



# MAUKA-MAKAI CONNECTION

How did the Hawaiian system of irrigating *lo'i* allow people to use water wisely in their *ahupua'a*?



## HAWAII DOE STANDARD BENCHMARKS

### Social Studies 7: Geography: WORLD IN SPATIAL TERMS

- **SS.4.7.3** Analyze the consequences of human modification of the physical environment in Hawai'i using geographic representations (including *lo'i kalo* and *loko i'a*).

### Language Arts 3: Reading: LITERARY RESPONSE AND ANALYSIS

- **LA 4.3.1** Explain the problem or conflict in a story and how it is resolved.

### KEY CONCEPTS

- The traditional Hawaiian system of irrigating *lo'i* made intensive cultivation of *kalo* possible and ensured that water was distributed fairly and used wisely in the *ahupua'a*.

Models provide a geographic representation to help us analyze how people used and cared for water resources.

### ACTIVITY AT A GLANCE

Students create, observe and analyze a model of the traditional Hawaiian irrigation system for growing *kalo* (taro) and draw insights and conclusions about water use in old Hawai'i and today.

### ASSESSMENT

Students:

- Create a model that shows how water was distributed in *ahupua'a* of old Hawai'i.
- Identify the major problem or primary conflict in a *mo'olelo* and describe how the problem or conflict is worked out.
- Compare the effects of land and water use in the *ahupua'a* and how similar practices are carried out today. Assess the positive and negative consequences of such uses on the environment, and makes connections to current environmental practices.

### TIME

3 - 4 class periods

### SKILLS

observing, analyzing, inferring, writing



## MATERIALS

### Provided:

- ✓ Learning Logs 6 and 7
- ✓ Model-building instructions
- ✓ *Mo'olelo: "Water Without Source"*
- ✓ *Aloha 'Āina* video (provided on DVD)
- ✓ *Mauka - Makai Connection* PowerPoint (provided on CD)

### Needed (per group; see Advance

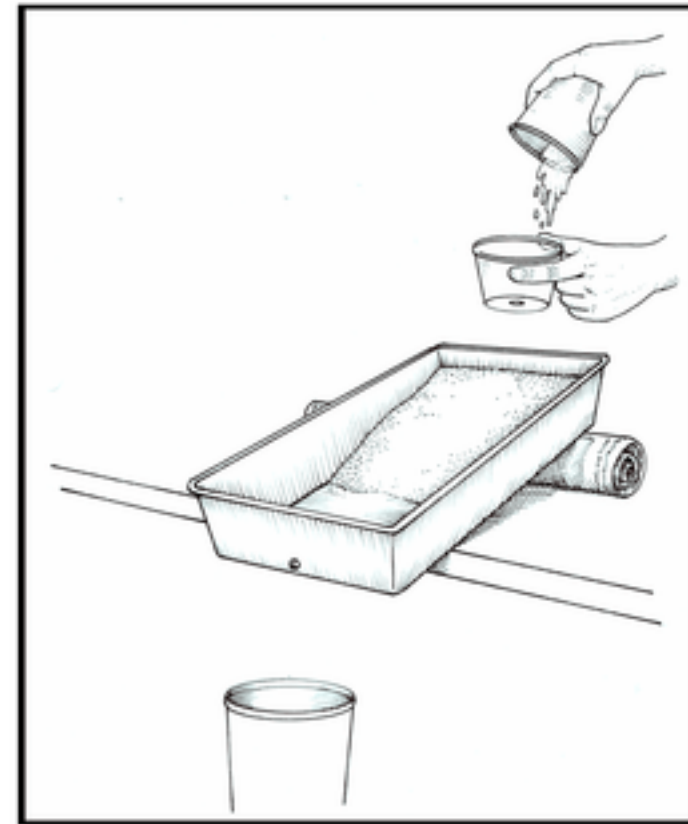
### Preparation):

- ✓ earth material (sand, soil, ceramic clay, grout, thinset mortar, powdered clay)
- ✓ tiny rocks or gravel
- ✓ large 9" x 13" roasting pan (inexpensive pans are available in bulk at Costco stores)
- ✓ 3 containers
  - container for water source (such as a Styrofoam™ saimin bowl or plastic cup with a small hole poked through the bottom)
  - container to pour water into the water source (water pitcher or cup)
  - container to catch water from the pan (bucket, tub, pan or dish)
- ✓ props to elevate pan at a "slope" (wood blocks, folded newspaper)
- ✓ digging stick (chopstick or any other stick, plastic knife or spoon)
- ✓ old newspaper
- ✓ large mixing stick or spoon
- ✓ index cards

