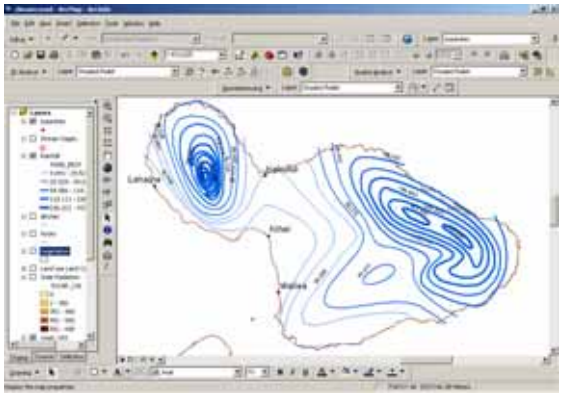
Isle of Infinite Variety: Climate and Land Use on Maui

Lesson Overview

In this activity, learners will explore and analyze the spatial relationships between elevation, rainfall, streams, a satellite image, land use, vegetation, and solar radiation on Maui.

Student Instructions

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



This map shows 4 major cities on Maui, the coastline, and the annual rainfall as represented by isohyets—lines of equal precipitation.

1) Which parts of Maui receive the highest amount of precipitation?

2) Which parts of Maui receive the lowest amount of precipitation?

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-functions of 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!

3) What is the *range* of rainfall on Maui? Would you consider this to be a large range or a narrow range? Why?

4) How much rain does **your** community receive each year?

Turn on the shaded relief image. This shows the terrain—the physical elevation of Maui.

5) What is the relationship between the terrain and the rainfall on Maui?

6) Based on the data you observed on the map, from what direction would you say that moisture-carrying winds come?

7) Does a part of Maui have the highest rainfall in Hawaii? If not, which island **does** contain the highest rainfall?

8) Does a part of Maui have the lowest rainfall in Hawaii? If not, which island **does** contain the lowest rainfall?

Zoom back to Maui and turn on the Landsat satellite image map layer.

9) Make at least two observations about the satellite image of Maui.

Observe the differences between the satellite images between the dry and the wet regions on Maui compared to the rainfall layer.

10) Does the amount of rainfall influence what Maui looks like from a satellite? Why or why not?

Turn on the solar radiation map layer. The solar map layer was compiled by a consultant that was hired to review old Hawaii Sugar Planters Association anemometer solar data collected from a number of different sites. The map is symbolized by the estimated solar calories per square centimeter per day.

11) What parts of Maui receive the most solar radiation?

12) Does Maui receive the most solar radiation on Hawaii? If not, which island **does** receive the most solar radiation? Why do you suppose this is the case?

13) Do you think Hawaii receives more or less solar radiation than other states? Why?

In order to determine if there is any relationship between elevation and solar radiation, you need to make the solar radiation map layer transparent. To do this, first turn the rainfall layer off. Then, right-click on the solar radiation map layer and select "Properties." Go to the Display tab and set the transparency to 50%.

14) Is there any spatial relationship between elevation and solar radiation? If so, what is it, and why do you suppose the relationship exists?

Turn the rainfall layer back on.

15) Is there any spatial relationship between rainfall and solar radiation? If so, what is it, and why do you suppose the relationship exists?

Next, you will explore the relationship between rainfall and land use land cover.

Expand the land use land cover map layer's legend by clicking on the "plus" sign to the left of the layer name. Make the layer visible. Notice the numbers in the legend. These correspond to how the land is used, as shown below:

Level I	Level II	
1 Urban or Built-up land	11	Residential
	12	Commercial and Services
	13	Industrial
	14	Transportation, Communications and Utilities
	15	Industrial and Commercial Complexes
	16	Mixed Urban or Built-up Land
	17	Other Urban or Built-up Land
2 Agricultural Land	21	Cropland and Pasture
	22	Orchards, Groves, Vineyards, Nurseries and Ornamental Horticultural Areas
	23	Confined Feeding Operations
	24	Other Agricultural Land
3 Rangeland	31	Herbaceous Rangeland
	32	Shrub and Brush Rangeland
	33	Mixed Rangeland
4 Forest Land	41	Deciduous Forest Land
	42	Evergreen Forest Land
	43	Mixed Forest Land
5 Water	51	Streams and Canals
	52	Lakes
	53	Reservoirs
	54	Bays and Estuaries
6 Wetland	61	Forested Wetland

	62	Nonforested Wetland
7 Barren Land	71	Dry Salt Flats
	72	Beaches
	73	Sandy Areas Other than Beaches
	74	Bare Exposed Rock
	75	Strip Mines, Quarries, and Gravel Pits
	76	Transitional Areas
	77	Mixed Barren Land
8 Tundra	81	Shrub and Brush Tundra
	82	Herbaceous Tundra
	83	Bare Ground
	84	Wet Tundra
	85	Mixed Tundra
9 Perennial Snow or Ice	91	Perennial Snowfields
	92	Glaciers

Use the identify tool  and specify that you wish to identify land use land cover features. Click on the largest brownish polygon on the east side of Maui. Then, identify the large polygon of the same color in the western highlands region on Maui.

