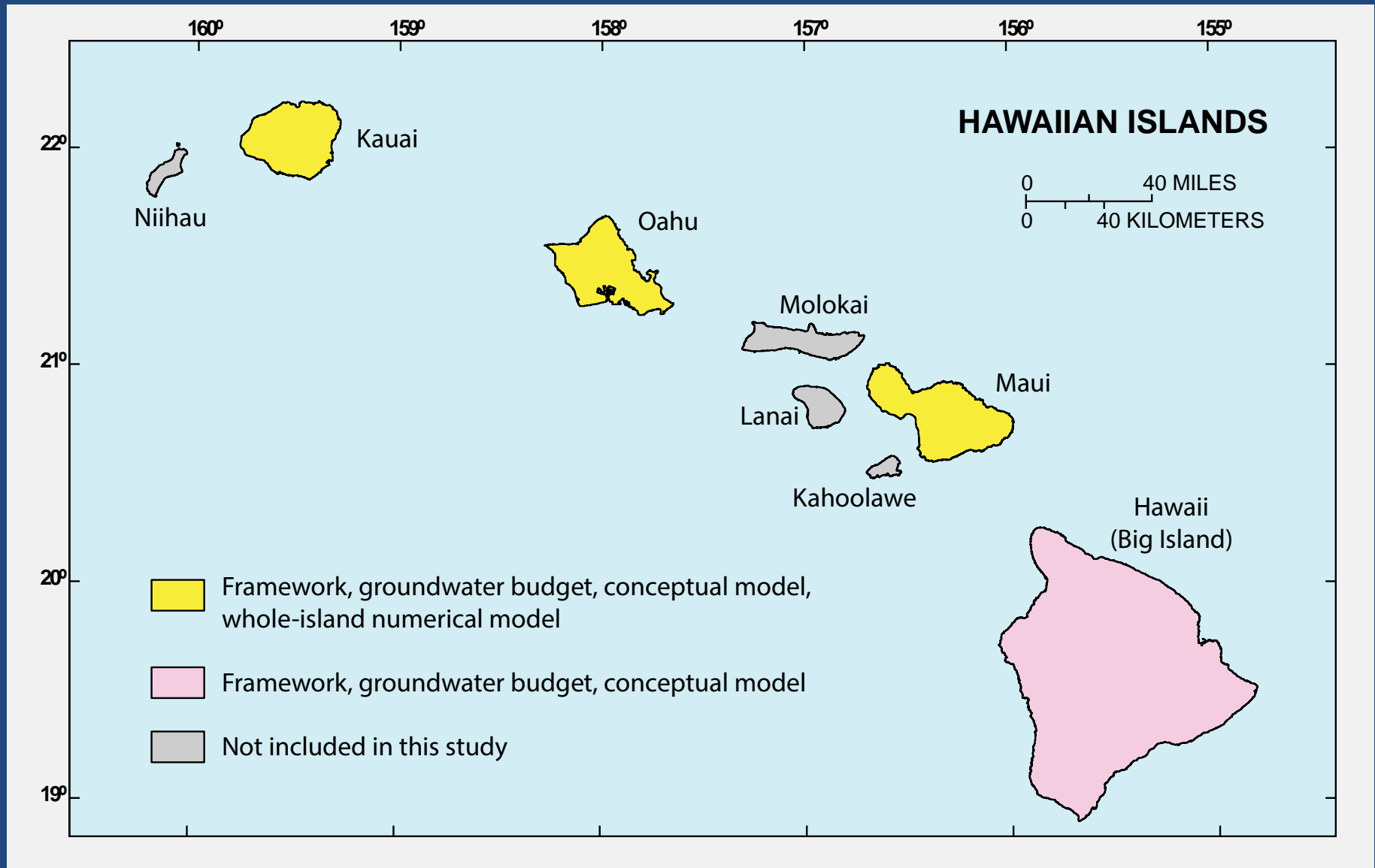
### Scope

- Current condition of the Hawaii volcanic aquifers
- Effects of human activities
- Responses to future stresses



# USGS Water Availability & Use Science Program

## Hawaii Volcanic-Rock Aquifer Study



# USGS Water Availability & Use Science Program

## Hawaii Volcanic-Rock Aquifer Study



Groundwater Resources Program

### Hawai'i Volcanic Aquifers—Hydrogeology, Water Budgets, and Conceptual Models



Scientific Investigations Report 0000–0000

U.S. Department of the Interior  
U.S. Geological Survey

Izuka, S.K., Engott, J.A., Bassiouni, M., Johnson, A.G., Miller, L.D., Rotzoll, K., and Mair, A.,

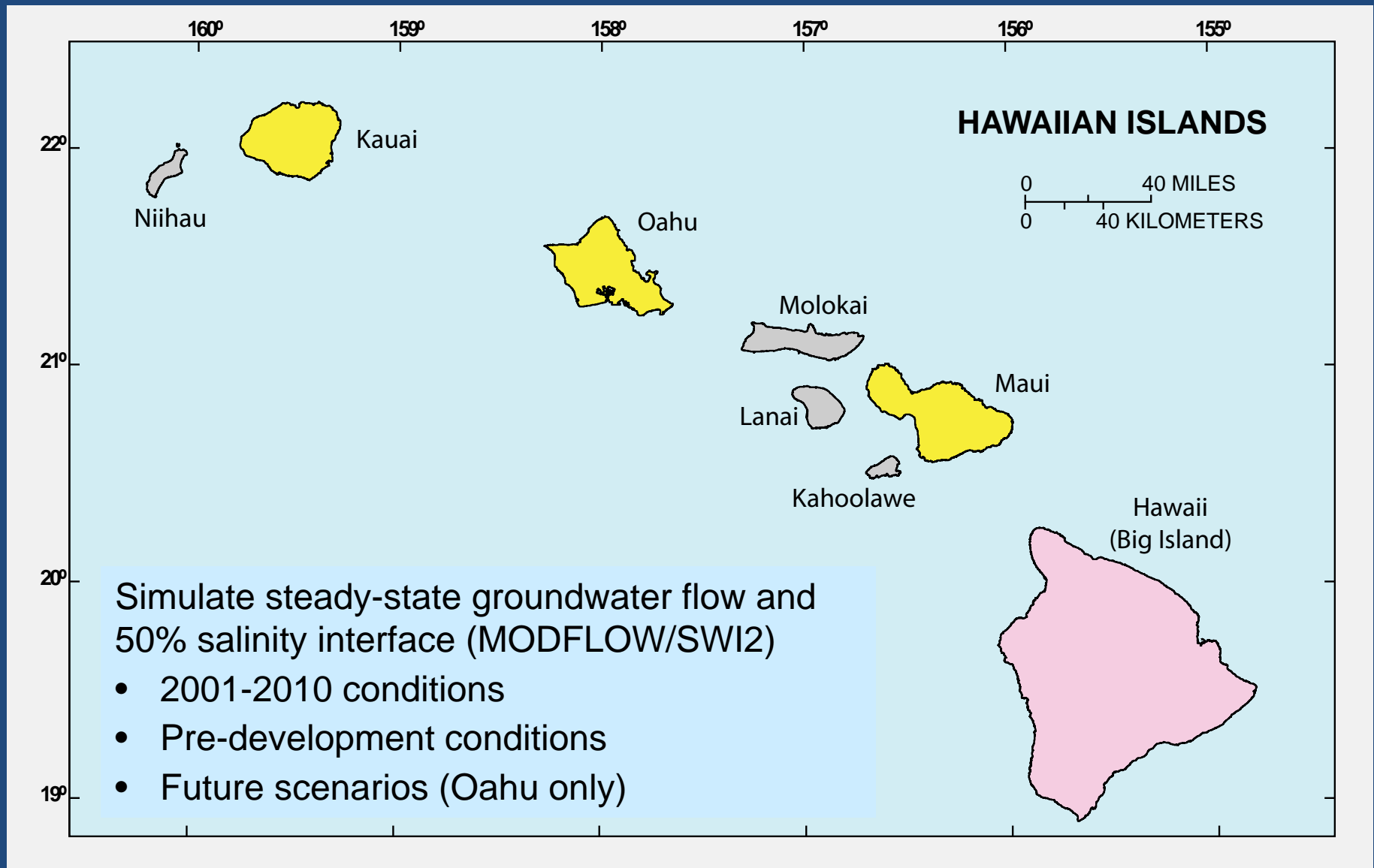
in press,

Volcanic aquifers of Hawai'i — hydrogeology, water budgets, and conceptual models:

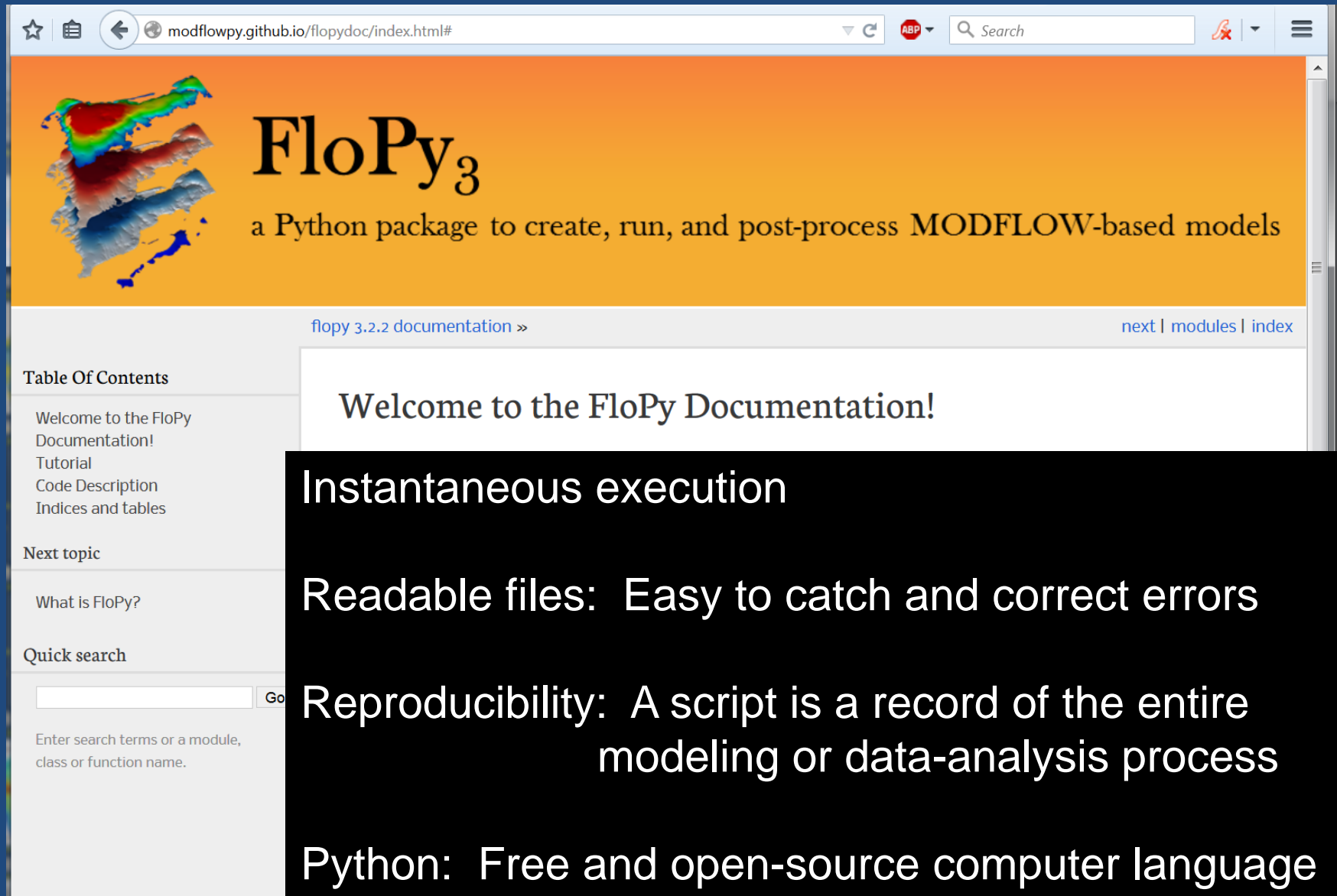
U.S. Geological Survey Scientific Investigations Report 2015-5164

# USGS Water Availability & Use Science Program

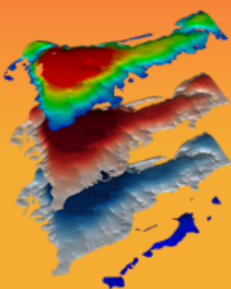
## Hawaii Volcanic-Rock Aquifer Study



# Script-Based Modeling



modflowpy.github.io/flopydoc/index.html#

 **FloPy<sub>3</sub>**  
a Python package to create, run, and post-process MODFLOW-based models

[flopy 3.2.2 documentation >>](#) [next](#) | [modules](#) | [index](#)

**Table Of Contents**

- Welcome to the FloPy Documentation!
- Tutorial
- Code Description
- Indices and tables

**Next topic**

[What is FloPy?](#)

**Quick search**

Enter search terms or a module, class or function name.

**Welcome to the FloPy Documentation!**

**Instantaneous execution**

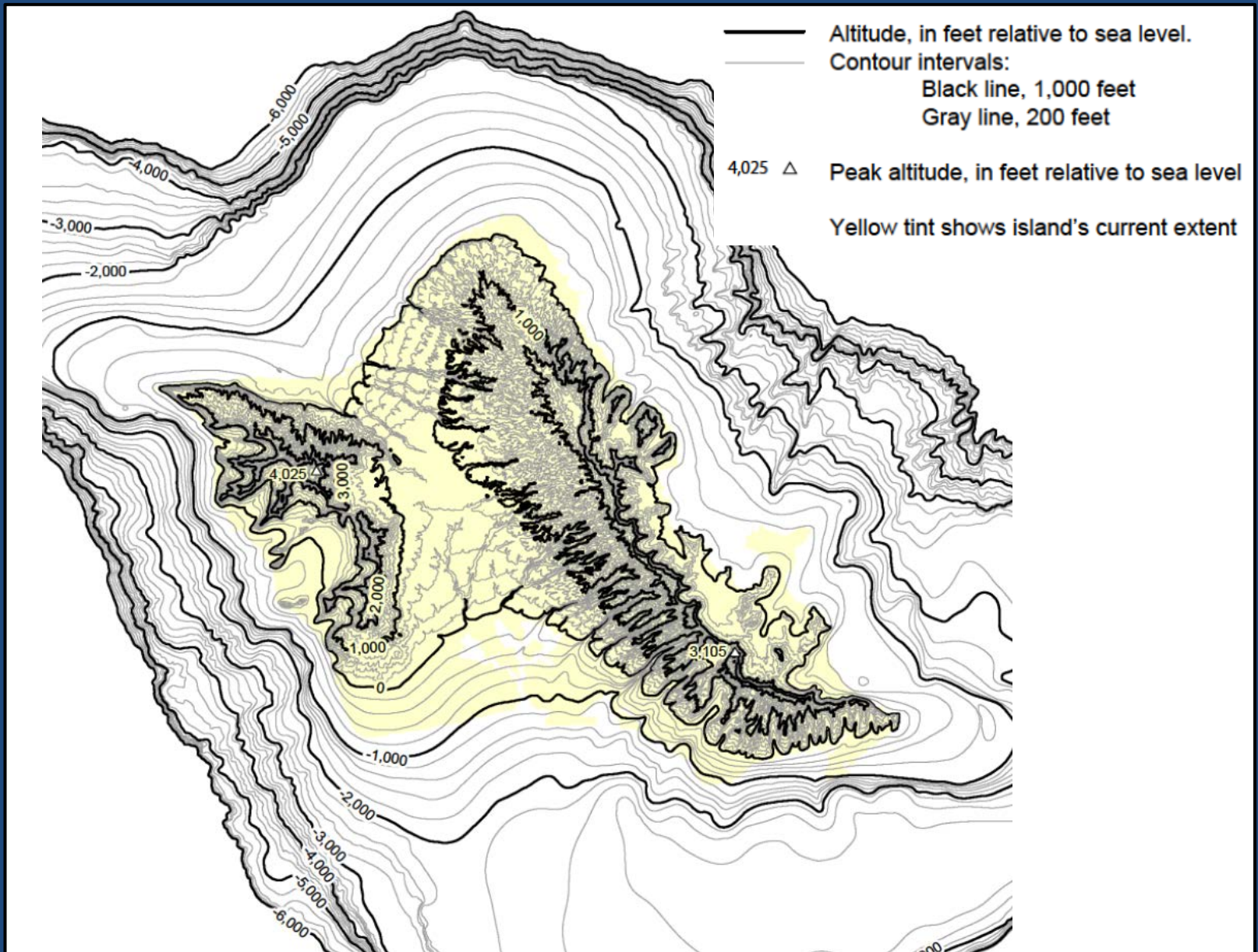
**Readable files: Easy to catch and correct errors**