## ADVANCE PREPARATION

- Assemble earth materials. The best models for this activity are models that do not easily "erode". Water should be able to flow over the earth material so that students can experiment with water diversion. Materials that work well are combinations of sand with soil, clay,

and grout and/or thinset mortar. (Find grout and thinset mortar in the ceramic tile section of a hardware store.) IMPORTANT: This model is not intended to demonstrate erosion, so very sandy earth material does not work well.



- You might want to pre-mix the grout and thinset mortar with water before you start the activity, as it is quite messy. Or you could ask a couple of your most reliable students to pre-mix it for you. Mix with a large mixing stick or spoon since the mix takes time to wash off the skin if mixed by hand.
- Collect small rocks for students to use in building dams and channels or purchase a bag of small gravel or cinders from your local garden store. (You can easily find tiny pieces of gravel at the edges of paved parking lots.)
- Use a sharp pencil to poke a very small hole through the bottom of each Styrofoam™ cup. This



provides a steady water source for the “stream” in the student models.

- ❑ Plan for clean-up! If students are using grout and/or thinset, you will need to have a place outside for clean-up such as outdoor faucet and/or hose.
- ❑ Plan your system for how students will get their materials, and organize the supplies accordingly.
- ❑ Preview Web sites students will be using for their research. See Resources at the end of this lesson.
- ❑ Optional: Make a model to use as a demonstration for students
- ❑ Copy Learning Logs 6 and 7 and the *mo'olelo* for each student.
- ❑ Copy the model-building instructions for each student group.
- ❑ Optional: Order the video, “*Ka Wai, Water of Life*”, from the Hawai'i State Department of Education's “*Na Ki'i Hana No'eau*” series of videos.

## VOCABULARY

*ahupua'a* – traditional Hawaiian units of land (use definition from Lesson 1 in this Unit)

## TEACHER BACKGROUND INFORMATION

“From a very early time in their history, Hawaiians, to a greater extent than any other Polynesians, exhibited engineering and building skill, ingenuity, industry, and planning and organizing ability in three types of construction: the grading and building of terraces for growing wet taro; construction of irrigation ditches and aqueducts to bring water to these terraces; and construction of fresh-and salt-water fishponds.” (Handy et al., 1972)

*'āina* – land, earth

*'auwai* – channels or ditches

built between streams and

*lo'i kalo* that distributed water through the wetland agricultural system of old Hawai'i

inference – the act of drawing conclusions from evidence or knowledge

*kahawai* – the Hawaiian word for stream; streams were the source of water for *lo'i kalo*

*kanawai* – the Hawaiian word for law; it translates as the equal sharing of water

*laulima* – to work cooperatively

*lo'i* – shallow pond for growing wetland taro

*loko i'a* – Hawaiian fishpond

*mālama* – care for

*mahi'ai* – farmer

*'ohana* – family

*po'owai* – a dam built to divert water from the stream into *'auwai*; the literal translation of this word is “water head, or water source” (*mānowai* and *paniwai* are other terms used for the dam)

*wai* – fresh water

*waiwai* – wealth or prosperity



As the above quote so clearly states, early Hawaiians demonstrated exceptional organizational and engineering skills in their construction of irrigation systems and fishponds. The engineering involved constructing multiple stone *lo'i* (terraces) for growing *kalo* (taro) and extensive *'auwai* (ditches) to transport water from the streams into the many terraces. The flow of water was diverted from the stream into the *lo'i*, then back into the stream, and finally down to the fishpond, where the combination of fresh and salt water attracted fish.

This system of using water allowed for sharing of the resource among farmers within the *ahupua'a*. Water was used wisely and returned to the stream, which allowed the fishpond or other nearshore fisheries to flourish. In more recent times, technology has enabled us to divert water out of wet windward *ahupua'a* and transport it to drier leeward areas. While this has advantages to leeward developers and farmers, it can have negative consequences to windward farmers and to stream plants and animals that require a steady flow of cool, running water.

