GIS Provides a Common Visual Language
Transforming our understanding of the world

Throughout history, technological innovations have triggered major transformations in the way we lead our day-to-day lives—the steam engine, electricity, the automobile, the computer. One of the most recent such innovations is the internet, or the World Wide Web. This single domino has been a catalyst for paradigm shifts in the way we learn, shop, and navigate, to name just a few. Through web-based mapping and data storage, GIS—once the realm of technical specialists—has become available to everyone. Now, whether you're a beginner or a professional, you can access, analyze, and share data and maps within your organization and beyond.

The activities, videos, and lessons in this chapter reveal the unique power of GIS and of web-based GIS in particular. The six lessons in chapter 1 offer instruction and practice with basic GIS concepts: layers, spatial distribution, classification, symbolization, filtering and querying, and building and publishing a web app. The chapter also includes questions that support reading comprehension, reflection, and discussion of ideas presented in chapter 1 of *The ArcGIS Book: 10 Big Ideas about Applying The Science of Where*. Finally, the chapter provides suggestions for further practice through lessons on Esri's Learn ArcGIS site.

Introductory activities

Video

Videos elevate motivation and enthusiasm as well as enhance discussion. The following videos represent Esri's new vision of GIS as "The Science of Where." Teachers can use them to generate interest and stimulate discussion.

The Science of Where—Unlock Data's Full Potential

The Science of Where - Unlock Data's Full Potential
esri

We believe digital transformation is leading business, government, and society into a new technological frontier. As the global ...

1:35

Exploring The Science of Where

Exploring The Science of Where
Esri Events

Join us on a journey of exploring The **Science of Where**! See More Esri UC 2017 Plenary ...

1:57

Leading The Science of Where

Leading The Science of Where
Esri Events

Find your own path, chart your own course. Apply real positive through geography. The opening video to Esri UC 2017 .

1:13

Applying The Science of Where

Applying The Science of Where
Esri Events

Come with us on a journey in **applying The Science of Where**! See More Esri UC 2017 Plenary ...

1:49

Activity

Explore Map Book Gallery, published annually since 1984:

GIS users around the world map mineral resources, ecosystems, hurricane surge, waterfowl migration, earthquake disasters, and wildfire maps, to mention just a few. Published annually since 1984, the *Esri Map Book* acknowledges the important and innovative accomplishments of such users. Leafing through, you'll be amazed at the great variety of maps. As you look at the maps in the map books, select three maps and for each map record the following:

- Organization that produced the map

- Reason or problem for the map

- Layers included in the map
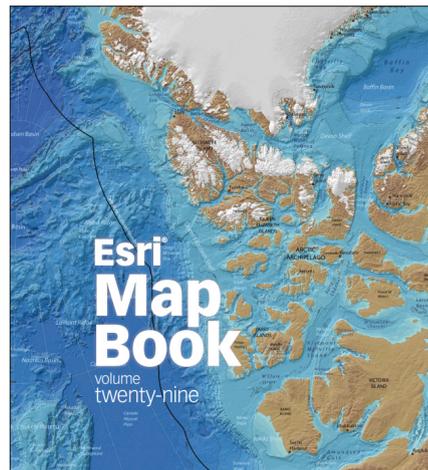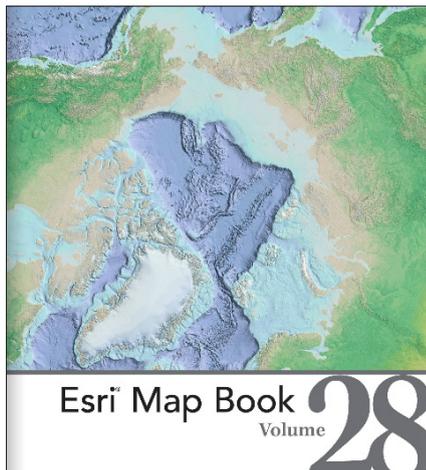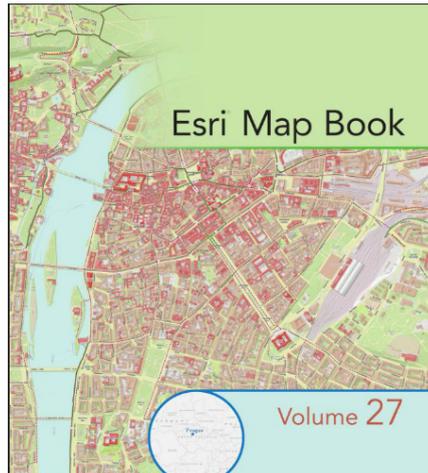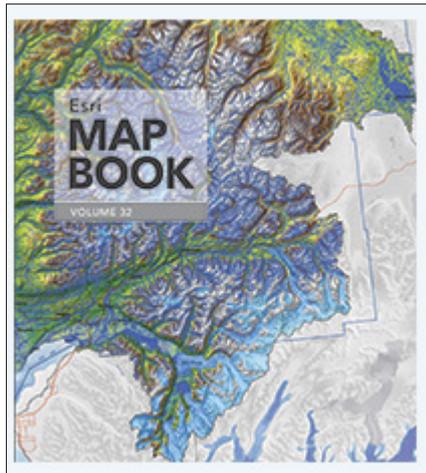
The ArcGIS Book, chapter 1
Questions for reading comprehension, reflection, and discussion

Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

Thought leader: Jack Dangermond
GIS: Understanding The Science of Where

Write an explanation of The Science of Where. Include in your explanation thoughts on data integration and GIS as a platform.

Enabling a smarter world
GIS provides a framework and process

List the different parts of the GIS framework with a brief explanation of each part.

Web GIS is collaborative
Geography is the key, the web is the platform

What is meant by geography is the key?

What does georeferenced *mean?*

How has web GIS changed and expanded our use of georeferenced data?

How GIS works and ArcGIS information items
The science of geography Layers

List five different types of layers that can be represented on a map.

What is the difference between a map and a scene?

Investigate the maps. Pick one map and write about the information it portrays.

Investigate the scenes. Pick one scene and write about the information it portrays.

Geospatial analysis yields insights

Explain geospatial analysis.

Apps extend the reach of GIS

What is an app and what is its purpose?

Understanding the Difference between Consumer and GIS Mapping Applications

Static Web maps vs dynamic Web GIS

Learn ArcGIS: Guided lessons based on real-world problems

Set Up an ArcGIS Organization

Administering an ArcGIS organization.

Designing the home page.

Sharing content and creating groups.

Creating custom roles and adding members.

Calculating credits for analysis and storage.

Managing licenses for ArcGIS apps.

Set Up an ArcGIS Organization
Configure the site for a new ArcGIS organization.

The Power of Maps

Exploring online maps and apps.

Interpreting maps.

Understanding spatial analysis.
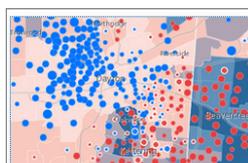
The Power of Maps
Try some of the many ways people use ArcGIS maps.

