

Groundwater Resources Program

**Groundwater Availability in Hawaii
Volcanic-Rock Aquifers**

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Overview

- **Objectives: assess current condition, reconstruct the past, provide tools and information for the future**
- **Federally funded**
- **Uses/complements cooperative work USGS does with State and County**

Water Mission of the USGS

- **Provide information to manage, protect, and enhance the Nation's water resources**
- **Address water-related hazards**
- **Provide information that is reliable, impartial, and timely**
- **Do science, not regulate or manage**



Kipapa Stream, Oahu

USGS Water Programs

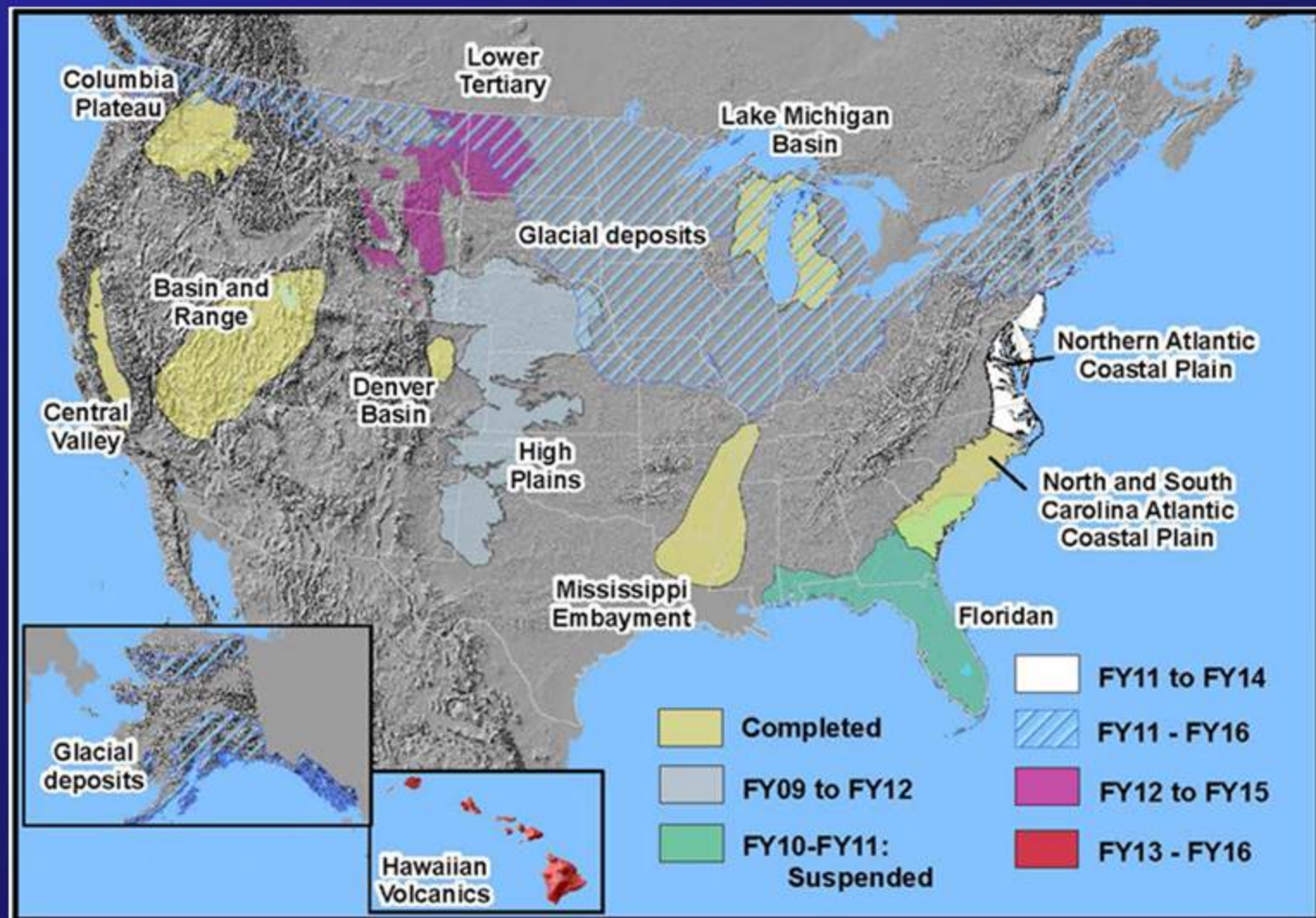
COOPERATIVE WATER PROGRAM

- Joint funding – USGS shares costs with State and County
- Meets specific management and planning needs
- Data collection & hydrologic investigations

GROUNDWATER RESOURCES PROGRAM

- Federally funded
- Quantifies groundwater at regional and national scales
- Uses/complements information from the Cooperative Water Program
- Major current activity – study groundwater availability of principal regional aquifers in US

Principal Regional Aquifers in the Nation



Hawaii Aquifers



Provide much of the freshwater taken for human use

- Drinking water
- Diverse industries – agriculture, tourism, military
- Traditional and cultural uses

Supports stream and coastal ecosystems

A photograph of an active lava flow, showing a bright orange and yellow glow from the molten rock, contrasting with the dark, solidified lava rock in the foreground and background. The lava flow is moving across a dark, textured surface.