16) What is the land use land cover in these area? Does this make sense, based on the rainfall this area receives?

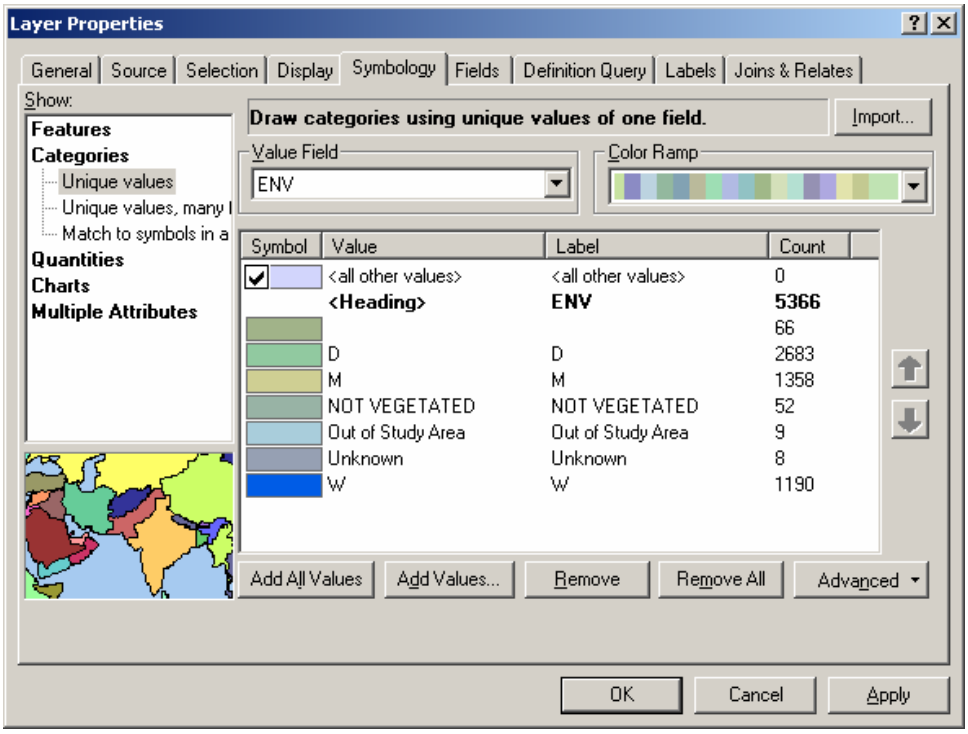
Use the identify tool  again and select the greenish area southeast of Kihei and northeast of Wailea.

17) What is the land use land cover in this area? Does this make sense, based on the rainfall this area receives?

18) What is the land use land cover in *your* community according to the map? Does this match the land use that you observe everyday in your community?

Turn off the land use land cover layer and compress its legend. Turn on the vegetation layer. Unlike land use, which shows how humans are using the land, the vegetation layer describes what is naturally growing on the land.

Right click on vegetation, select Properties, and go to the symbology tab. Symbolize the layer as unique values, based on the field ENV, and then select “add all values” as follows:



Select OK. The code in this field describes the vegetation as follows:

Code	Description
D	Dry habitat species
M	Mesic (moist) habitat species
W	Wet habitat species

Turn on the rainfall map layer.

19) What is the relationship between the vegetation habitat and rainfall?

Next, make a map of the field CANOPY_TYP, showing the density of the Tree Canopy Crown Cover. The description of the canopy type is as follows:

Code	Description
c	Closed canopy, most crowns interlocking; > 60% cover
o	Open canopy, some or no interlocking crowns; >25-60% cover
s	Scattered trees; 5-25% cover
vs	Very scattered trees; <5% cover

20) Is there a relationship between the *density* of the trees on Maui and the rainfall? If so, what is it, and why does it exist?

Next, you will investigate the relationship between rainfall and the heights of streams. First, turn off the vegetation layer and turn on the stream gages and the hydro layers. The gaging stations are recording instruments that measure stream height, and sometimes, water quality. Second, zoom to a

stream gaging station in a wet area of the island. Use the identify tool and identify the gaging station. The gaging stations are identified by the field "ID." Write down the ID number of this gaging station. Third, go to http://water.usgs.gov, select real-time water information, and select Hawaii. Search for the gaging station with the ID number that you selected.

21) How old is the information that the gaging station is giving you?

22) What is the cubic feet per second passing through the gaging station?

23) What is the maximum flow that this station has ever experienced?

Zoom to the dry part of the island and select a gaging station there. Check online for the real-time information on that gaging station.

24) How old is the information that the gaging station is giving you?

25) What is the cubic feet per second passing through the gaging station?

26) What is the maximum flow that this station has ever experienced?

27) How do the data for the gaging station on the wet part of the island compare to the dry region gaging station? Why?

28) Present the results of your investigations from this lesson to the class in a 5-minute oral report on the relationships between elevation, rainfall, solar radiation, satellite imagery, land use land cover, vegetation, and streamflow? Use the maps and data you have been studying in your presentation.