Get Started with ArcGIS Online

Adding layers to a map.

Adding data stored as spreadsheet or file data to a map.

Changing map symbols

Configuring pop-ups.

Sharing the map as a web app.

Get Started with ArcGIS Online
Learn the basics of making maps online.

Working with GIS layers

Your company is introducing online GIS into its suite of tools that beginning employees must know to compete in today's workplace. They have asked you to create an online lesson that introduces employees to GIS. One of the main focuses that they want shown in the lesson is the wide variety of data types that can be represented in a GIS.

Build skills in these areas

➢ Opening and navigating an existing online map

➢ Understanding the difference between accuracy and resolution

➢ Accessing tables

➢ Interpreting legends

➢ Distinguishing between different types of layers

➢ Adding x,y (longitude and latitude) data

➢ Adding address data (geocoding)

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

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1. Open the map and basic navigation

1. Click GIS Layers to open the web map you will be using in the following exercise.
2. Take a few minutes to familiarize yourself with the interface.

    - Zoom In
    - Zoom Out
    - Locate the scale bar

3. Click Modify Map in the upper right corner.

4. Click Show Contents of Map under Details to show and review the content pane.
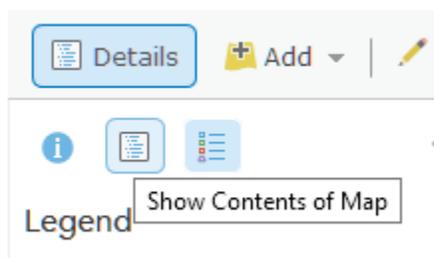
5. Practice turning the layers on and off by checking the boxes.

Q1 How many different layers do you see represented?

2. Understand the difference between resolution and accuracy on the World Imagery Layer

The map opens with Light Gray Canvas Basemap showing. This web map is designed to draw attention to thematic content by providing a neutral background.

1. Turn on World Imagery by checking the box.

   Q2 What data is represented by the World Imagery Layer?

2. Check on the World Imagery layer.

   Q3 What information is available? Record the data, resolution, and accuracy of the imagery.

It is important to understand the difference between the accuracy and the resolution of the imagery. Accuracy tells you how closely the image matches the true value on the ground. Resolution refers to the measurement of the finest detail that can be displayed by the sensor.

3. Expand the World Imagery layer by clicking World Imagery. Notice that there are different resolutions shown. This can be noticed as you zoom in and out of the image. This represents a multiscale image. For example, 30 cm resolution shows imagery at a much greater detail than 15 m resolution.
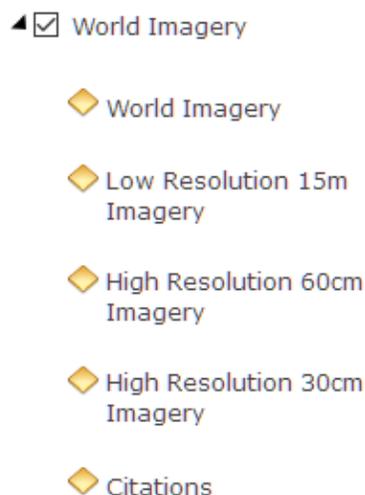
4. For the World Imagery layer, click More Options, then choose Show Item Details. Note the layer details open in a new web page or tab.

   Q4 Using the item details, write a sentence explaining the resolution and accuracy of the World Imagery layer.

5. Locate your home city or a place of interest you wish to explore by typing an address in the locator tab.
6. Click on a pixel in the map. Notice how the pop-up reveals details on the source of the imagery, its resolution, and its accuracy.

3. Observe a digital elevation model as an example of raster data

In its simplest form, a raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information, such as elevation or temperature. Rasters are digital aerial images or imagery from satellites. The World Imagery Layer in the previous section is an example of a raster image. In this section you will investigate a digital elevation model where each pixel represents an elevation.

1. Turn on the Digital Elevation Model.
2. Zoom in until you can see the image at the pixel level.

   Q5 Describe two types of landscapes that you can distinguish with the digital elevation model of the US.

4. Examine attributes and legends of vector layers

There are four layers left to examine in your beginning GIS layer map: USA States, USA Freeway System, USA Parks, and USA Major Cities. All these layers are called vector layers. Each layer has a spatial component (polygon, line, point) that is dynamically linked to a table of attributes. Each layer has its own unique table of attributes that can be accessed by clicking the table icon below the layer name. Turn on each layer one at a time and open its attribute table.

Q6 Complete the chart below.

Layer Name	Vector Type	Two attributes
USA States		
USA Freeway System		
USA Parks		
USA Major Cities		

5. Enter x,y data (longitude and latitude)

This entire lesson is about geography, or location on Earth's surface, as the unifying link in geospatial technologies. You do not have to rely on prepared or existing layers to enter data into your GIS system. You can add point data to your GIS map in several different ways. One way is to add point data to your GIS map by specific longitude and latitude coordinates.

1. Turn all layers off except World Imagery Layer.
2. In the upper right search tab enter the following longitude and latitude: -100.336389, 44.368056
   Hint: These values are in decimal degrees.
3. Click Add to Map Notes. The Map Note creates a new layer to store the point.
4. In the upper right search tab enter the following longitude and latitude: -84.388077, 33.749041 Add to Map Notes.
5. In the upper right search tab enter the following longitude and latitude: -112.096389, 33.448056 Add to Map Notes.

   Q7 What cities were located by their longitude and latitude? Why are some of the numbers negative? Hint: Change the imagery basemap to imagery with labels basemap.

6. Enter address data (geocoding)

Another way of entering point data is by geocoding. Geocoding is the process of turning an address into a locational point on a map. The ArcGIS software has a built-in World geocoder which allows this to happen.

1. In the upper right search tab type the following address: **16 Cory Street, Augusta, ME 04330.**
2. Click Add to Map Notes.
3. In the upper right search tab type the following address: **77 North Front Street, Columbus, OH 43215**. Add to Map Notes.
4. In the upper right search tab type the following address: **2101 O'Neil Avenue, Cheyenne, WY 82001**. Add to Map Notes
5. Zoom to the USA layer to see the location of all the Map Note Points you have located.

7. Complete your assessment

In this lesson you have expanded your vocabulary.

Q8 Explain the meaning of the following words.
- *Raster*
- *Attribute*
- *Georeferenced*
- *Geocoding*
- *Accuracy*
- *Resolution*
- *Vector*

Show me my home

Location and place are two of the five themes of geography. Where is it located? What is it like there? These are the questions that organize space. With the availability of satellite and high- resolution aerial imagery, our perspective of location and place has never been greater. In this introductory activity, you will describe your location on Earth from three perspectives: your absolute location, your location within a regional boundary, and your location within a global boundary.