**Reproducibility: A script is a record of the entire modeling or data-analysis process**

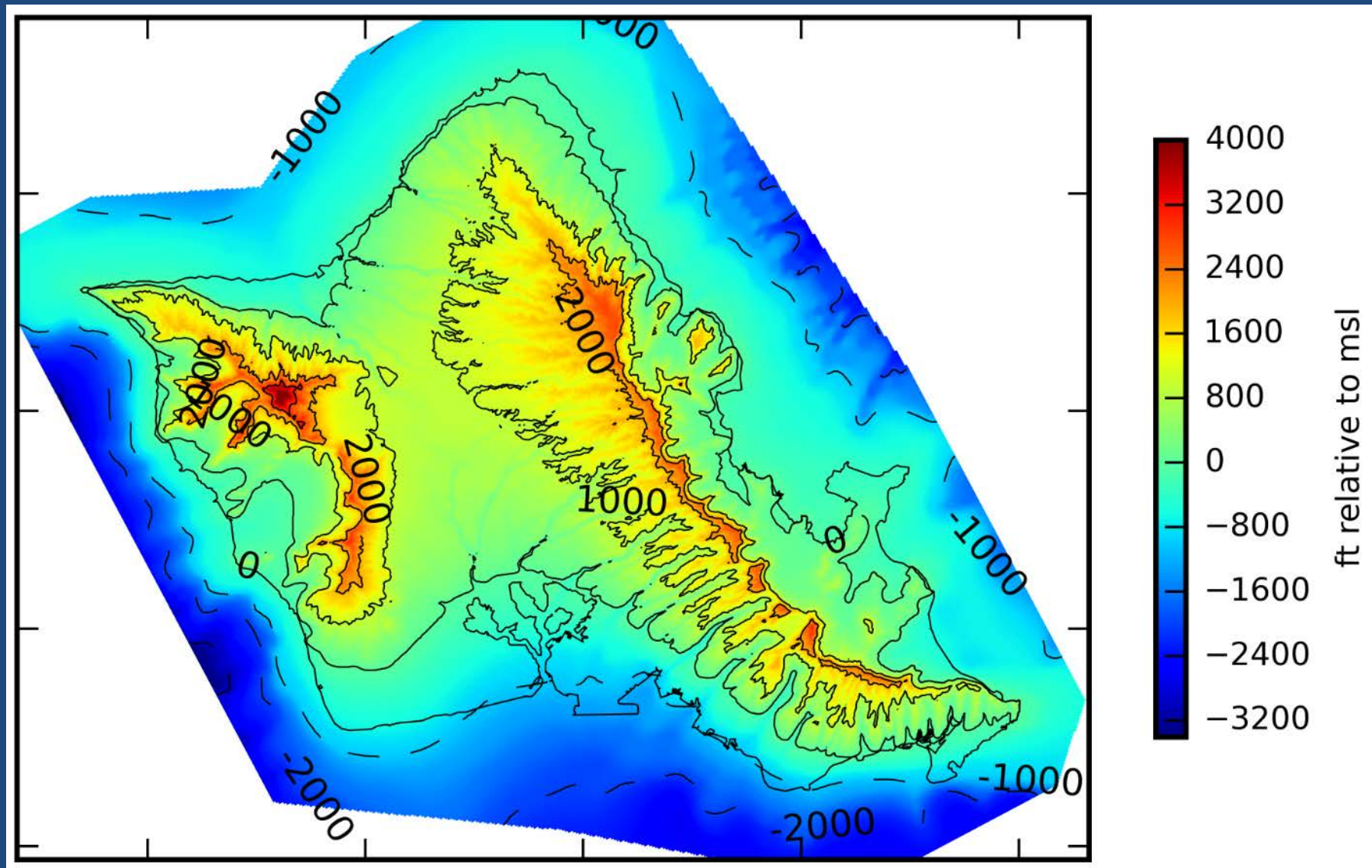
**Python: Free and open-source computer language**