Groundwater Resources Program
Hawaii Volcanic-Rock Aquifer Study

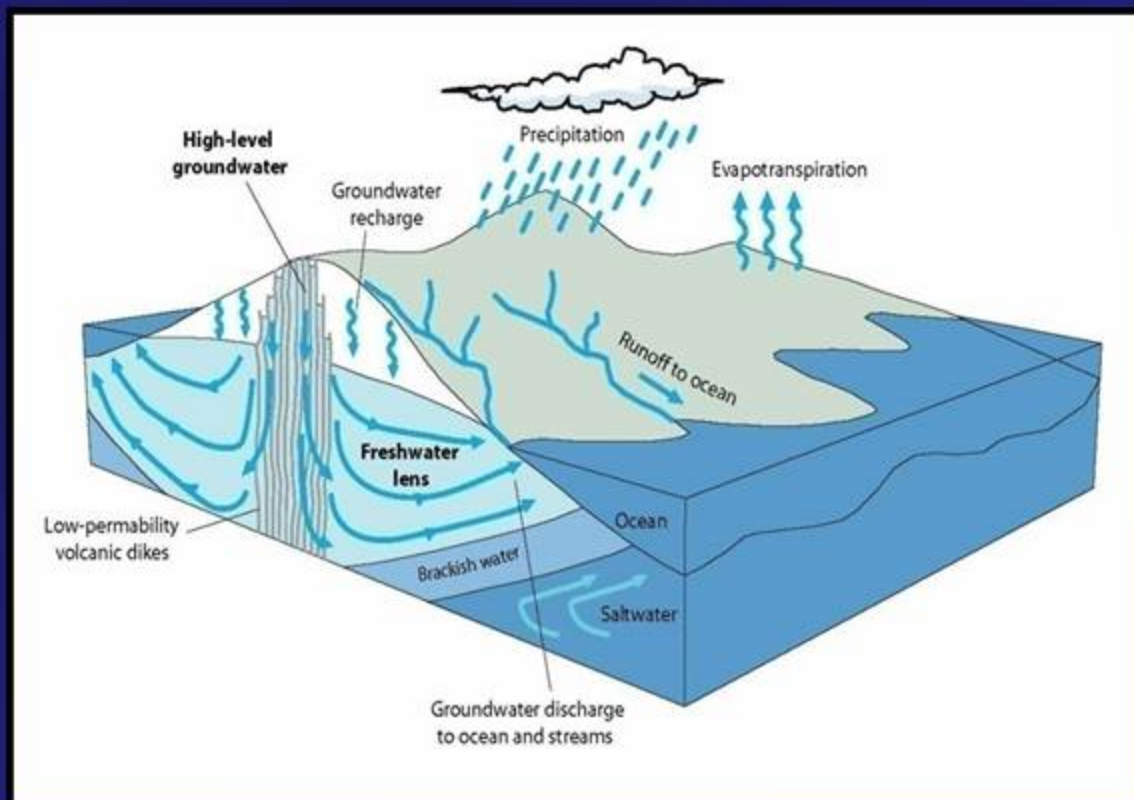
Active lava flow, Kilauea, Big Island

Objectives

- **Document current condition of the Hawaii volcanic-rock aquifers**
- **Determine effect of human activities**
- **Develop tools to assess responses to future stresses**
- **Evaluate adequacy of current data networks**

Hawaii Differs from Other Study Areas

- **Separate islands, not a contiguous aquifer**
- **Saltwater surrounds, underlies fresh groundwater**
- **Limited capacity to store fresh groundwater**
- **Sharp contrasts in climate within each island**
- **Sharp contrasts in geology and hydrology within each island**



Hawaii Included in USGS National Groundwater Assessments Since Early 20th Century

1923 – Described large production from Honolulu basalt aquifers

1963 – Described high extraction rate for population size

1978 – Described abundant groundwater, but also problems with seawater intrusion

1980s-90s – USGS Regional Aquifer System Analysis (RASA)

- Access to new computer-based tools: Numerical groundwater modeling, Geographic Information System (GIS)
- Limited to Oahu



Need for Updated Groundwater Assessment

Lihue basin, eastern Kauai

Factors Impacting Groundwater are Changing

- **Population growth – 1.11 million in 1990; 1.36 million in 2010**
- **Land-use changes have altered the groundwater budget**
- **Climate change effects detected in rainfall and stream base flow records**
- **Native forests reduced; replaced by invasive plants**



Irrigation diversion, Wailua River, Kauai

Improved Technologies

Groundwater models

Recharge assessment

Geologic & hydrologic surveying

**Faster, more powerful
computers**



Passive seismic survey, northern Oahu

New Information

New subsurface data

Revised state-wide geologic maps

Revised, higher-resolution rainfall maps

Numerous hydrologic studies since last assessment

- ❖ Not all Hawaii aquifers fit conventional concepts



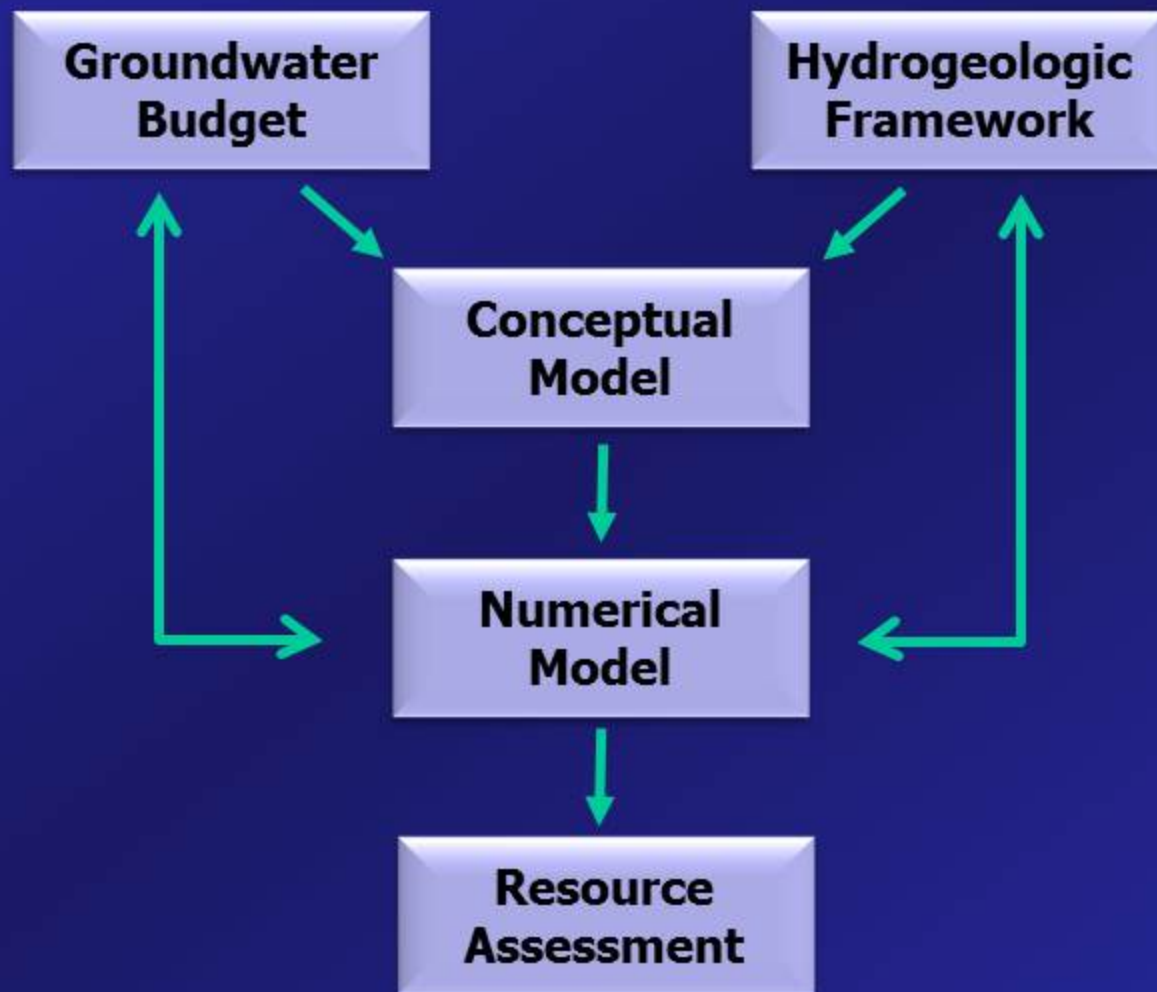
Monitor-well drilling and testing, Lihue, Kauai