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

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1. Click Imagery with Metadata.
2. Click Open in Map Viewer.
3. Click Content in the left panel.
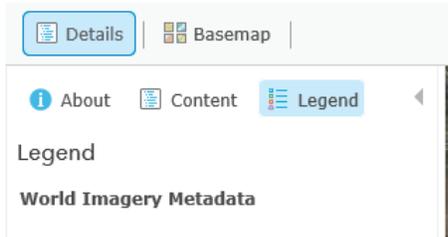
4. Zoom all the way out to the world view of the map.

5. Examine the layers in the Contents pane.

   Notice that some of the layers are dimmed. Multiscale maps allow you to view geographic data across a range of scales, also known as zoom levels, from buildings to the entire globe. Specifying at what zoom levels content is drawn is known as setting the visible range.

   You will see the Esri Eastern Africa office for an example of the procedure to follow to describe a location.

6. In the Search box in the upper-right corner, type Eastern Africa, Kilimanjaro Ave, Nairobi.

Q1 Write a description of the local area.
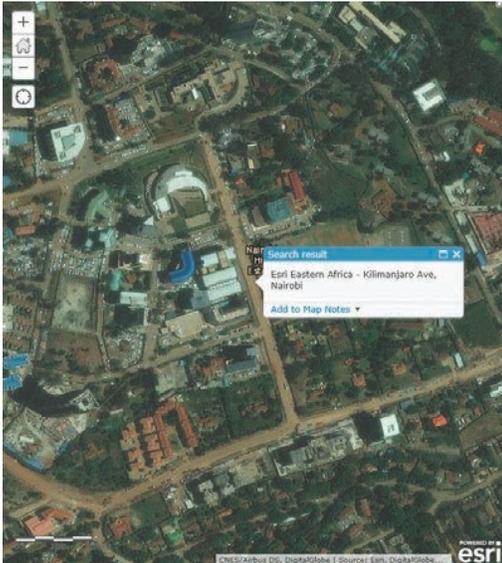
7. Zoom out until you can see the administrative boundary of Nairobi.

Q2 Write a description of the landscape features within the Nairobi administrative boundary.

8. Zoom out until you can see the administrative boundary of Kenya.

Q3 Write a description of Kenya.

9. Zoom out until you can see the continent of Africa.

Q4 Write a description of Africa.

10. Repeat the preceding steps with your local location.

Analyzing Nepal earthquake epicenters

The Nepal Earthquake Epicenters map shows epicenters of the earthquakes that occurred in and around Nepal. The year of the earthquake, its epicenter, and its magnitude can be viewed by clicking the points on the map. The points are also symbolized by the magnitude of the earthquake. The district divisions can be seen on the map as outlines. In this lesson you will see how the data can be displayed differently by changing the symbolization of the map, which will allow the viewer to visualize and observe even more information.

The United Nations Disaster Assessment and Coordination (UNDAC) team members need an emergency response system map to respond to the Nepal earthquake. They have seen the original Nepal Earthquake Epicenters map and are impressed. However, for their immediate need, they have asked that the map be altered to show the following:

- The epicenters of the 2015 earthquakes must be seen at all scales
- All 75 districts should be shown by population
- All recorded earthquakes with a magnitude of 5 and above should be shown. On the Richter scale, earthquakes above 5 can be felt by everyone and can cause slight damage to all buildings.

Build skills in these areas

- ➢ Opening and modifying an existing online map
- ➢ Changing transparency
- ➢ Changing style to unique values
- ➢ Change style to Counts and Amounts
- ➢ Changing size and color of symbols

Nepal earthquake epicenters

What you need

- ➢ Account not required
- ➢ Estimated time: under 30 minutes

Publication date: February 21, 2019

Map and style the earthquakes

1. Click the Nepal Earthquake Epicenters map.
2. In the upper right corner, click Modify Map.

As you zoom in and out of the map you can see that the Nepal Earthquake 2015 layer disappears and appears according to the scale of the map. The UNDAC always wants this layer visible.

3. Click the three dots at the end of the NE 0425 layer. This layer shows the epicenters of the earthquakes.
4. Go to Set Visibility Range.
5. Move the slider to the left to set the visibility to the World. This makes this layer visible at all scales.
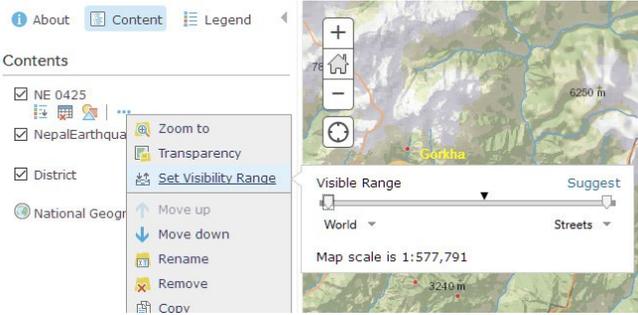
6. Again, click Contents under Details if the content pane collapses.
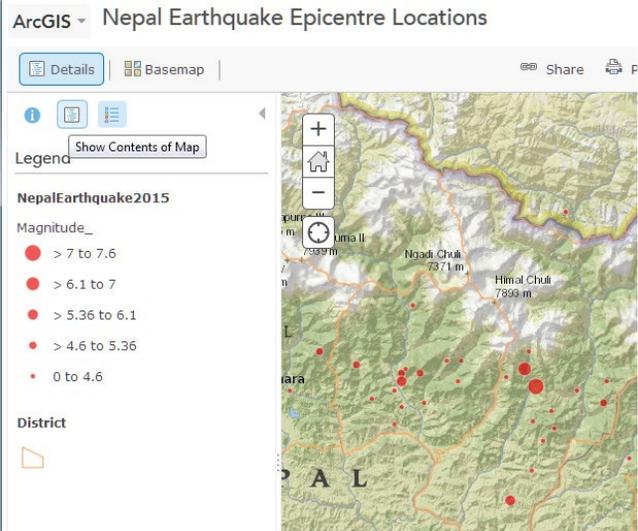
7. Type Nepal in the search window and the map will zoom to the extent of Nepal and display the 75 districts. The 75 districts are shown, but only their outlines are visible. All values of the districts look the same, which means they are classified on the map as location and only show you the distribution of the data.

When you classify or style data, you have many options. The Change Style menu is your gateway to changing the look of your data.

8. Click Change Style under the District layer.
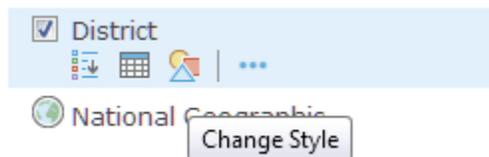
9. The individual districts can be seen more distinctly if you choose DISTRICT as the attribute. A single symbol will give you a unique symbolization by the district name.
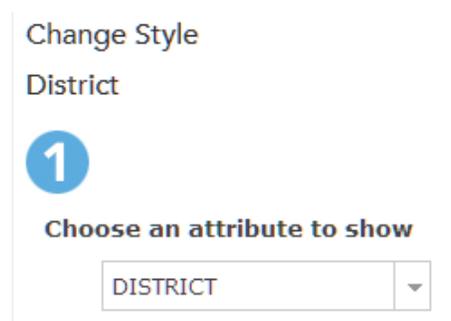
All districts are not displayed in a unique color on the map.