# Basalt Structural Contours



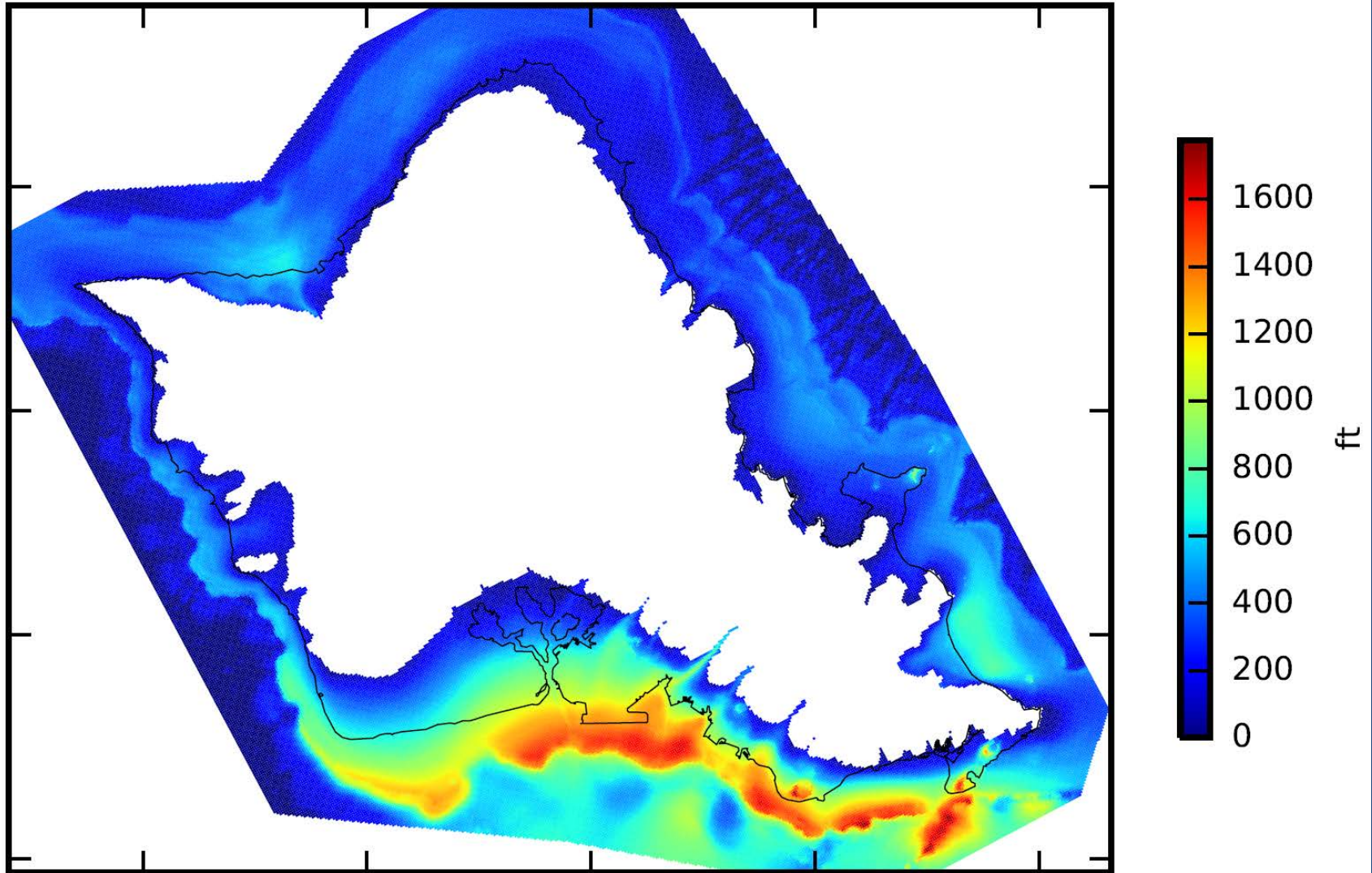
# Elevation of Basalt Surface



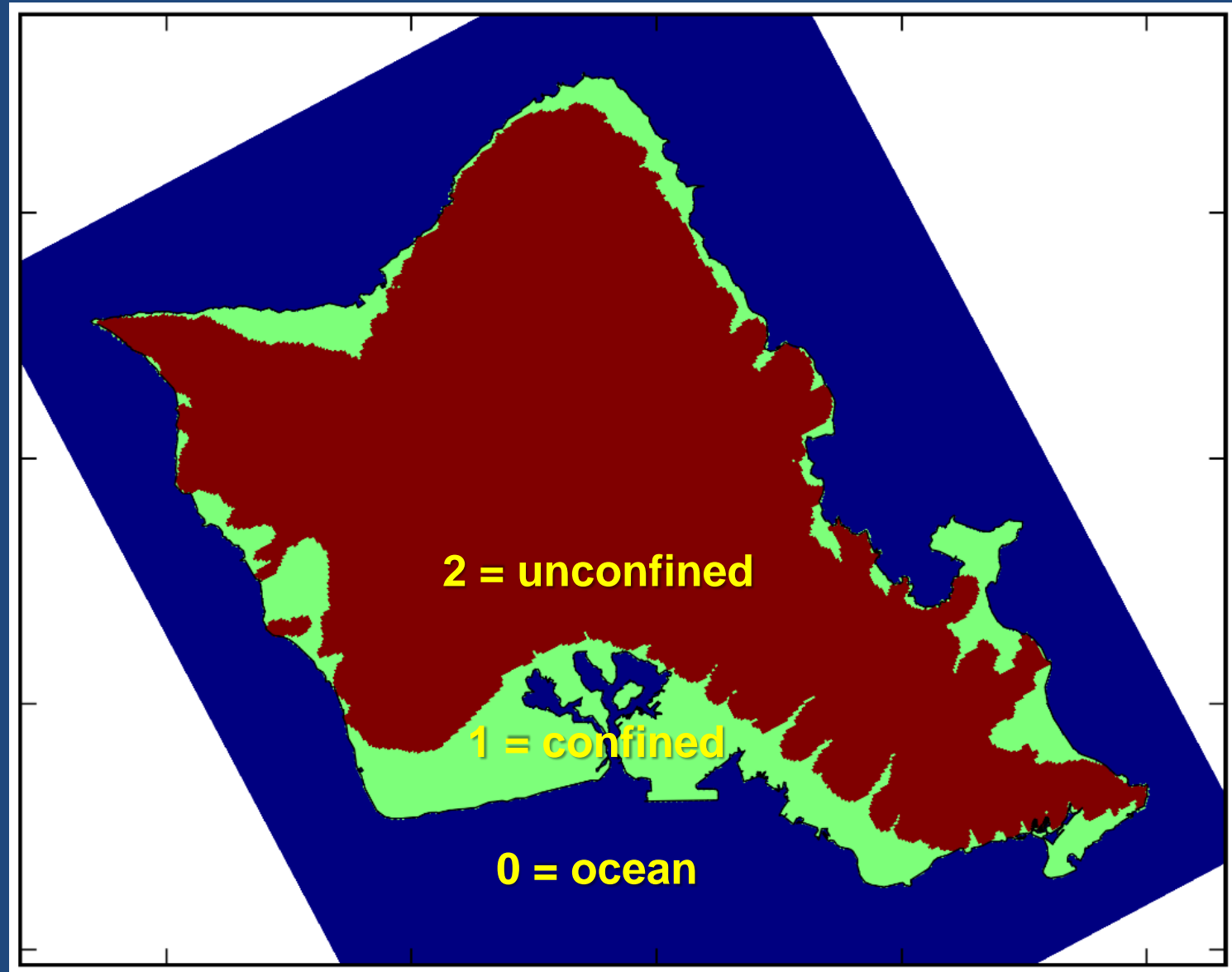


# Sediment Thickness

Surface Elevation – Basalt Elevation = Caprock Thickness

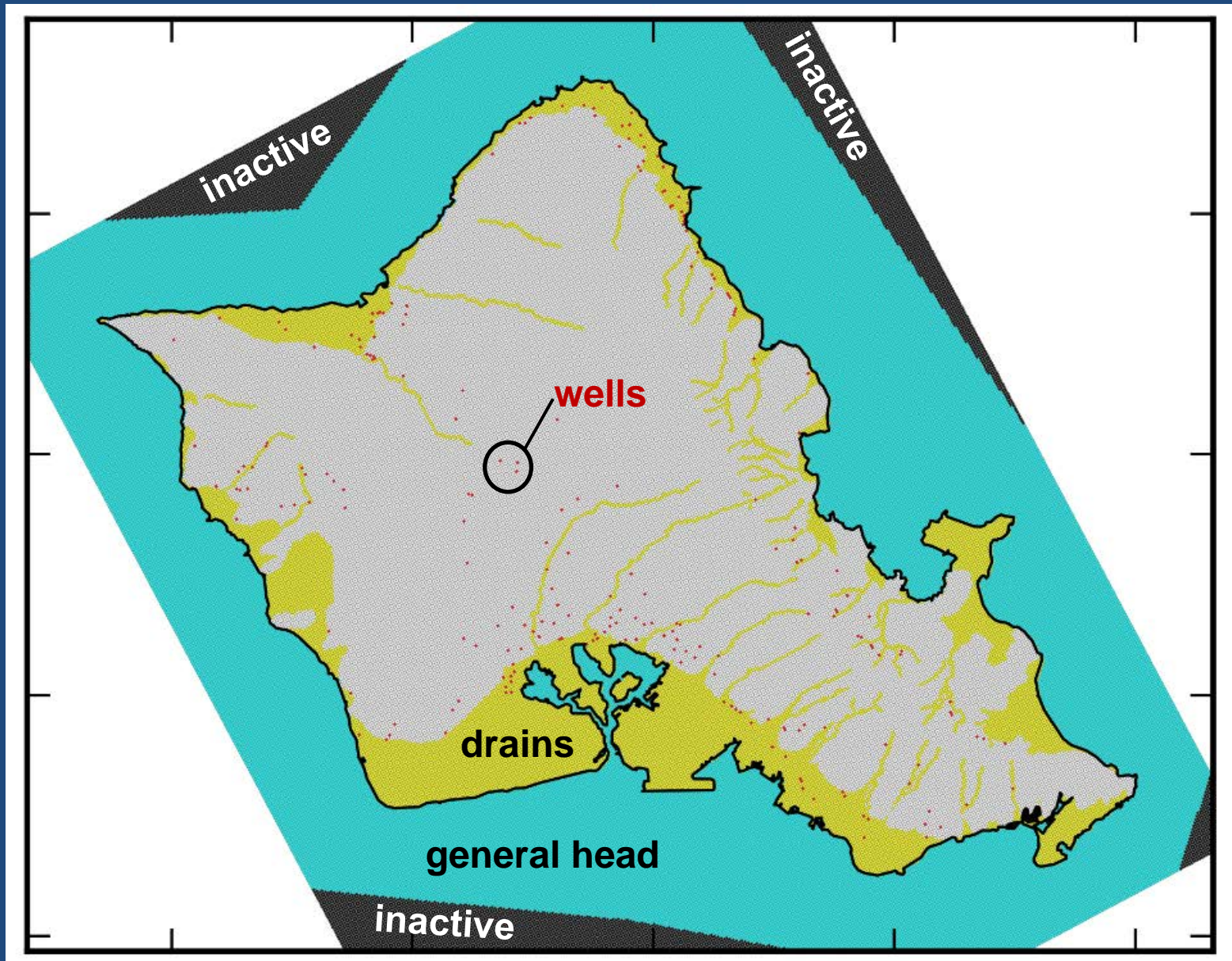


