

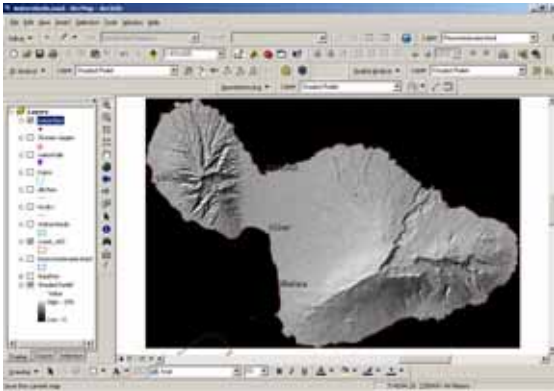
Freshwater Oasis in Saltwater Sea: Watersheds on Maui

Lesson Overview

In this activity, learners will explore and analyze the spatial relationships between elevation, aquifers, watersheds, rivers, ditches, and waterfalls on Maui and throughout Hawaii.

Student Instructions


Start ArcGIS and access ArcMap. Open an existing map entitled watersheds.mxd from the folder that your instructor directs you to. You should see a map that looks like the image below:



This map shows a shaded relief map made from elevation data on Maui. It also shows the coastline and 4 major cities.

Go to View → Bookmarks and select "Haleakala."

1) What are the small bumps on the erosional valley floor?

Use the zoom in tool  to draw a box around the areas you wish to examine more closely. You can

Geography Standards

- How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.
- The physical & human characteristics of places.
- The process, patterns, and functions of human settlement.
- How physical systems affect human systems.

Science Standards

- Science in Social Perspectives: Types of Resources.
- Motions and Forces
- Populations and Ecosystems
- Change, Constancy, and Measurement
- Structure of the Earth System
- Environmental Quality
- Science and Technology in Local, National, and Global Challenges

Mathematics Standards

- Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
- Problem-solving, reasoning and proof, communication, and representation.


Environmental Studies Standards


Historical Thinking Standards

- Historical Analysis and Interpretation: Consider multiple perspectives
- Historical Issues-Analysis and Decision-Making: Formulate a position or course of action on an issue.

Technology Standards

- Students demonstrate sound understanding of the nature and operation of technology systems and are proficient in the use of technology.
- Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.
- Students use technology to enhance learning, increase productivity, and promote creativity.
- Students use productivity tools to collaborate in constructing models, prepare publications, and produce other creative works.
- Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
- Students use technology to locate, evaluate, and collect information from a variety of sources.
- Students use technology tools to process data and report results.
- Students use technology resources for solving problems and making informed decisions.
- Students employ technology in the development of strategies for solving problems in the real world.

always go back to the full extent of your map layers using the globe  tool. Note that the “full extent of the map layers” in this project is the entire state of Hawaii. Therefore, it might be easier to zoom to the extent of each map layer by right-clicking on the layer and selecting “zoom to layer.” Alternatively, you can go to View→ Bookmarks and select “Maui”, or create your own bookmarks!

Use the measure tool  to drag a line across a few of these “bumps” on the erosional valley floor.

- 2) What is the diameter of most of these features?
- 3) Zoom out a bit and examine the two or three major erosional valleys extending from the top of Haleakala. Name the directions that these major erosional valleys run from the top of Haleakala to the coast.
- 4) What is the primary force that created these erosional valleys?
- 5) Based on the shaded relief, what is the steepest side of Haleakala—the northwest side or the south side?

Zoom to Maui and examine the other area of high elevation on the west side of Maui.

- 6) Name at least two differences between the west Maui highlands and the southeast side of Maui (Haleakala).
- 7) Name a possible reason why the two highlands regions are different in appearance.
- 8) Which highland area—the west side or the southeast (Haleakala) side—do you think is older? Why?
- 9) Turn on the waterfalls layer. Does the location of the waterfalls make sense based on the elevation and terrain on Maui? Why or why not?

Turn on the aquifers layer. The aquifers are colored based on a code. Read the description of what this code means below:

TYPEA/TYPED - 3 digit/character code describing aquifer hydrology and geology:

1st Digit:	Hydrology Value	Definition	Description
	1	Basal	Fresh water in contact with seawater
	2	High Level	Fresh water not in contact with sea water

2nd Digit:	Hydrology		
	1	Unconfined	Where water table is upper surface of saturated aquifer
	2	Confined	Aquifer bounded by impermeable or poorly permeable formations, and top of saturated aquifer is below groundwater surface
	3	Confined or Unconfined	Where actual condition is uncertain
3rd Digit:	Geology		
	1	Flank	Horizontally extensive lavas
	2	Dike	Aquifers in dike compartments
	3	Flank/Dike	Indistinguishable
	4	Perched	Aquifer on impermeable layer
	5	Dike/Perched	Indistinguishable
	6	Sedimentary	Nonvolcanic lithology


10) If you were a prospective landowner who wanted a well that tapped into fresh water not in contact with seawater, on which parts of the island would you seek land for your well?

11) Study the aquifer boundaries. What spatial relationship exists between the highest peaks on Maui and the aquifer boundaries? Why?

Make the watersheds layer visible and study the boundaries.

12) Is there any spatial relationship between the watershed boundaries and the aquifer boundaries? If so, what is it?