10. Click Options.
    a. Use the top slider to scroll down.
    b. Click Done. All the districts will not be displayed until you click the double arrow point up.
    c. Clicking the double arrow will display all the districts uniquely.
    d. Click OK and Done.
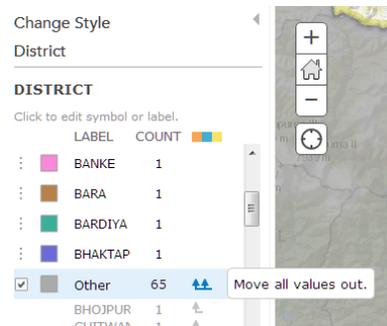
Now all the districts are displayed on the map and in the Contents pane as unique values. It is now much easier to see the unique districts.
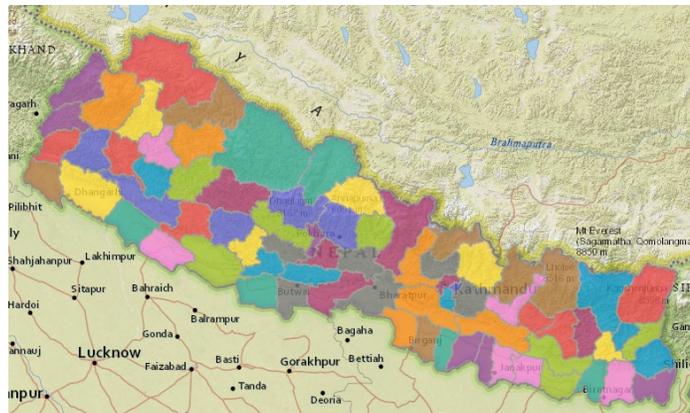
You have displayed the districts by a unique value, using the District name field; however, the UNDAC wants the districts displayed by population. Seeing the districts displayed in a choropleth map by population would provide the responders with information about districts that would need the most resources during an earthquake. Numeric data can be displayed with counts and colors that display the features on the map as a color gradient.

11. Click District and click Change Style.
    a. Under Choose an Attribute to Show, select POP_91. Notice that the display changes from unique symbology for each district to a range of colors representing the population density. Darker colors showing higher population and lighter lower population.
    b. Click Done.
12. Uncollapse the District layer to see the legend.
13. Right-click the District layer and select Create Labels to label the districts by name.

Q1 Write a brief explanation of how the legend helps you understand the map.

Q2 What does the legend show about the population?
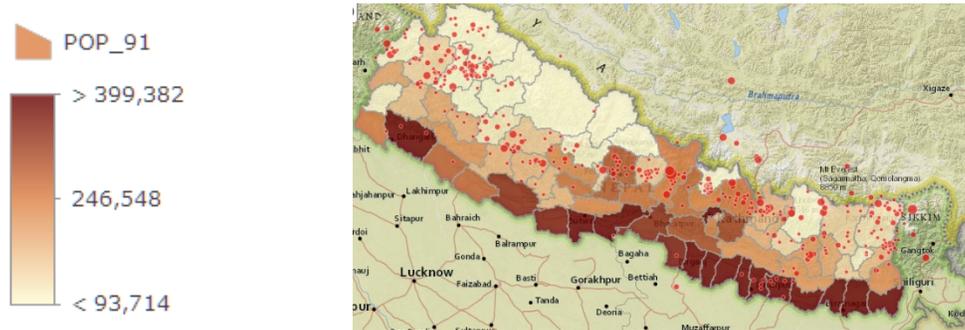
14. Click NepalEarthquake2015 and go to Change Style.
15. Click the Counts and Amounts (Size) options.
    a. Scroll down and change the classes to 2.s
    b. Move the slider to 5.

This shows values 0-5 in one class and 5 and above in the Other Class.
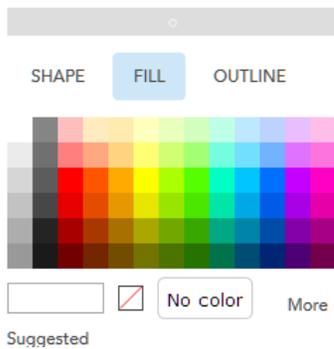
16. Click Legend.

You might have to expand the style pane to see the legend.

17. Click 0 to 5.
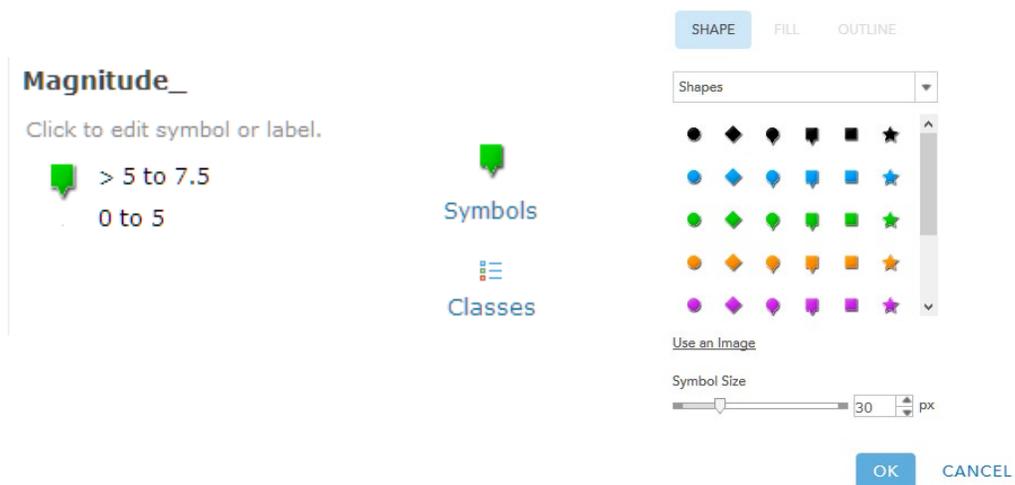18. Click Fill and choose No Color.
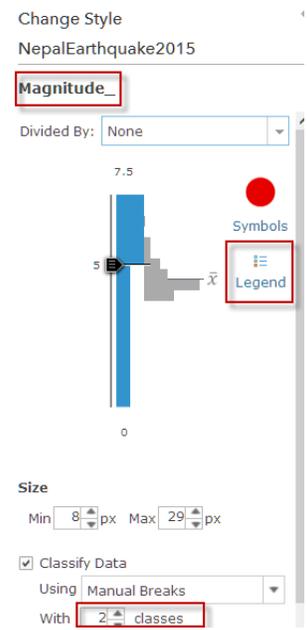
19. Click Outline and choose No Color.
20. Click OK.

