EPSCOR Merging the Data Needs of the State Agencies with those of the Scientific Community

A Proposal for a Collaborative Resource (Re-)Analysis

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• The quality of Hawai‘i’s groundwater resources are among the best in the world

• We all recognize these resources as critical assets for our communities

• For most communities, the available resource is adequate to meet current needs.... BUT
The resource is under varying degrees and urgencies of threat from multiple stressors:

- Increasing demand on a finite resource
- Contamination
  - Red Hill (headlines)
  - Pesticide use – (headlines)
  - Wastewater Disposal
    - Injection (headlines)
    - On-Site Disposal (headlines)
    - Reuse
- Climate Change
  - Manmade - or Not – headlines (cause doesn’t matter, it happens)
These threats are managed by:

- **CWRM** – to protect groundwater from over production
- **DOH** – to protect groundwater from contamination
- **DWS** - to ensure quality groundwater is delivered to the user

All over committed and under-resourced to fully manage the complete spectrum of threats that the resource is subject to...
To Address These threats Requires:

- An understanding of the groundwater issues facing Hawaii
- A scientific understanding of the groundwater flow and contaminant transport processes
- An Academic/Agency collaboration
Science Problem:
We don’t yet fully understand the evolution of Hawai’i’s volcanoes

Agency Problem
No on-site water source for the Pohakuloa Training Area
The Hawaii Island Water Problem

- Seemingly unrelated but merged to a common path!
The Hawaii Island Water Problem

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• The path is a re-assessment of how we view groundwater storage and flow
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- The path is a re-assessment of how we view groundwater storage and flow
- First is a re-evaluating our conceptual model of groundwater flow
Conceptual Model for Hawaii’s Groundwater
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Hasn’t changed much in over 70 years
If Our Conceptual Models Are Inaccurate:
If Our Conceptual Models Are Inaccurate:

- Why do we care?
If Our Conceptual Models Are Inaccurate:

– Why do we care?

– What is being done to reevaluate our knowledge of groundwater?
Why Do We Care?

Current management is based on surface features and the assumed discharge of groundwater at the coast.
Why Do We Care?

Current management is based on surface features and the assumed discharge of groundwater at the coast.

But what if groundwater storage and flow doesn’t behave in this manner?
Maui Extends Well Beyond the Current Shoreline
Current Shoreline is a Relatively Recent Feature

Maui Shoreline During the Pleistocene, now largely submerged

From Macdonald et al., 1983
What is being done to reevaluate our knowledge of groundwater??

We are looking inside of the island.
What is being done to reevaluate our knowledge of groundwater??

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We are looking inside of the island
What is being done to reevaluate our knowledge of groundwater?

We are looking inside of the island.
What Are We Finding?

Hawaii Scientific Drilling Project

Primary motivation was geological not groundwater

Fresh water where we didn’t expect it!

• Artesian freshwater
• Encountered beneath saltwater
• Confined by the buried soils at the interface between Mauna Loa and Mauna Kea
• Also deeper layers of confined freshwater
The hydrology of Mauna Kea is much more complicated than assumed:
- Deep structures
- Aquitards
- Greater freshwater saturated volume

Affecting the groundwater storage, accumulation, distribution, and flow
The hydrology of Hawaii’s volcanoes is complicated

- Hawaii’s volcanoes are not large homogeneous “sponges” with uniform flow
- Deep structures, including dike complexes and aquitards are controlling groundwater accumulation, distribution, storage, and flow
- More water is being stored inside Mauna Kea than was thought
- To optimally manage and protect the aquifers we need to understand how these internal structures affect water (and contaminant) flow
What Are We Finding?

Gravity survey (Flinders, 2013)

- Dense structures have greater gravitational pull
- These dense features may affect the flow of groundwater
- Particular interest
  - Saddle region
  - South of the Haulalai summit
What Are We Finding?

Electrical Resistivity

The likely occurrence of high level water
What Are We Finding?