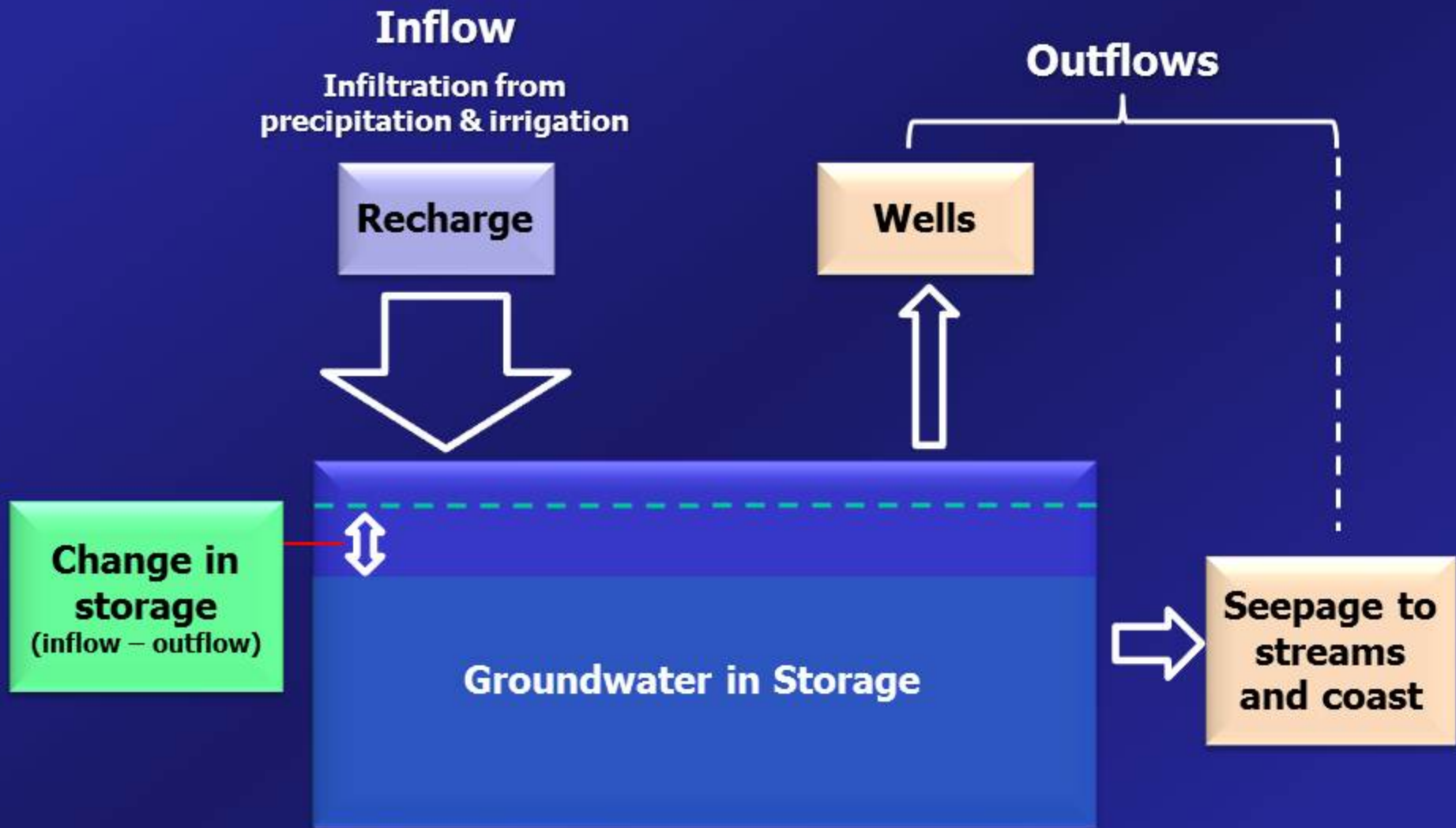
Study Approach

Northeast coast of Maui

Study Elements



Groundwater Budget



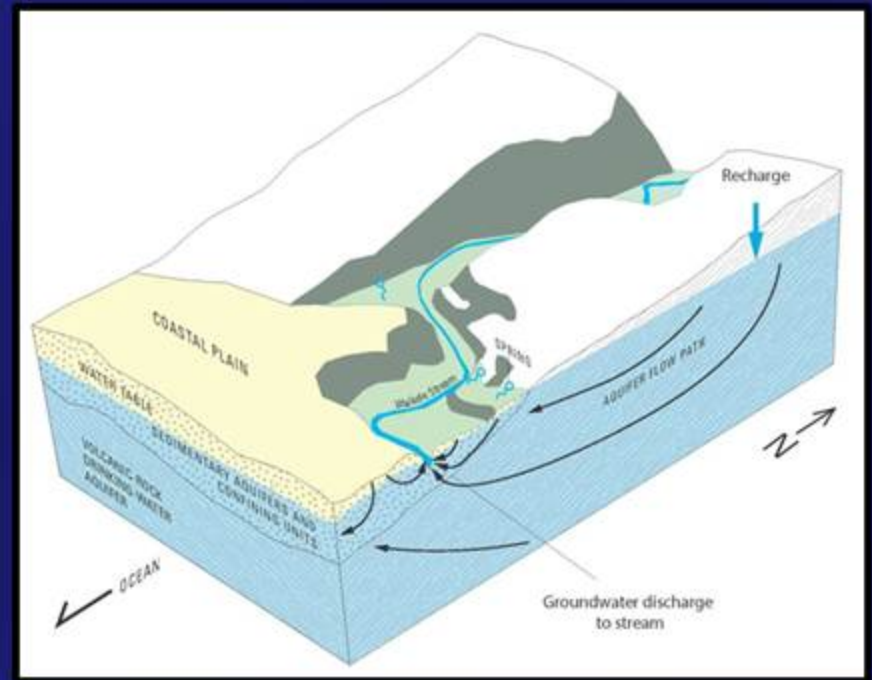
Hydrogeologic Framework and Conceptual Model