This leaves only the earthquakes with a magnitude of above 5 shown on the map.

21. Click 5 to 7.5
22. Click Symbol, change the size of the symbol to 30, and choose a distinct symbol.
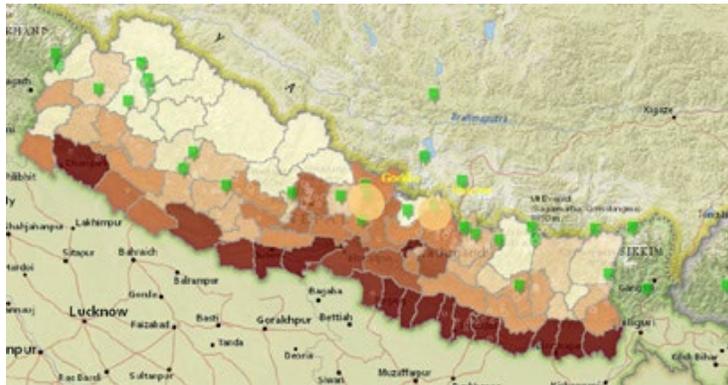

23. Click OK.

Q3 Where on the map are the earthquakes with a high magnitude in relationship to a district with a high population?

24.Check off the District layer and observe the basemap layer.

Q4 What would make rescue efforts difficult in the northern districts?

In this lesson you have learned how to classify data by unique values, counts, and amounts. You have learned how to change transparency and change the size and color of symbols for better cartographic display.
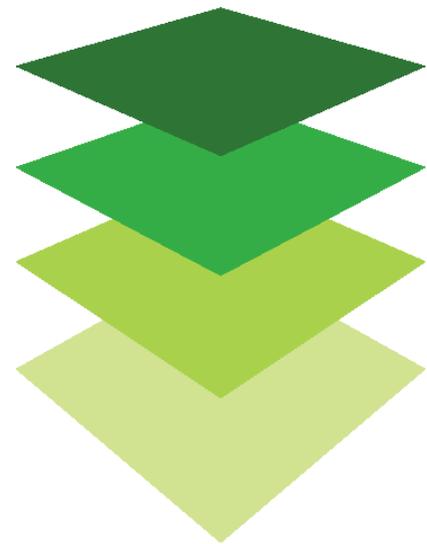
Querying and filtering earthquakes

The US Geological Survey (USGS) wants to use its live-feed earthquake data to promote understanding of earthquakes and their magnitude and depth. The USGS has asked you, as a representative of the American Association of Geographers, to write a lesson using this live-feed earthquake data, combined with the querying/filtering capabilities of the ArcGIS Online software.

Note: All answers will vary because of the last 60- day time frame of the data.

Build skills in these areas

➢ Opening and modifying an existing online map

➢ Filtering data by attributes

What you need

➢ Account not required

➢ Estimated time: under 30 minutes

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On the map, earthquakes over the past 60 days are symbolized by magnitude and depth. Here are some basic facts about earthquakes:

- Earthquakes between 5 and 7 are the ones that occur most frequently and cause damage.
- Earthquakes that are 7 and above are extremely damaging and much rarer.
- Earthquakes deeper than 300 kilometers are usually associated with convergent boundaries.

Richter scale of earthquake magnitude			
magnitude level	category	effects	earthquakes per year
less than 1.0 to 2.9	micro	generally not felt by people, though recorded on local instruments	more than 100,000
3.0-3.9	minor	felt by many people; no damage	12,000-100,000
4.0-4.9	light	felt by all; minor breakage of objects	2,000-12,000
5.0-5.9	moderate	some damage to weak structures	200-2,000
6.0-6.9	strong	moderate damage in populated areas	20-200
7.0-7.9	major	serious damage over large areas; loss of life	3-20
8.0 and higher	great	severe destruction and loss of life over large areas	fewer than 3

1. Symbolizing, Querying and Filtering

Symbolizing

1. Click Earthquakes. This map shows earthquakes that happened over the previous 60 days.
2. Click Show Map Contents under Details.
3. Click USGS Seismic Data – All Events by Mag to show the legend.

The earthquakes have been symbolized by their magnitude.

☑ USGS Seismic Data - All Events by Mag.

Magnitude

● Mag 7.5 or >

● Mag 6 to 7.5

● Mag 4.5 to 6

● Mag 3 to 4.5

Mag < 3

Filtering

You can use a filter to create expressions that meet certain criteria. In this section you will show earthquakes that have a magnitude greater than 5.

1. Click Filter under the USGS Seismic Data layer.
2. Choose the Magnitude field from the drop-down menu.
3. Click Unique.
4. Type 5 for magnitude.
5. Click Apply Filter

You now see only the spatial display of the earthquakes that meet your criteria.

Filter: Earthquakes - Points   >

| View | Edit |

＋ Add another expression   □ Add a set

Display features in the layer that match the following expression

| Magnitude ▼ | is greater th ▼ | 5 ▼ |

○ Value ○ Field ◉ Unique

□ Ask for values ▼

APPLY FILTER   CLOSE

Querying

You can ask questions that have more than one criterion. For example, you could ask to see all the earthquakes that have a magnitude of greater than 5 and a depth of more than 300 kilometers. If you have more than one expression, choose to display features in the layer that match All or Any of your expressions. All requires the criteria you have specified must be true. Any means that only one of your expressions must be true for the features to display.

1. Click Filter.
2. Click Remove Filter.
3. Click Edit.

   o Click Magnitude is greater than 5.

   o Add another expression.

   o Depth (kilometers) is greater 300.

   o Click Value.

   o Type in 300. (kilometers)

   o Display features in the layer that match **all** of the following expressions.

4. APPLY FILTER.

Filter: USGS_Seismic_Data - All Events by Mag.

| View | Edit |

+Add another expression ☐ Add a set

Display features in the layer that match all of the following expressions ▾

| Magnitude ▾ | is greater than ▾ | 5 | ✖ |

◉ Value ○ Field ○ Unique

☐ Ask for values ▾

| depth ▾ | is greater than ▾ | 300 | ✖ |

◉ Value ○ Field ○ Unique

☐ Ask for values ▾

APPLY FILTER   APPLY FILTER AND ZOOM TO   CLOSE

The map shows earthquakes that have both a magnitude greater than 5 and a depth (kilometers) greater than 300.

4

In this lesson you have learned how to ask questions of spatial data using the attributes to show the designated spatial values on a map.