Electrical Resistivity

The likely occurrence of high level water
Exploratory Drilling Based on Geophysics Surveys
Perching Formation
The second borehole, drilled ~10 km west of the first one, found equally unexpected results.
What Are We Finding?

Drilling confirmed geophysical findings

- Water Table
- Hot Possibly Saline Water

High level water on top, heated water at depth
What Does This All Mean?
What Does This All Mean?

We manage based on these conceptual models.
What Does This All Mean?

When perhaps we should manage based on this conceptual model.
What Does This All Mean?
Sustainable yield considerations!
What Does This All Mean?

Sustainable yield considerations!
Source water protection considerations
What Does This All Mean?

Sustainable yield considerations!
Source water protection considerations!

Changing our management approach requires a solid scientific basis that comes with Academic/Agency collaboration to fully understand the occurrence of Hawaii’s groundwater
EPSCOR

• Experimental Program to Stimulate Competitive Research

• Develop a collaborative effort among the UH, CWRM, DOH, and county DWS to:
  – Better define the distribution and extent of groundwater aquifers statewide
  – Develop better models for groundwater flow that can more reliably project the rates and direction of flow of the groundwater (and potential contaminants)

“...we still don’t have an understanding of the groundwater system. There’s nowhere near enough outflow in the surface waters to balance the recharge...” MacDonald, 1974
How Do We Propose To Do This

• Geospatial Database
  – Compile “legacy” data into geospatial database
  – Use data to develop suite of visualization tools

• Geophysics
  – Conduct geophysical surveys of suspected groundwater barriers and at monitoring wells
  – Apply geophysical methods to contaminant problems

• Geochemistry:
  – Use as novel tracers
  – Monitor in real time with downhole monitoring instruments
  – Improve estimates of coastal discharge

• Input acquired data into 3D groundwater models
How Do We Propose To Do This?

- NSF proposal that would allow us to accomplish these goals in the Keauhou/Kiholo and Pearl Harbor/Honolulu aquifers

- Provide funding for interns, field work, development of the visualization software, monitoring tools, models, etc.

- Also working on a proposal to DOD for site specific work in the Pearl Harbor area
Collaboration Across Programs and Agencies

- Acquire legacy data and clear guidance on (C.I.) access restrictions
- Agree on the types of monitoring that would be most beneficial
- Identify a subset of wells that can be monitored
- Agree on what mapping or sorting capabilities would be most useful to potential users
What is the Desired End State

– A better understanding of the groundwater flow and storage inside the islands

– A suite of useful, user-friendly data tools for agency and research staff

– A set of data visualizations that will allow the agencies to better convey the condition of our groundwater resources (and the threats thereto) to the public and decision-makers

– More robust modeling capabilities that can reliably reflect storage and transport processes and can support agency needs (e.g. SWAP, contaminant plume definition)

– Train future groundwater science professionals!
Does this need for new science mean as State Agencies and Water Systems We Are We Negligent in our Duties?
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NO!!!!!!
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NO!!!!!!

• We work full time (plus) to manage and protect our valuable groundwater resources
• But, we need the assistance of best scientific minds
• We as State Agencies can also provide valuable insight on the science and the issues
Knowledge is a Two Way Street!
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- Cutting edge scientific knowledge
- High tech resources;
- Highly skilled research staff!
Knowledge is a Two Way Street!

- Operate on the front lines;
- Know the issues;
- See how things work; and
- Provided technical support for the EPSCoR Proposal
Academic/Agency collaboration is not a new concept!

We have been doing it for quite some time!
Examples

• Pesticide licensing evaluation model (Stenemo et al., 2007);
• Sustainable yield model (Liu et al., 2012);
• Wastewater Training Center (R. Babcock);
• Coastal nutrient flux studies (C. Glenn and the Submarine Groundwater Discharge Group);
• Source Water Assessment Program;
• On-site sewage disposal system study;
• The Lahaina groundwater tracer study; and
• Many others
GOAL

Move the Academic/Agency collaboration from the project level to one of public policy!