# Boundary Conditions

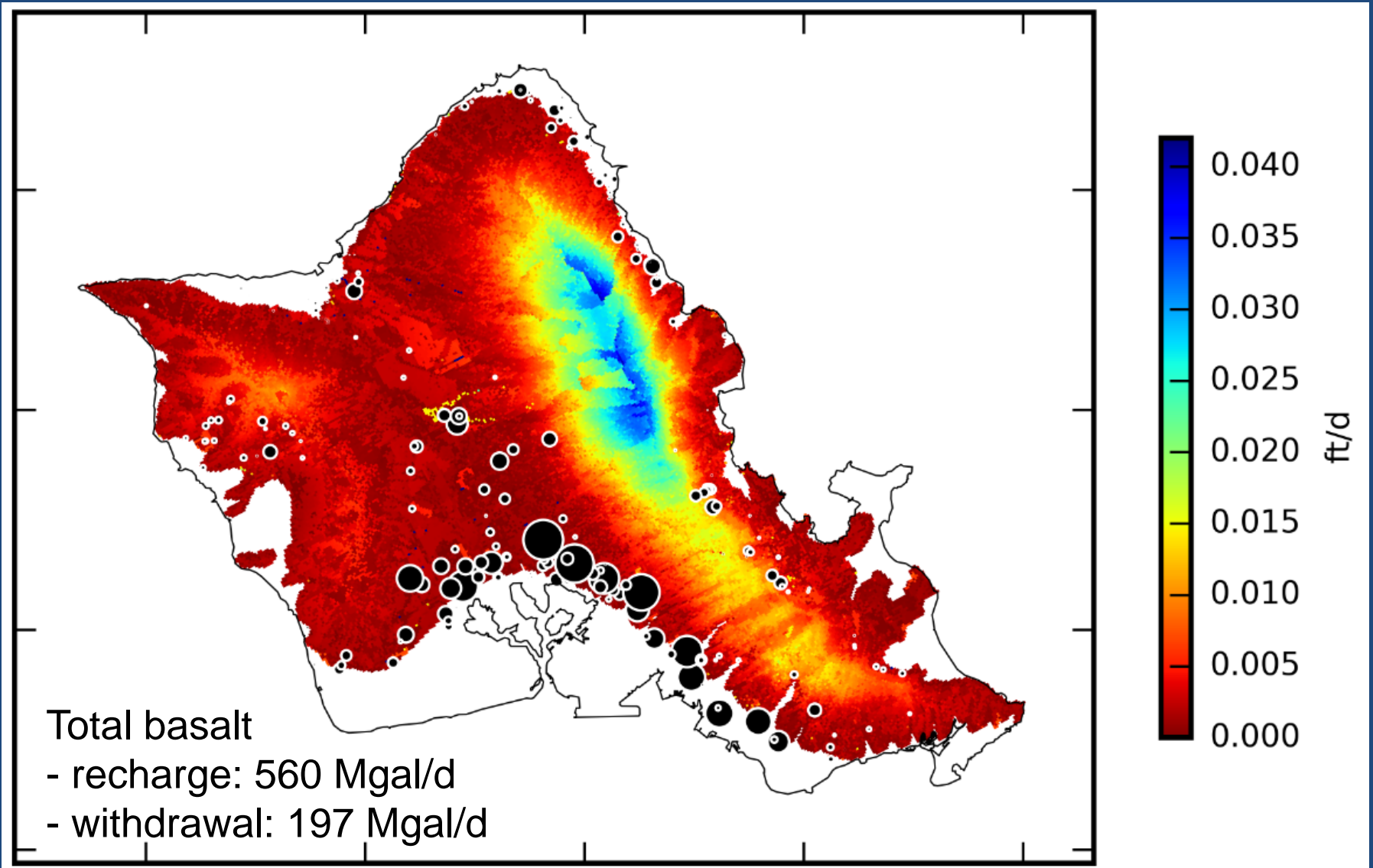




# Boundary Conditions

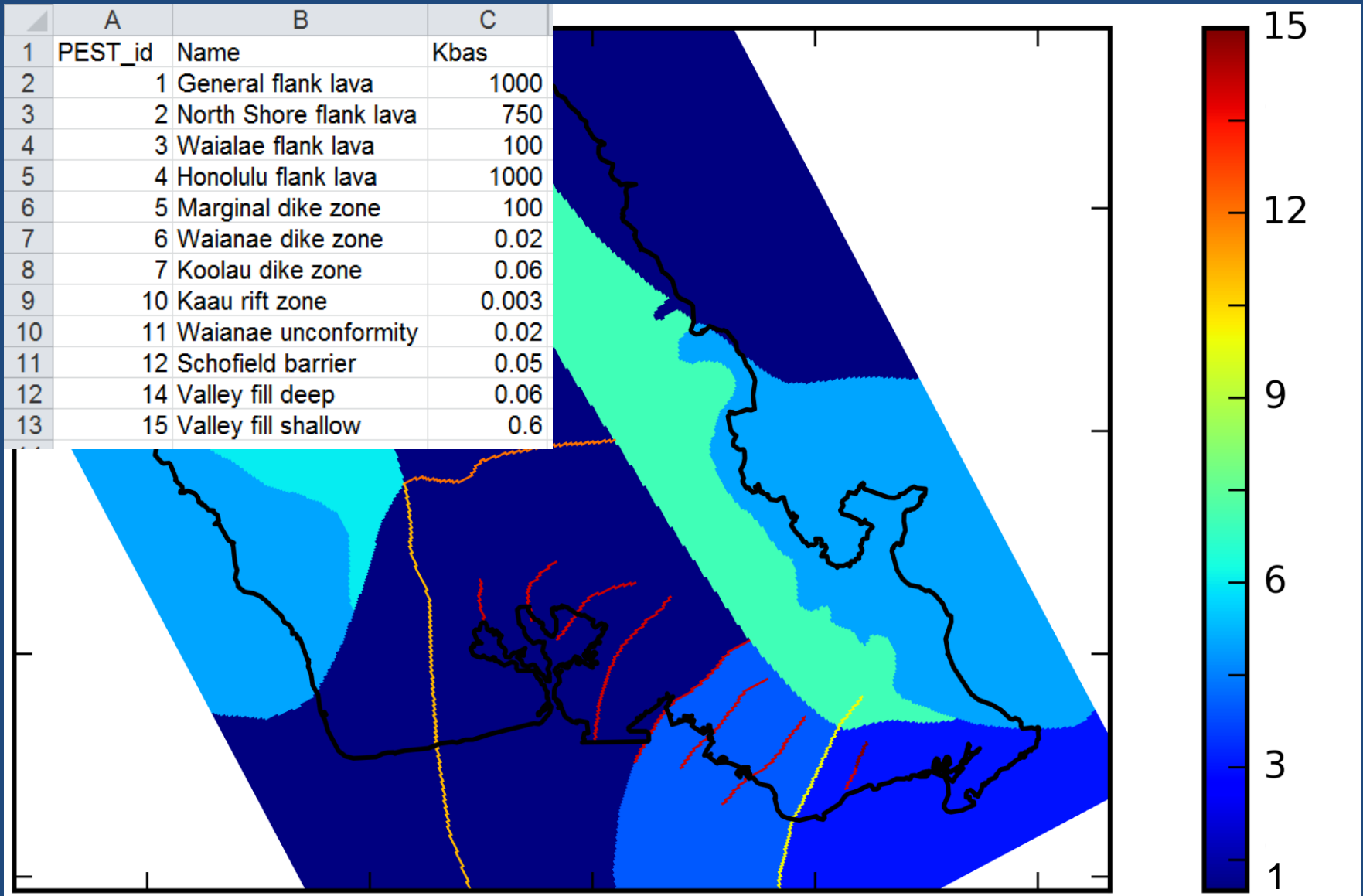


# Average 2001-2010 Withdrawals & Recharge

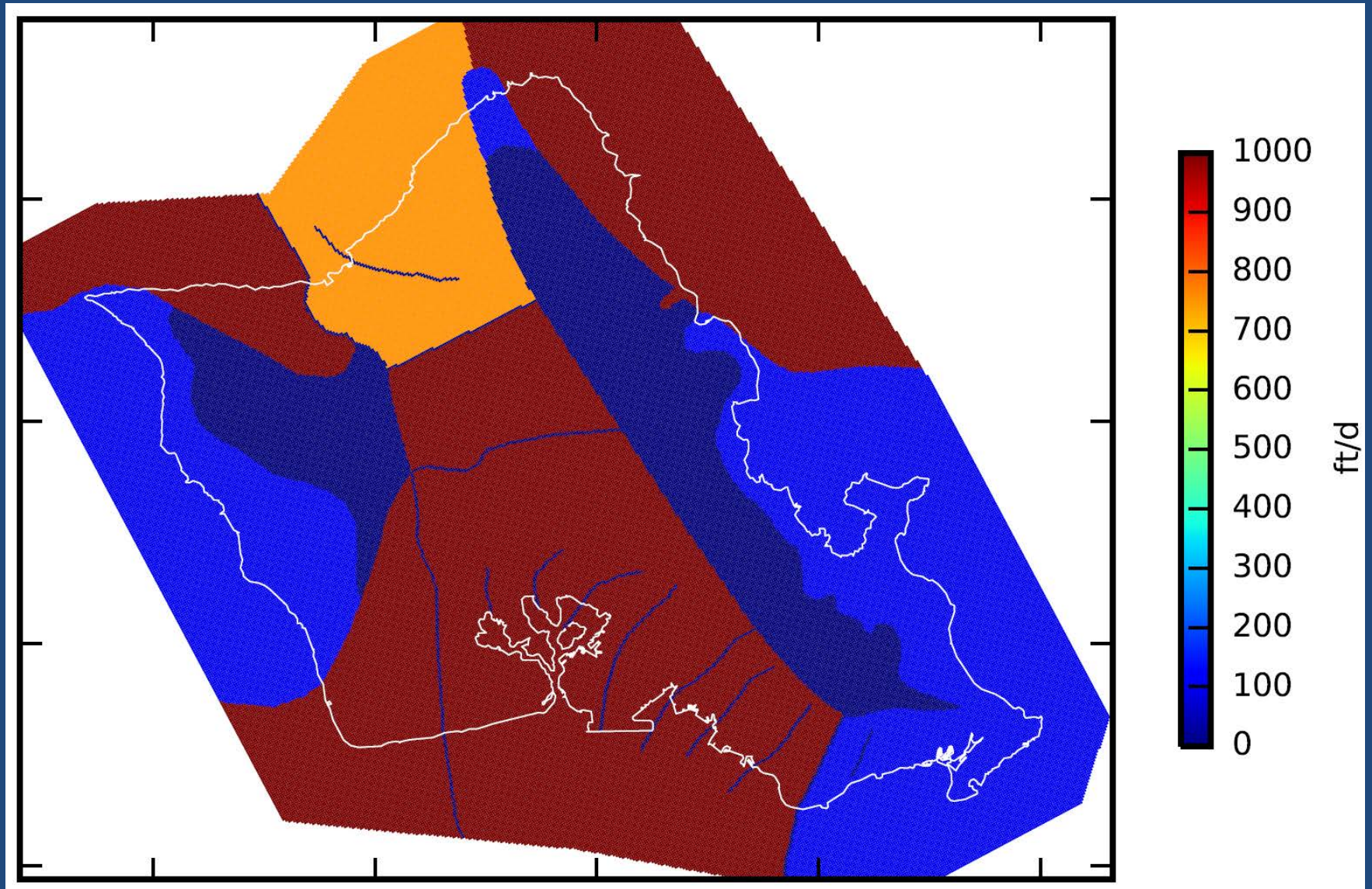




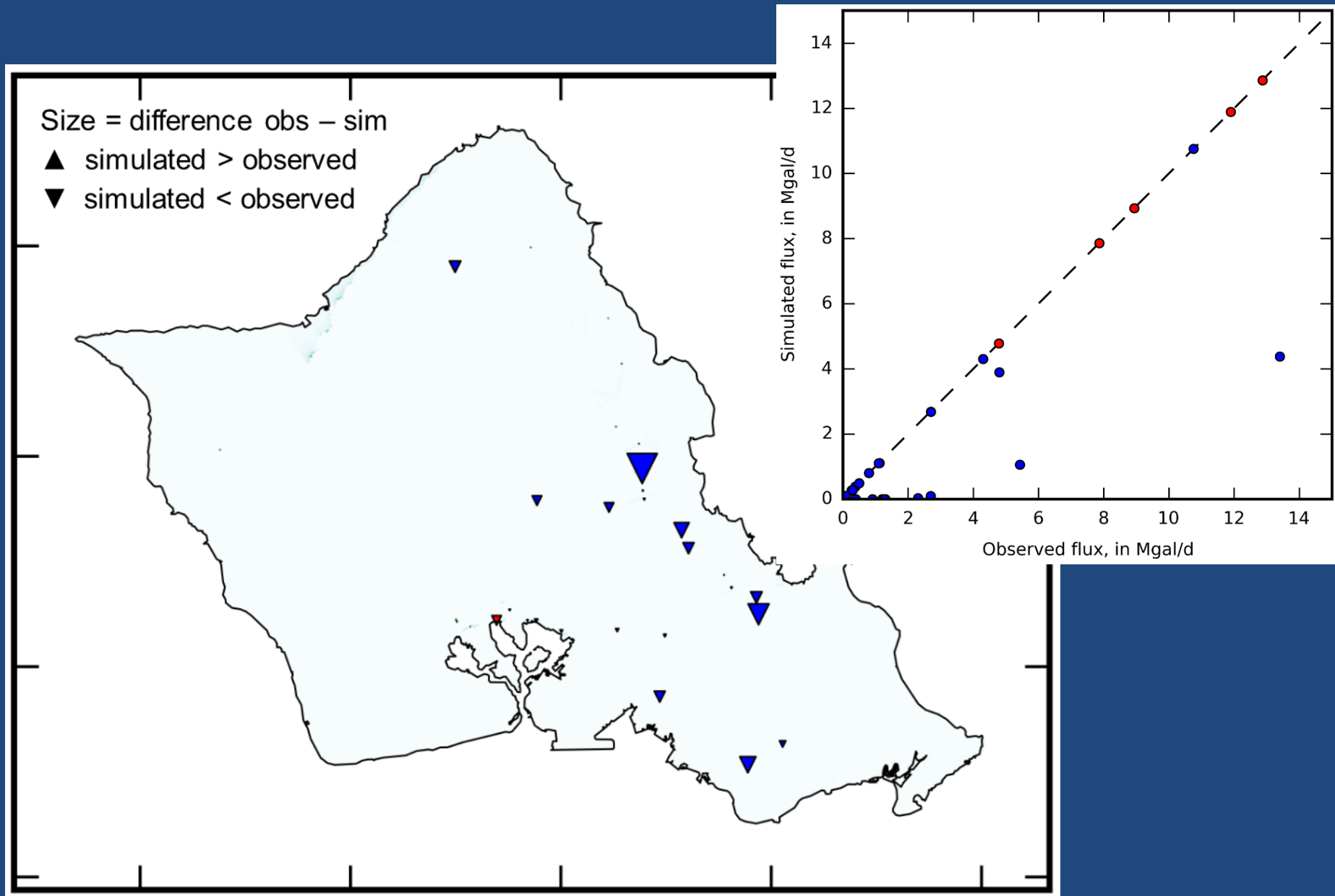
# Integer Grid of Aquifer Zones



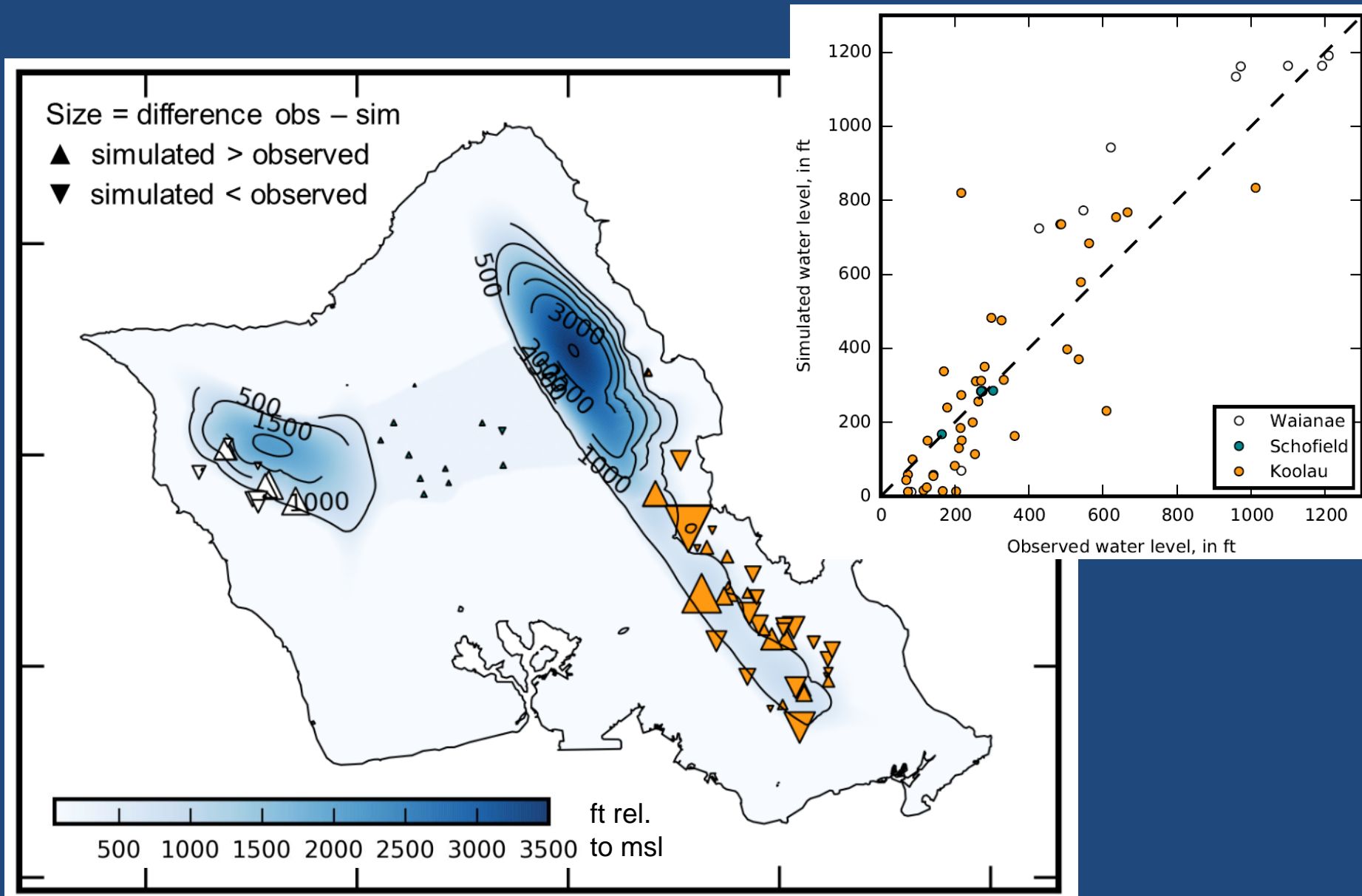