Learn more

Using Filters

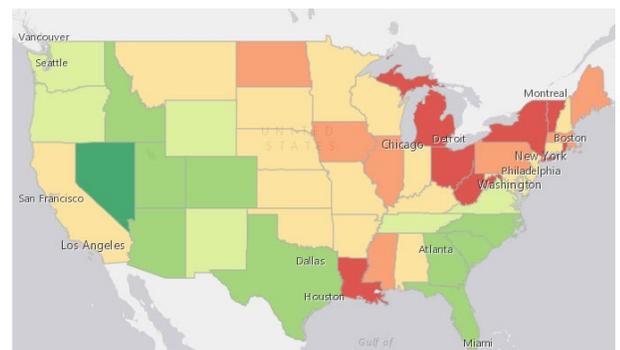# Mapping US population change 2000-2015

The US Census Bureau is preparing a report on changing population trends between 2000 and 2010. The Census Bureau has hired your data visualization company to produce a map showing Symbolizing the data rate of change by state and county during this time period. Your company has chosen to use ArcGIS Online to produce the required product. The Census Bureau has given you data for the population of 2000 and 2010 for both states and counties. It has asked for a map symbolized to distinguish areas of population growth from areas of population decline. The Census Bureau wants to be able to have a story map web app on its website that the public can view. In the following lessons you will enrich a layer to your map, add fields, and calculate values. You will also clarify the legend and publish the lesson as an app showing the rate of population change by region.

Build skills in these areas

➢ Opening a map
➢ Enriching layers
➢ Adding a field
➢ Calculating values
➢ Symbolizing the data
➢ Publishing a map as a web app

What you need

➢ Account required
➢ Estimated time: over 1 hour

1. Open the map

1. Sign into your ArcGIS organizational account
2. Open US Population Change 2000 to 2010.
3. Click the Show Map Contents Button under Details.

The map opens, showing the Topographic basemap, state, and county boundaries. States are counties are political boundaries.
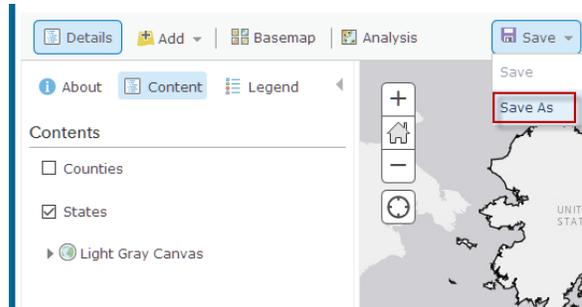
2. Change basemap

Click Basemap on the top menu and change the basemap to Light Gray Canvas.
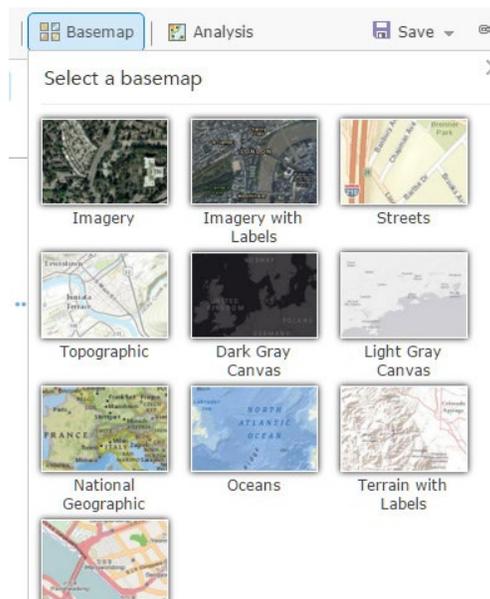
3. Save the map

1. On the top of the page, click Save and choose Save As.

2. In the Save Map window enter the following information:
   a. Title: US Population Change_yourinitials.
   b. Tags: Add individualized tags.
   c. Summary: Map indicates the annual rate of total population change from 2000 to 2010.

3. Click SAVE MAP.

4. Show table and examine attributes

To see information about features in a layer, you can display an interactive table at the bottom of the map.

1. Click the Show Table icon for States.

2. Examine the table. Notice the table shows only basic information.

STATE_NAME	STATE_FIPS	SUB_REGION	STATE_ABBR
Hawaii	15	Pacific	HI
Washington	53	Pacific	WA
Montana	30	Mountain	MT
Maine	23	New England	ME

3. Close the table by clicking the X in the upper right corner.

5. Enrich data for states

Data enrichment produces an enriched layer that retrieves information about the people, places, and businesses in a specific area. Detailed demographic data is returned for your chosen area. You are interested in a layer that shows the total population of 2000 and 2010.

1. Click States and Perform Analysis.

The analysis icon can be activated by either clicking the analysis icon under State or by clicking Analysis on the top ribbon.
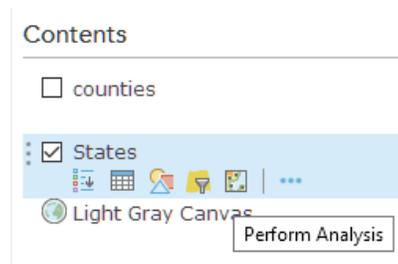
2. Click Data Enrichment and Enrich Layer.

3. Click Enrich Layer to activate the Enrich layer pane. States is the chosen layer to enrich with new data.

4. Click Select Variable to open Data Browser and browse for variables:
 a. Be sure the United States is chosen in the upper right corner.
 b. Click Population.
 c. Click the Arrow to go to the next page (2 times).
 d. Click Show all Population Variables.
 e. Click 2000 data in 2010 Geography (U.S. Census) to uncollapse the layer
 f. Check 2000 Total Population (U.S. Census).
 g. Click 2010 Population (U.S. Census).
 h. Check 2010 total Population (U.S. Census).

Data Browser

POPULATION TOTALS

Population Totals variables (20)
 ▼ ☑ 2000 Data in 2010 Geography (U.S. Census)
   ☑ ⓘ 2000 Total Population (U.S. Census)
   ☐ ⓘ 2000 Population in Families (U.S. Census)
   ☐ ⓘ 2000 Population in Households (U.S. Cen:
 ▼ ☑ 2010 Population (U.S. Census)
   ☑ ⓘ 2010 Total Population (U.S. Census)
   ☐ ⓘ 2010 Population Density (Pop per Square
   ☐ ⓘ 2010 Male Population (U.S. Census)
   ☐ ⓘ 2010 Female Population (U.S. Census)
   ☐ ⓘ 2010 Population in Households (U.S. Cen:
   ☐ ⓘ 2010 Population in Families (U.S. Census)
   ☐ ⓘ 2000-2010 Population Annual Compound
 ▶ ☐ 2015 Key Demographic Indicators (Esri)
 ▶ ☐ 2015-2020 Key Demographic Indicators (Esri)
 ▶ ☐ 2010-2015 Key Demographic Indicators (Esri)

BACK   APPLY   CANCEL

5. Click Apply.
6. Give Result layer a unique name such as enriched_states_yourinitials.
7. Uncheck Use current map extent.
8. Click Run Analysis.
9. Click Save at the top of the menu.

6. Add field and calculate: states

1. Click Show Table on enriched_states. The interactive table appears at the bottom of your map.

    Notice that the table now shows 2000 Total Population and 2010 Total Population. It also shows the Federal Information Processing Standard (FIPS) number developed by the US federal government for use in computer systems.