**Hydrogeologic Framework –
3D distribution of rocks,
structures, and hydraulic
properties**

**Conceptual Model –
groundwater occurrence and
flow in aquifer**

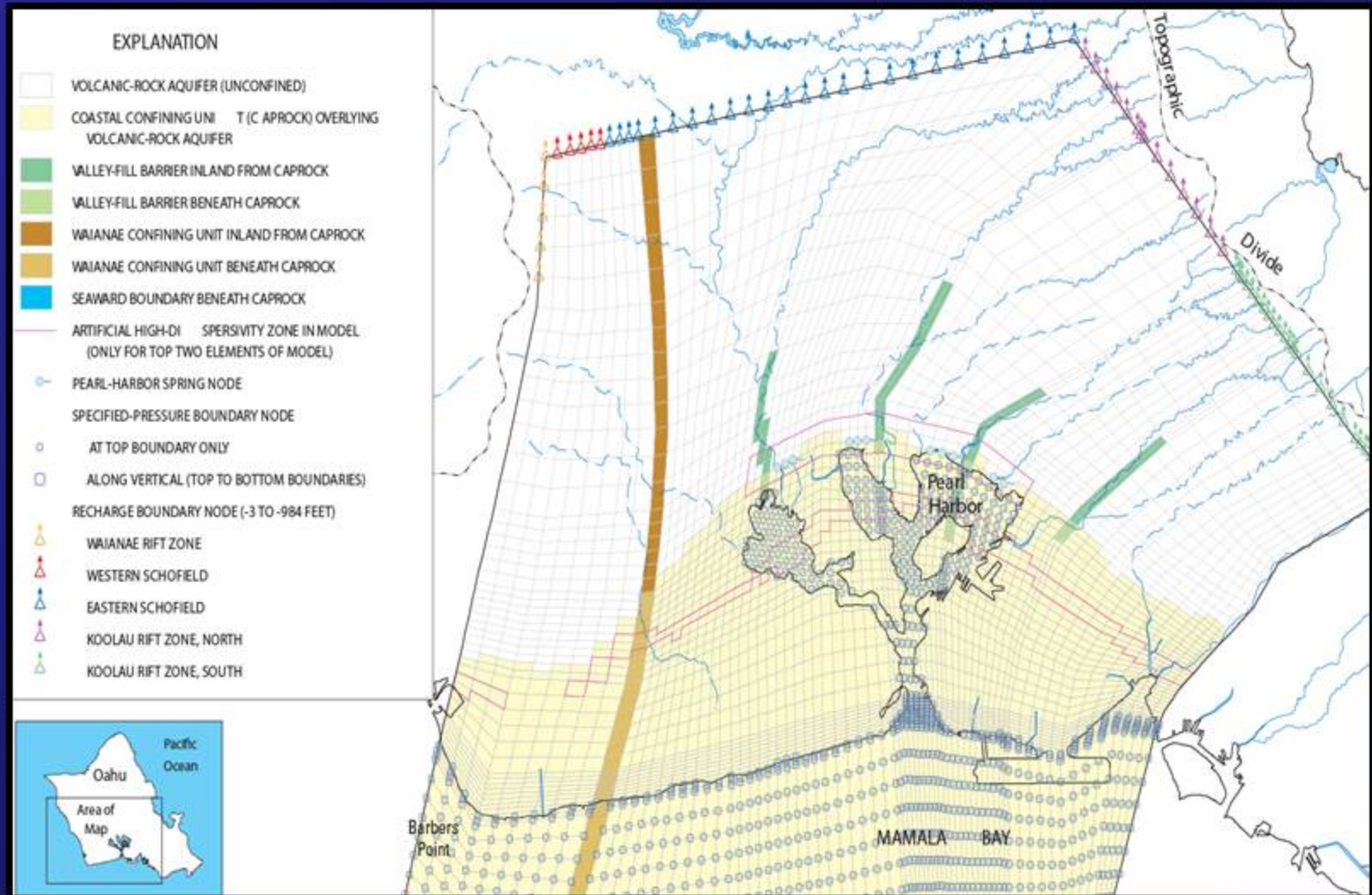
Require data on

- Geology
- Water levels
- Aquifer & well performance tests
- Well yields

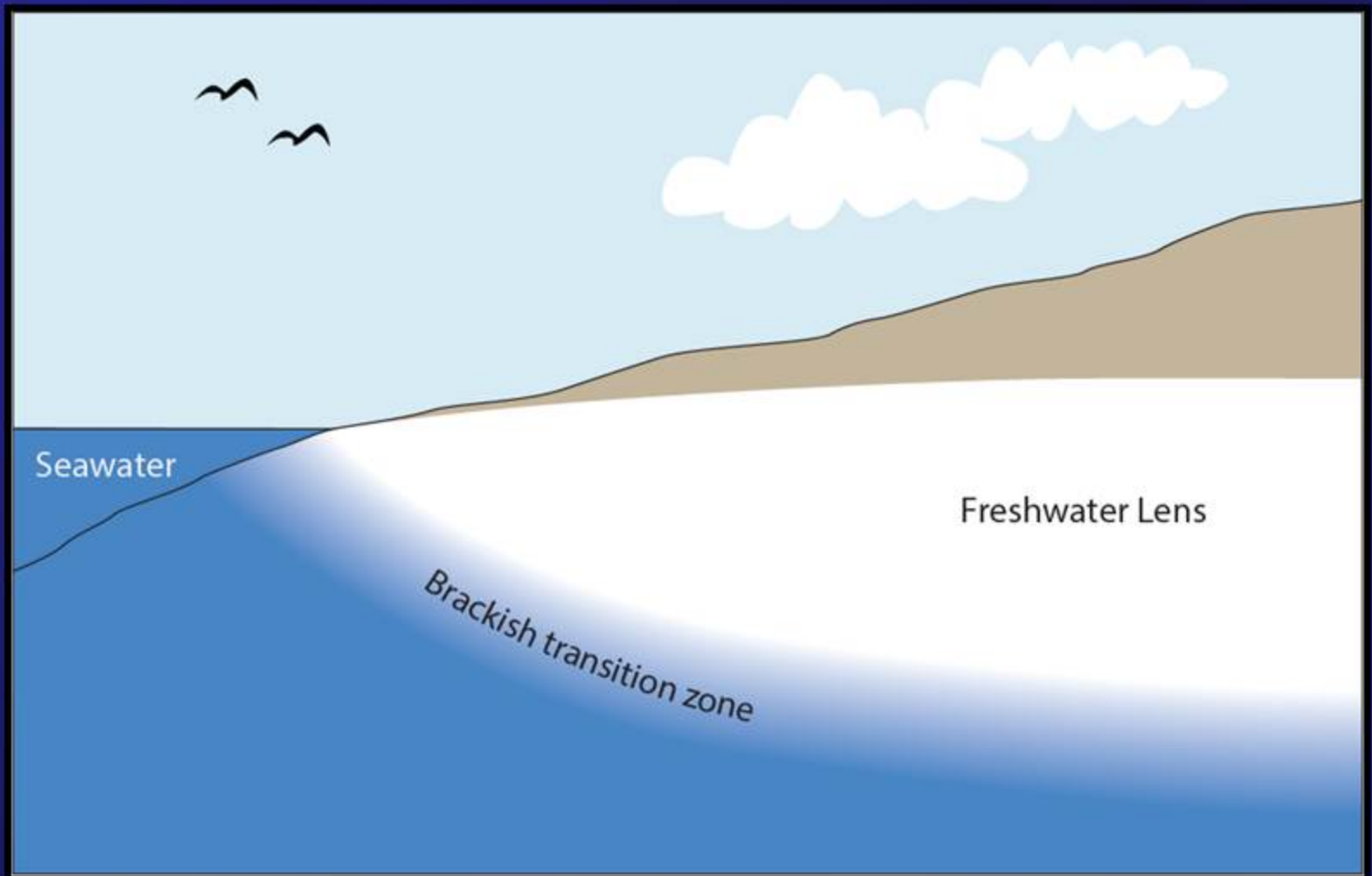