# Hydraulic Conductivity



# Simulated Drain Fluxes

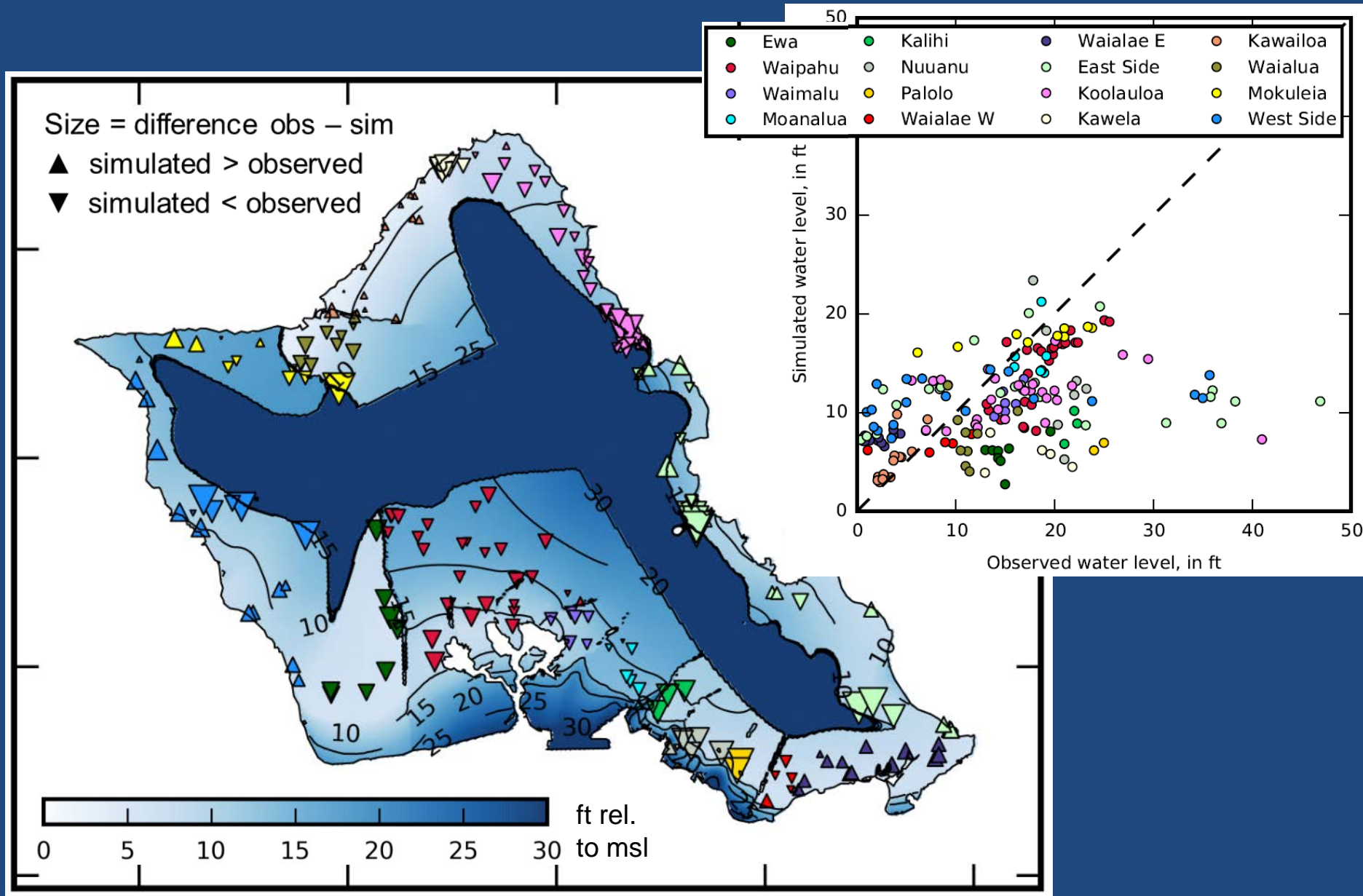


# Simulated High-Level Water Levels



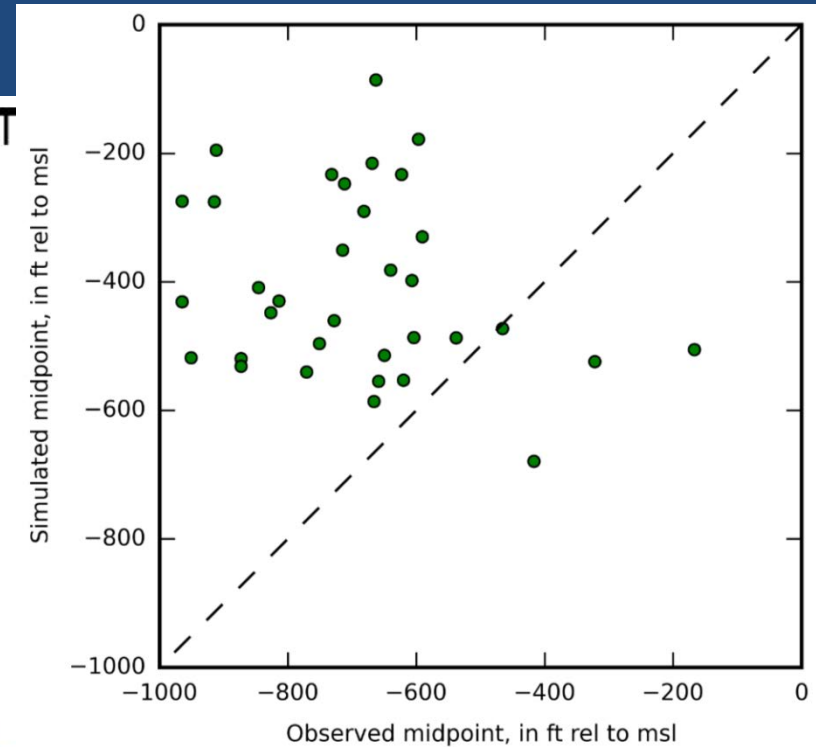
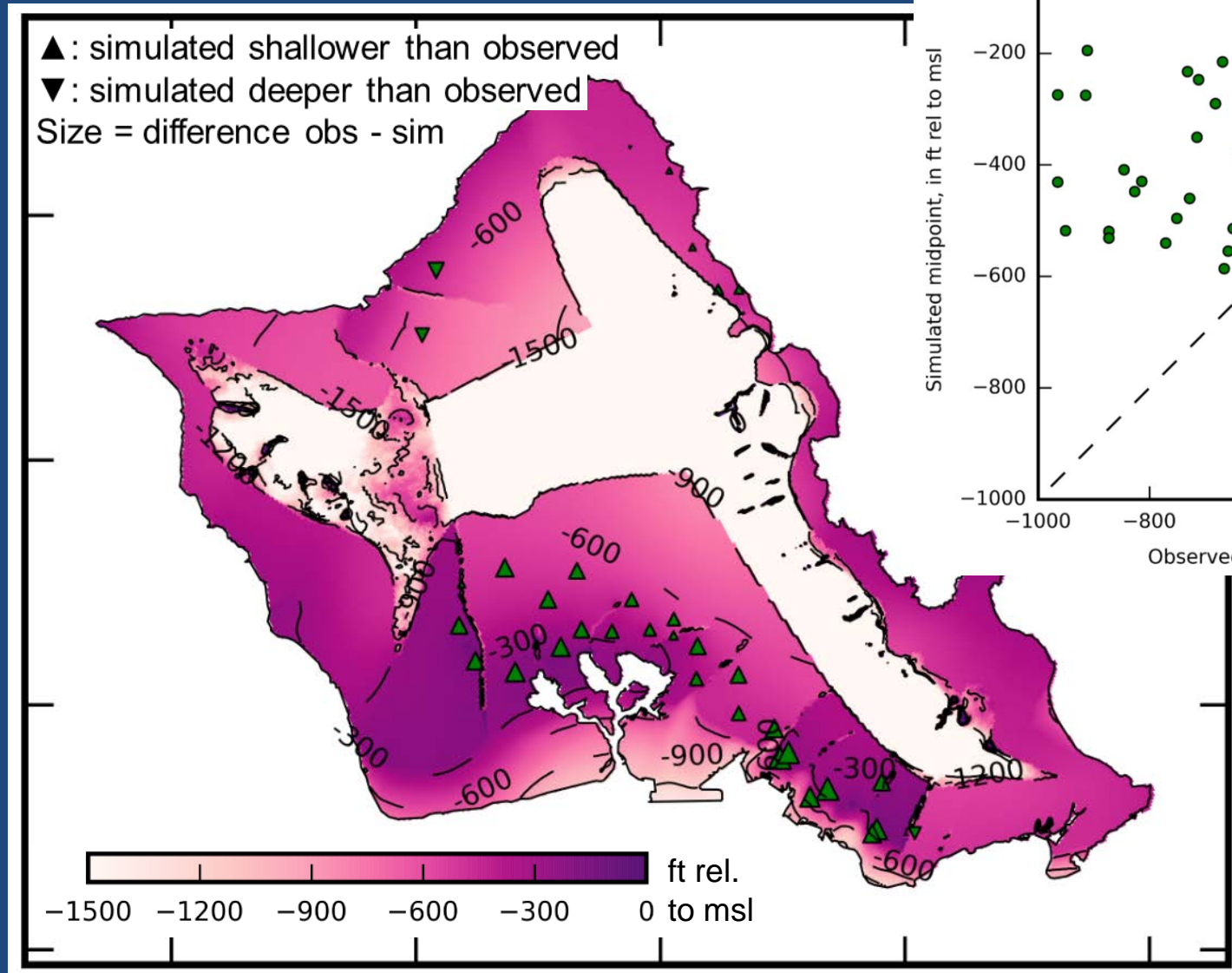


# Simulated Freshwater-Lens Water Levels