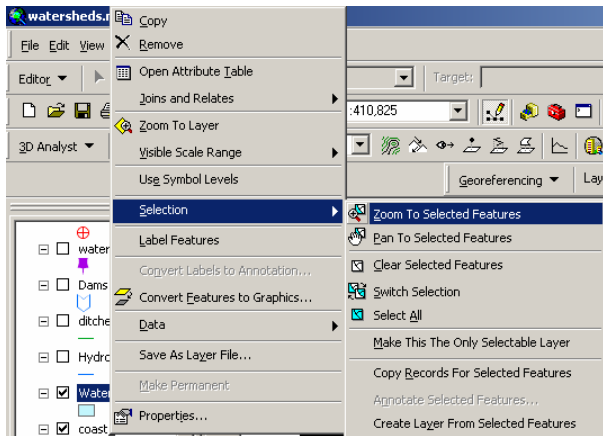
Hawaiian ali'i (kings) divided the land into sections that were responsible for annual tributes to the kings—the ahupua'a. Each ahupua'a contained nearly all of the resources that were required for survival. They were often entire valleys with the ridges serving as the boundaries, and varied from 100 to 100,000 acres in size. The name ahupua'a came from the word ahu--an altar of stones—and pua'a—pig. The image of a pig's head was placed on an altar that marked the boundaries between ahupua'a and were used as a gathering point. Ahupua'a usually covered land from the mountains to the sea, so that each of them contained wood for houses, tools, and canoes, valleys for plants for food and medicine, and the sea for food and recreation. Ahupua'a were often synonymous with land units today called "watersheds."

Use the identify tool  and select a watershed. The watershed name is under the field "wuname." You will use the identify tool to answer the question below.

13) Name three watersheds that you think would have made the best ahupua'a. Why do you think these would have made the best ahupua'a? How could you start a research project to find out if these in fact were ahupua'a?

Right click on the watersheds layer and open the attribute table for watersheds. Each watershed has its own row in the table. Find the “acres” field in the table, right click on it, and sort descending. The largest watershed in Hawaii is the record at the top of the list. Select the row containing this watershed by clicking in the left-most column in the table. Close the table and go back to the map.

Right-click on the watersheds map layer, and select “selection” and “zoom to selected features” as follows:



Zoom out a bit if you need to.

14) Is the largest watershed on the island of Maui? If not, which island is it on? Does this surprise you?

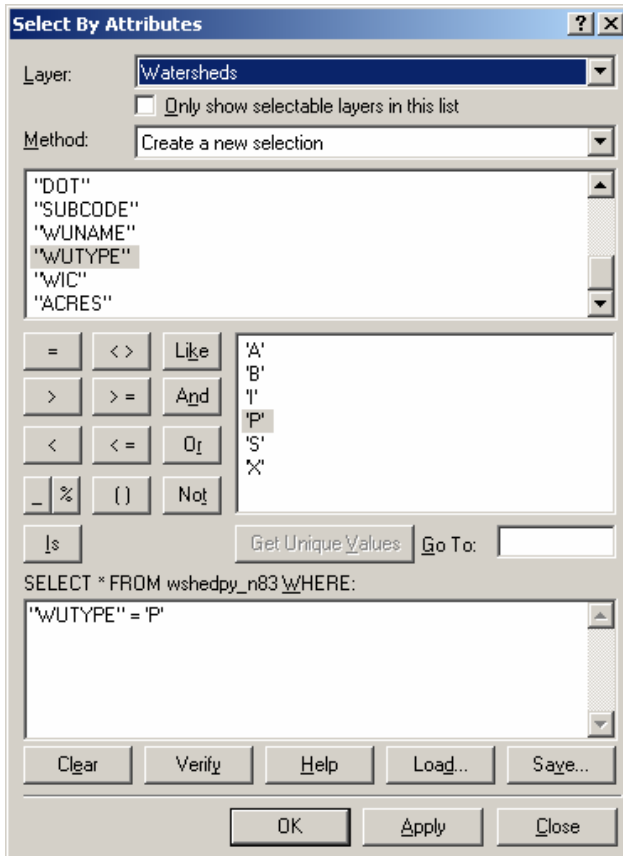
Go back to the table and, beginning with the second largest watershed, select each watershed, one at a time, until you find the largest watershed on Maui. You can keep the table open and to the side of your map, so you can see the selected watersheds appear in cyan when you select them.

15) What is the largest watershed on Maui, and how many acres is it?

Notice in the watershed table the field “wutype”. This field indicates whether the watershed is perennial or intermittent. In your investigation of ... you wish to find all of the perennial watersheds.

16) What is the difference between perennial and intermittent?

Under the “selection” menu, choose “select by attributes” and select all of the watersheds with wutype = “P”, or perennial, as follows:



17) Examine the highlighted watersheds. Knowing what you know about the rainfall on Maui, does the pattern of perennial watersheds make sense? Why or why not?

Turn on the restricted watersheds map layer. Right-click and zoom to the extent of this map layer. "Restricted Watersheds" are those watersheds where water supplies are vulnerable to contamination by public access and are therefore restricted to public access. Access to these watersheds requires permits.

18) Do any restricted watersheds exist on Maui?

19) Should we be concerned about any watersheds on Maui? Why or why not?

Turn off the restricted watersheds layer. Turn on the hydro layer. This includes streams and ditches on Maui.

20) What is the difference between a stream and a ditch?

21) Knowing what you know about the rainfall on Maui, does the density of hydro lines make sense? Why or why not?

Turn on the ditches map layer. Zoom in to the area northeast of Kihei.

22) Which of the following is true? Circle your answer.

A – Both ditches and streams may cross other streams, depending on the terrain.

B – Ditches may cross streams, but streams never cross other streams.

23) What is the reason you answered the way you did to the previous question?

24) Turn on the dams map layer. Why are dams constructed?

25) Based on the location of the dams, what area of Maui would you think contains the most agricultural land? Why?

26) Present the results of your investigations from this lesson to the class in a 5-minute oral report on the relationships between elevation, terrain, aquifers, watersheds, streams, ditches, dams, and waterfalls. Use the maps and data you have been studying in your presentation. Include in your presentation what you think we should do in the future regarding effective management of watersheds on Maui.