    The information in the table that you need to calculate the annual rate of change from 2000 to
    2010 is State_Abbr, the 2000 Total Population, and the 2010 Total Population.

2. Click Table Options in the upper right corner of the table and choose Show/Hide Columns.
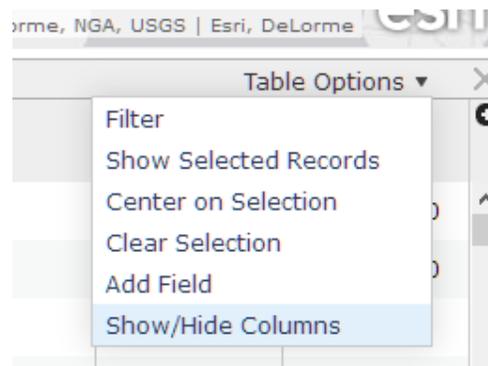
3. Uncheck all the fields except State_Abbr, 2000 Total Population and 2010 Total Population. Close the table by clicking the X in the upper right.

    Your next step is to add a new field to the table to store the calculation that you are going to make.

4. Click Table Options in the right corner of the table and choose AddField.

Table Options ▾
Filter
Show Selected Records
Center on Selection
Clear Selection
Add Field
Show/Hide Columns
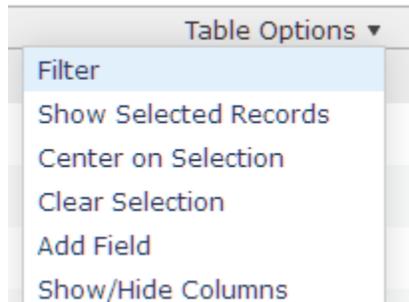
5. Add the following parameters to the Add Field menu.
   a. Name = rate_change
   b. Alias = annual rate of change from 2000 to 2010
   c. Type = Double
   d. Click Add New Field

Add Field   ✕

Name: rate_change

Alias: ' change from 2000 to 2010

Type: Double   ▾

Default Value:
(Optional)

ADD NEW FIELD

You can now see the new field added to the table.

6. Click the column you have just created (Annual rate of change from 2000 to 2010) and choose Calculate. This opens the Expression Builder dialog box.

You are trying to find the average rate of change per year from 2000 to 2010. If you subtract the population of 2000 from the population of 2010 and divide by the population of 2000, you will have the rate of change for 10 years; if you divide that number by 10, you will have the annual rate of change; and if you multiply that by 100, you will have a percentage. The formula is shown below.

7. Click the Annual rate of change from 2000 to 2010 field and click Calculate.

8. Choose SQL.
9. Type or copy the following formula in the Expressions Builder:

((TOTPOP10 - TOTPOP00) / TOTPOP00) / 10 * 100

10. Click Calculate. When you click Calculate, it populates the rows with the annual rate of change for each state.
11. Close the table by clicking the X in the upper right corner.
12. Click DONE.

7. Symbolize and adjust legend states

You want to distinguish your features based on the color gradient provided by the field you just calculated. The color gradient you should choose is Counts and Amounts (Color).

1. Click Enriched States and click Change Style.
2. In the Choose an attribute to show window, choose annual rate of change 2000 to 2010.
3. Choose Counts and Amounts (Color).
4. Click Options.
5. Check Classify Data and choose Natural Breaks.
6. Choose 6 classes.
7. Click Symbols and choose Red to Green ramp.
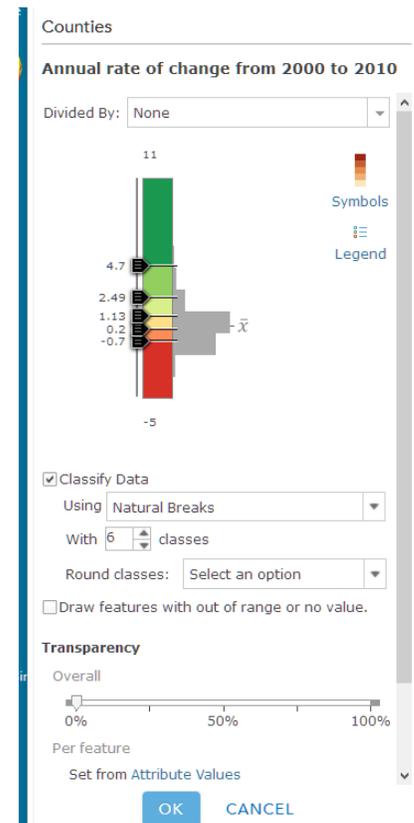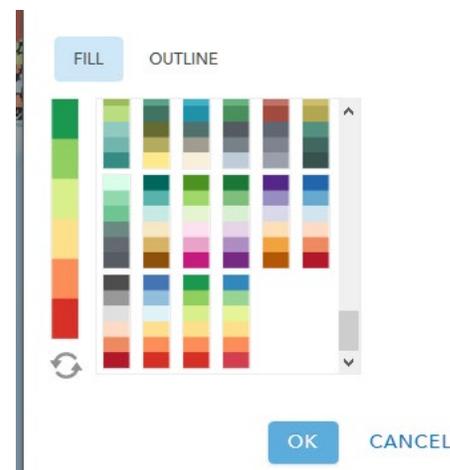
8. Click Legend.
9. For Round classes choose 0.1.
10. Click Legend and type percent symbols in the legend entries. You might must enlarge the style pane to see legend.
11. Click OK.
12. Click Done.
13. Click States and the legend will show.
14. Save map.

Write a description of the spatial distribution of the US by state population 2000 to 2010.

8. Enrich data by Counties for States

For this exercise counties of three states, Virginia, Nebraska, and Arizona, have been chosen.

Virginia

1. Click Counties and Filter.
2. For the expressions, choose:
3. Click Apply Filter

Only Virginia counties are shown on the map.

4. Using previous knowledge, enrich counties for pop2000 and pop2010.
5. Name the file.
6. Run Analysis.
7. Hide fields not needed, Keep checked Name, 2000 Total Population, and 2010 Total Population.
8. Add field rate_change.
9. Use the following expression when you calculate in the Expression Builder.