Numerical Groundwater Modeling

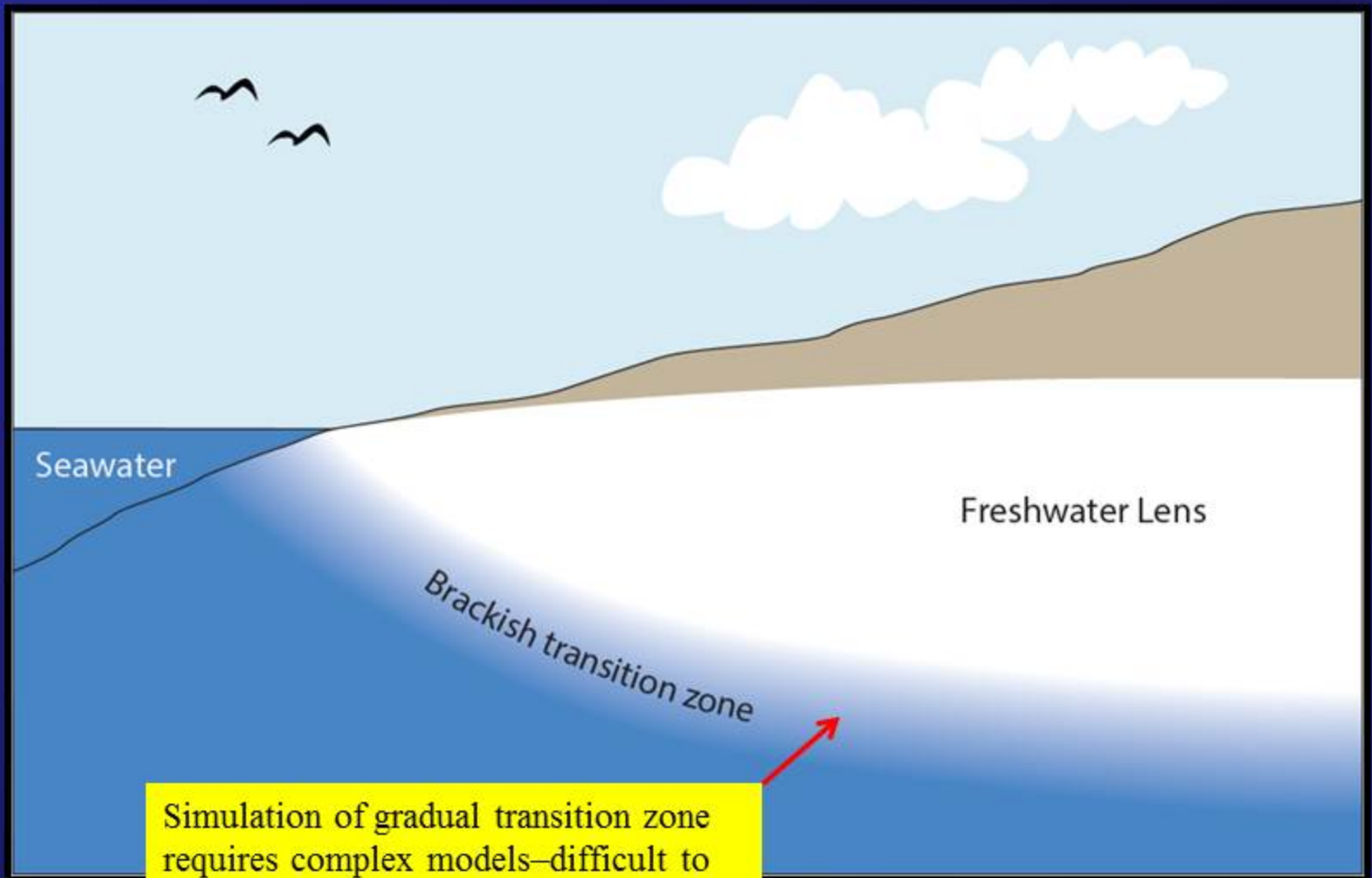
Computer Simulation of an Aquifer



Models Must be Able to Simulate Saltwater-Freshwater Systems

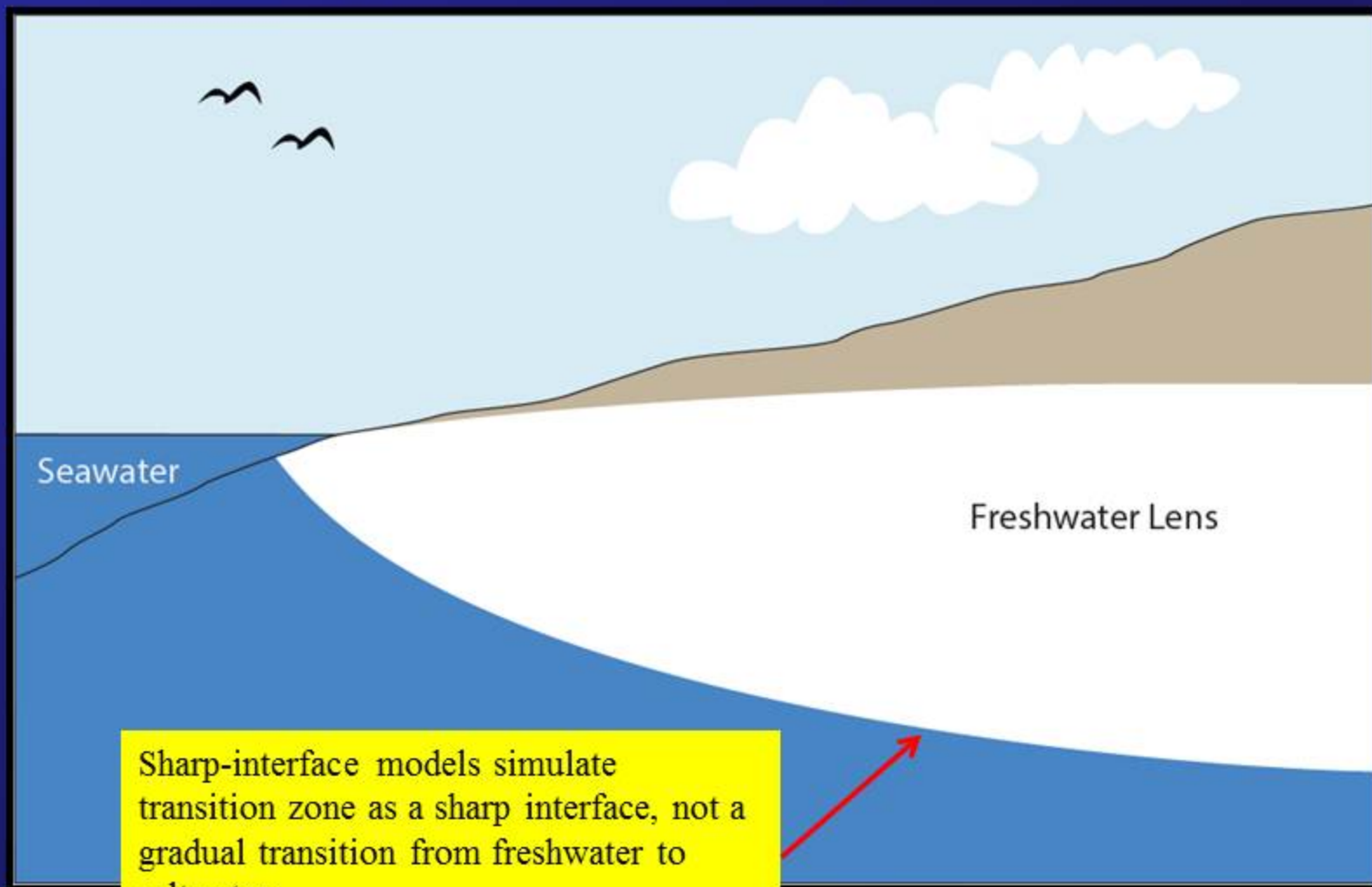


Modeling Transition Zone



Simulation of gradual transition zone requires complex models—difficult to use at island-wide scale