# Simulated Midpoint of the Transition Zone

## 50% Seawater-Salinity Depth



# Outlook

- Statistical parameter estimation: PEST
- Run the calibrated model
  - with pre-development recharge and without withdrawals
  - future climate scenarios  
(future land cover & rainfall -> future recharge,  
future withdrawals)
- Assess changes in
  - water levels
  - discharge to streams and ocean
  - freshwater volume (50% salinity interface to water table)
- Compare results of Kauai, Oahu, and Maui

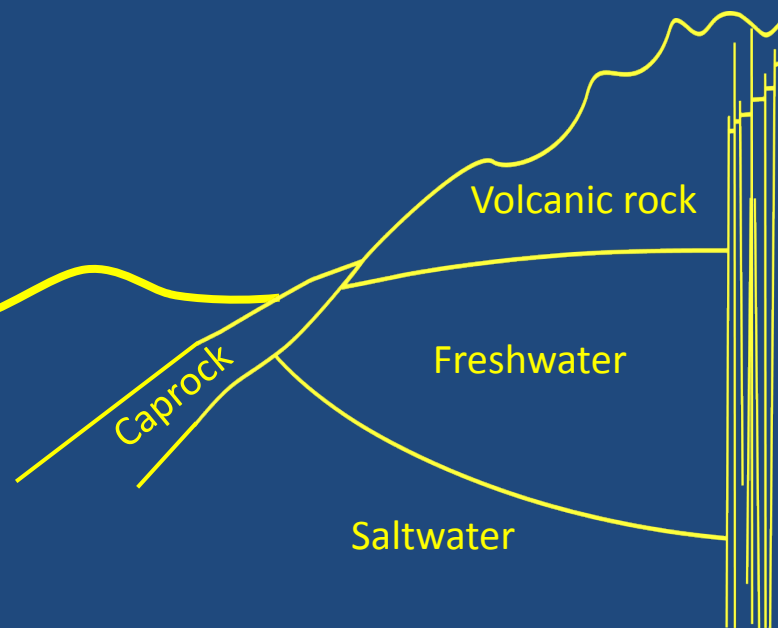
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