## TEACHING SUGGESTIONS

1. **Discuss the water connection between mountains and reef on islands in the Pacific Ocean.**
  - Write the essential question for this lesson on the board and review the standards that students will be working on.
  - Read *Water Without Source*. Ask students to identify the theme in the story, and to support their opinion with details from the story. Here are a few possible themes students may identify:
    - ✓ Water was a valuable resource in old Hawai'i.
    - ✓ In old Hawai'i, water was considered a gift from the gods.
    - ✓ People in old Hawai'i valued *'ohana* (family).
2. **Show the *Aloha 'Āina* DVD to students and discuss what "*Aloha 'Āina*" means.**
  - Refer to the DVD reflection in the Introduction to this teacher's guide for discussion questions.
3. **Show the PowerPoint presentation provided with this unit.**
  - Ask students to identify the most important ideas and to take notes.
  - If desired, have students search the Honolulu Board of Water Supply on the Internet for more information about use of water in old Hawai'i.
  - If available, show the video, "*Ka Wai, Water of Life*", from the Hawai'i State Department of Education's "*Na Ki'i Hana No'eau*" series of videos.
4. **Review the most important ideas students discovered about water in old Hawai'i.**



- Add key vocabulary words to a word wall or word bank.
- Distribute **Learning Log 6**. (Refer to Vocabulary for definitions.)
- Review discussion questions with students.

**5. Introduce the model-making activity.**

- Divide the class into small groups of three to four students.
- Distribute the instructions for model building to each group.
- Carefully go over the procedures and expectations. (If needed, demonstrate what you expect students to do, or show them a model constructed ahead of time.)
- Write the key objectives of this activity on the board or chart paper and emphasize them:

**How was water distributed in *ahupua'a* of old Hawai'i?  
What materials work best to create a model of this system?**

**6. Make the models! (Encourage scientific inquiry by having students examine each "earth material" in the context of permeability, porosity and erosion.)**

- Students will need a full hour for gathering materials, building and trying their models, and clean-up.
- This is a very engaging activity for students, but it is important that you keep them focused on the main objective. Monitor groups carefully and keep them moving towards completion.
- Make sure students have designed their system before applying the water.
- At about the half-hour mark, students should be starting to pour water into their Styrofoam™ cups.
- If any models are not working well because the earth material is eroding, challenge the students to problem-solve and figure out a way to make the model work. (Most likely they will need to add more clay, or they are pouring on too much water.)
- Give students 15 minutes for clean-up and remind them not to wash grout or thinset in the indoor sinks.
- Find a place in the room to display the models. The students will be talking about them when you're not looking!

**7. Discuss the model-building activity with students, and review the main ideas of this lesson.**

- Ask students to share their models with the class and answer the essential question for the lesson in their presentations.
- Have students write a reflection about what they learned on an index card and ask them to display their reflections next to their models.



8. Instruct students to complete Learning Log 7 (illustrating and describing the water distribution system in old Hawai'i).

### ADAPTATION / EXTENSION

Arrange a field trip to see *lo'i kalo* and *loko i'a* (see Lesson 5 in this Unit).

### REFERENCE

Handy E.S. Craighill, Elizabeth Green Handy and Mary Kawena Pukui. 1972 (1995). *Native Planters in Old Hawaii: Their Life, Lore, and Environment*. Bernice P. Bishop Museum Bulletin No. 233, Bishop Museum Press. Honolulu, HI.

### RESOURCES

'Āinakumuwai: Ahupua'a of Nāwiliwili Bay. Created June 2001. Retrieved September 24, 2006, from <http://www.hawaii.edu/environment/ainakumuwai/html/water.htm>

'Āinakumuwai: Ahupua'a of Nāwiliwili Bay. Created June 2001. Retrieved September 24, 2006, from <http://www.hawaii.edu/environment/ainakumuwai/html/land.htm>

Lo'i Virtual Field Trip. © Kamehameha Schools. Retrieved September 24, 2006, from [http://ksdl.ksbe.edu/loi/comp-irr\\_sys.html](http://ksdl.ksbe.edu/loi/comp-irr_sys.html)

State of Hawai'i, Department of Land and Natural Resources, Department of Aquatic Resources. Retrieved September 24, 2006, from [http://www.hawaii.gov/dlnr/dar/streams/stream\\_hawns.htm](http://www.hawaii.gov/dlnr/dar/streams/stream_hawns.htm)