Sharp-Interface Simplification



Sharp-interface models simulate transition zone as a sharp interface, not a gradual transition from freshwater to saltwater.

Easier to create whole-island models.

Resource Assessment

Sharp-interface models

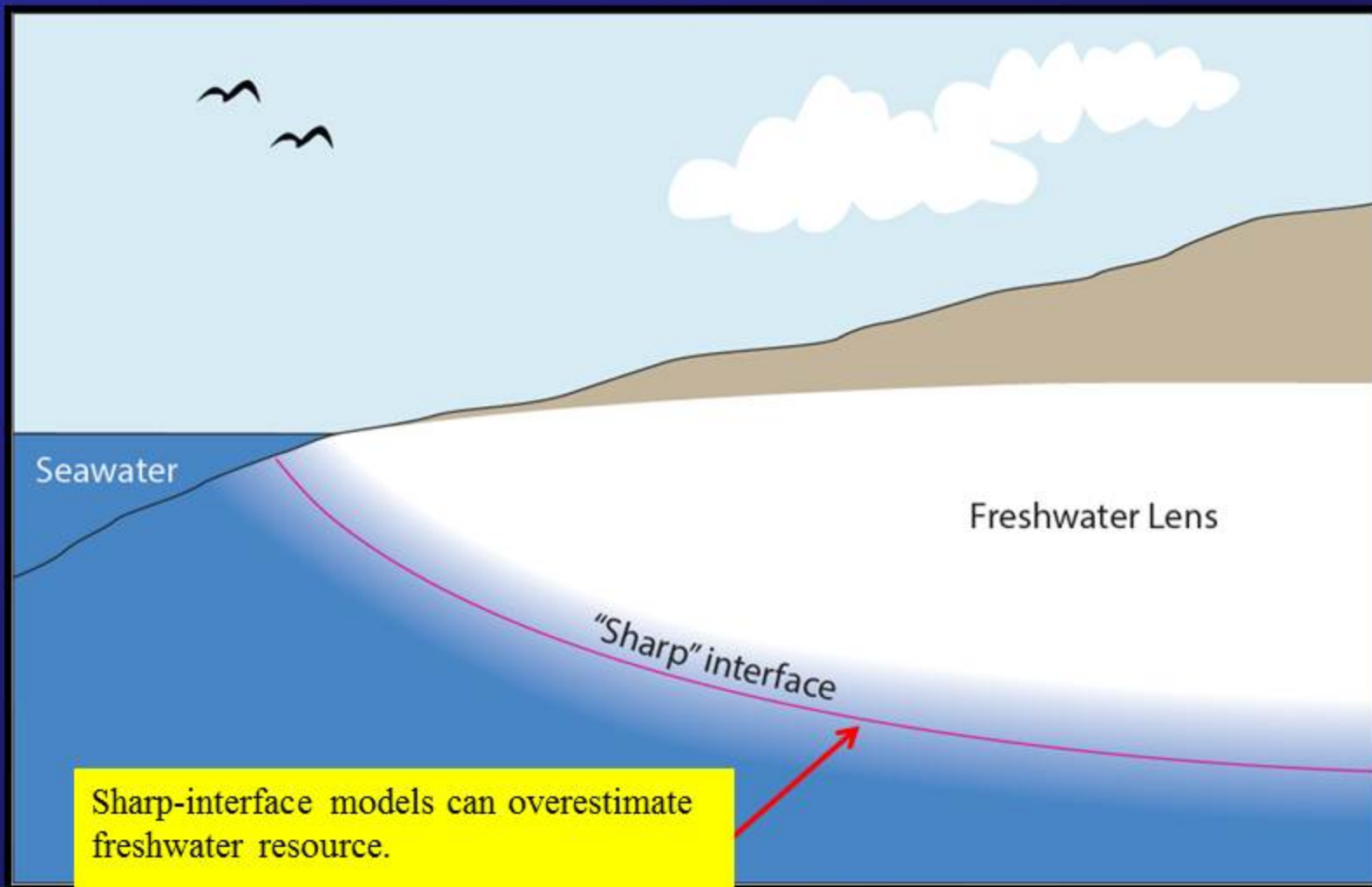
- Allow whole-island models
- Meet resource assessment objectives

Use models to assess groundwater resources

- Study past, present, future human impacts
- Study effects of climate change

Models can be used to evaluate adequacy of current data network

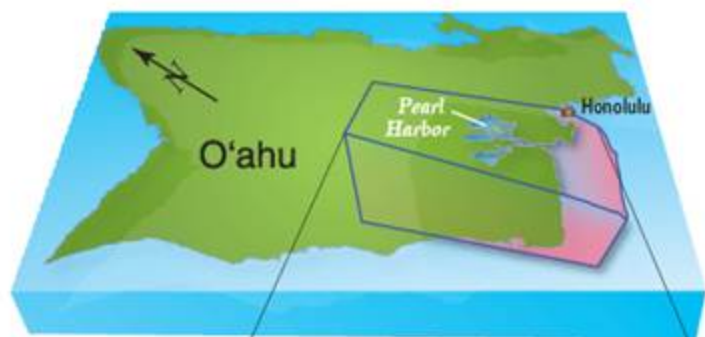
Limitation of Sharp-Interface Models



Sharp-interface models can overestimate freshwater resource.

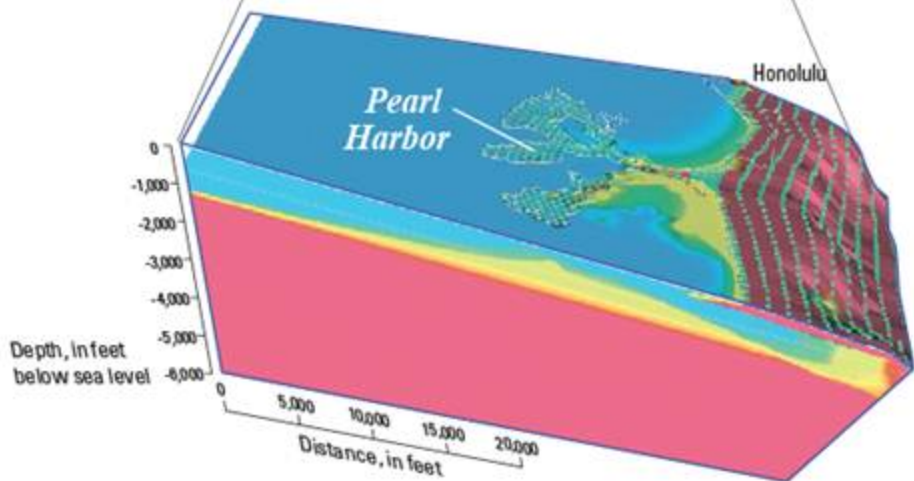
In critical areas, gradual transition zone must be simulated

Future use of Models from this Study



Continue to be used as a tool for assessing future conditions at island-wide scales

Provide a hydrogeologic framework in which more complex models can be embedded

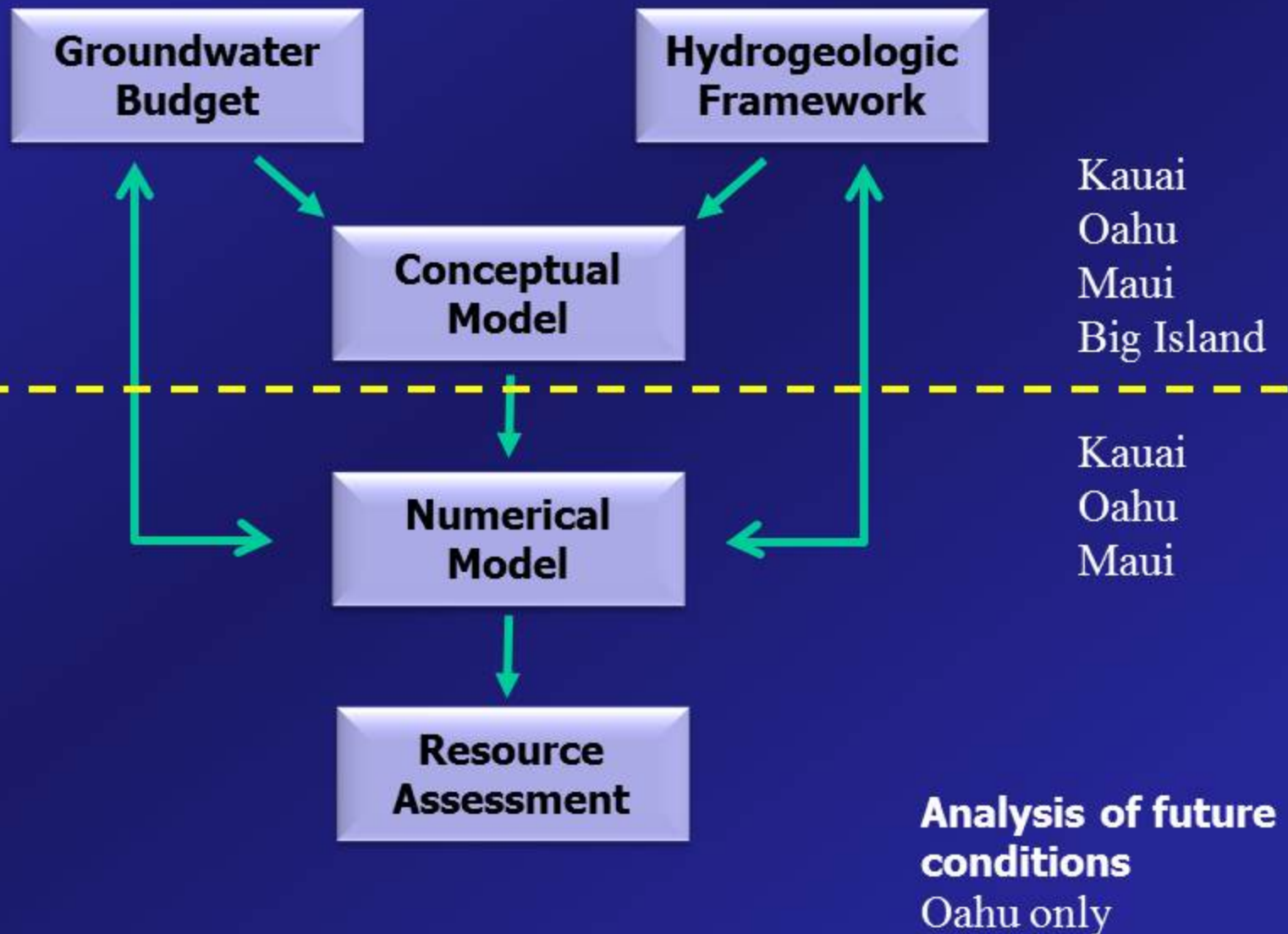




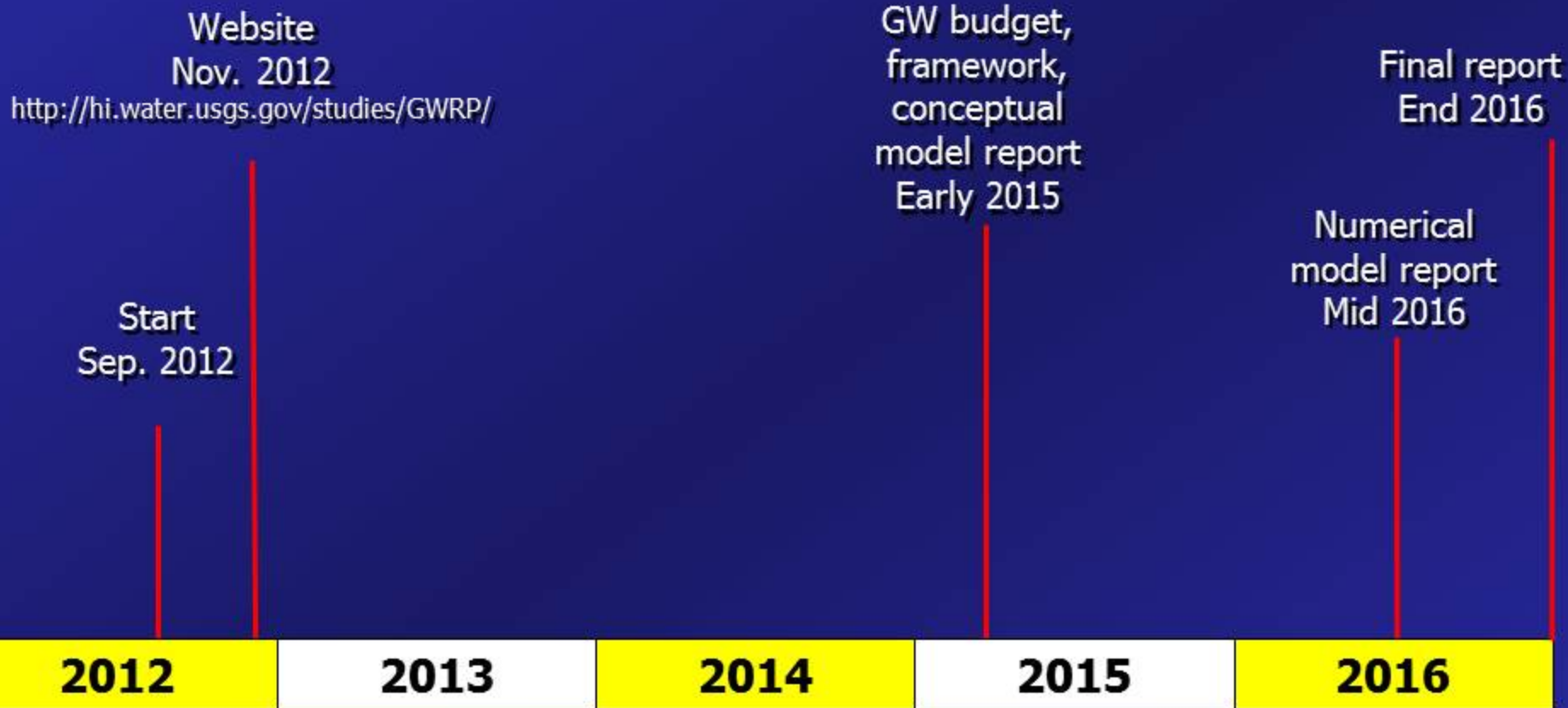
Study Scope

West Maui Volcano, from off Lahaina coast

Study Elements



Study Period



Recap: Hawaii Volcanic Rock Aquifer Study

- **Updated assessment of groundwater availability in the Hawaii Volcanic Rock Aquifers**
- **Objectives: assess current condition, reconstruct the past, provide tools and information for the future**
- **Fully federally funded by the USGS Groundwater Resources Program**
- **Uses and complements studies already funded by the USGS Cooperative Water Program**



Fumes from active lava flow, Kilauea, Hawaii