10. Symbolize and adjust legend.
11. Save the map to use in your web app.
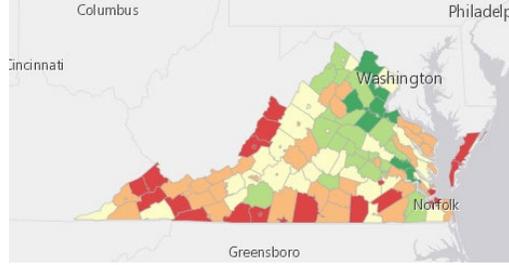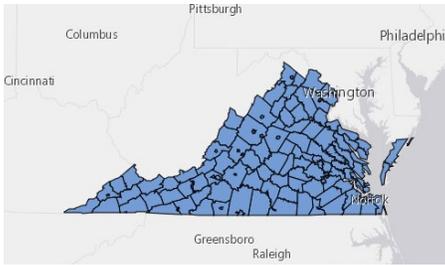
Nebraska

12. Remove the filter for Virginia.
13. Filter for Nebraska.
14. Repeat steps 4-11.
15. Click Save.
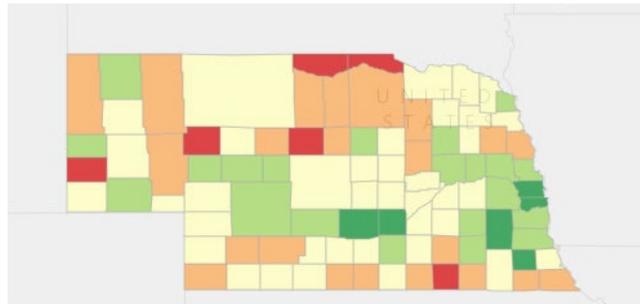
Arizona

16. Remove the filter for Nebraska.
17. Filter for Arizona.
18. Repeat steps 4-11.
19. Save.

9. Create a web app

You can create a web app from your map using a configurable app template. Your client has asked that the population rate change map you have built be displayed as a web app. Your client has asked you to use the configurable Story Map Series Web App.

1. Click Share.
2. Click Create a web app.
3. Select Build a Story Map.
4. Select Story Map Series.
5. Click CREATE WEB APP.
6. Specify a title, tags, and summary for the new web app.
7. Click Done.
8. Select Tabbed on the Welcome to Map Series Builder.
9. Click Start.
10. Type Rate f Change Population 2000 to 2010 as the title for your Tabbed Map Series.

What do you want to call your Tabbed Map Series?

Rate of Change Population 2000 to 2010

11. Click the arrow.
12. Add State Change for the Add tab.
13. Type US Population Change 2000 to 2010 for your map.
14. Check Legend.
15. Click Add.

ADD TAB

State Change

CONTENT: ● Map 🗺️   ○ Image 📷   ○ Video 🎥   ○ Web page 🔗

Map	U.S. Population Change 2000 to 2010 ▼
Location	Inherited from the first map ❓
Content	Map default Custom configuration ❓
Popup	Map default Custom configuration ❓
Extras	☑ Legend ❓

ADD   CANCEL

16. Write an analysis of the map in the text box.
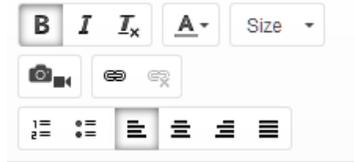
The northeast and Louisiana show a decline in population over the 2000 to 2010 time period. The western states, particularly Nevada, show a gain in population.
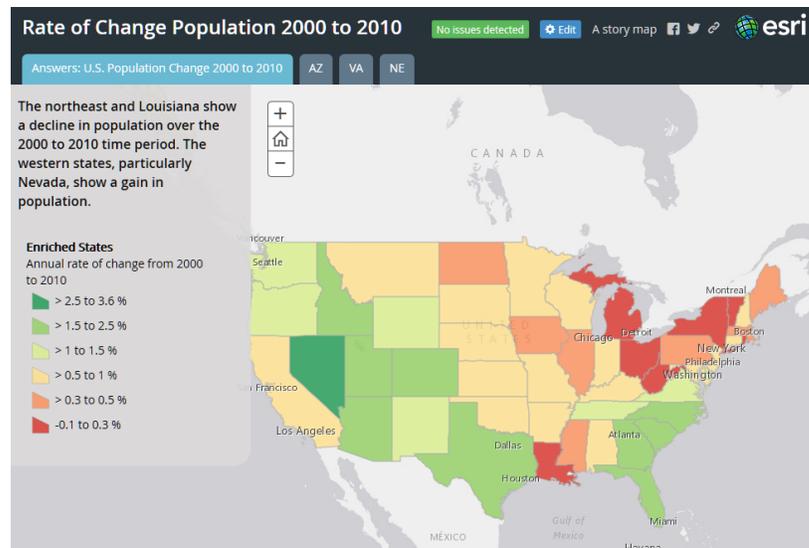
17. Add the map VA.
18. Add the map NE.
19. Add the map AZ.
20. Click Save.

21. Click Share on the top of the page. The Organization tab is highlighted.
22. Click View live.

Perform additional analysis

The enrichment tool gives you access to a vast amount of data. For an additional learning activity, choose a variable to study and, using the above exercise as a guide, repeat the process for the chosen variable. For example, you may be interested in calculating the change in density of the population older than age 65 in the past 10 years. You can do this analysis either by state or at the county level.

Steps for this exercise:

1. Enrich population over 65 in 2000.
2. Enrich population over 65 in 2010.
3. Calculate population density (2000 people over 65/area)
4. Calculate population density (2010 people over 65/area)

((Density 2010 -Density 2000)/Density 2000 * 100)/10

Analyzing the opioid crisis in America: Symbolize data and calculate with Arcade

The current opioid epidemic killed more than 33,000 people in 2015 and is considered one of the worst drug crises in American history. Public officials are collecting data and looking for solutions to the problem. Data has been collected by both the Centers for Medicare & Medicaid Services (CMS) and the Centers for Disease Control and Prevention (CDC). Medicare and Medicaid data are public and derived from Medicare Part D information. The data includes information about prescribing rates and prescription claim rates. Prescriber-level data provides the number of prescriptions as well as the number of claims (including new prescriptions and refills) for opioid drugs. It is to be noted that the Medicare and Medicaid programs provide coverage for the elderly and the poor age 65 and older. Drug- poisoning deaths have been obtained from the CDC. The opioid related deaths are for the entire general population.

Data Dictionary County Opioid Data:
prescribed opioids 2013 – Part D (prescriptions written for opioid drugs)
opioid claims 2013 – prescriptions filled for opioid drug claims submitted to health care provider
overall claims 2013 – total drug claims of all types submitted to health care provider
prescribed opioids 2014 – Park D (prescriptions written for opioid drugs)
opioid claims 2014 – prescriptions filled for opioid drugs claims submitted to health care provider
overall claims 2014 – total drug claims of all types submitted to health care provider

Data Dictionary Opioid Opioid-Related Deaths:
POP2013 – population 2013
POP 2014 – population 2014
POP 2015 – population 2015
Deaths 2013 – deaths caused by opioid related factors
Deaths 2014 – deaths caused by opioid related factors
Deaths 2015 – deaths caused by opioid related factors

Both the CMS and CDC have data collections. They know that the mapping of this data will help increase their understanding of the opioid crisis. They have contracted you as a GIS analyst to produce maps showing the following:

- Opioid Claims 2014
- Percentage Opioid Claims 2014 (Opioid Claims 2014/Overall Claims 2014)
- Number of opioid deather normalized by population (2014 and 2015

Build skills in these areas

➢ Classifying data by color
➢ Classifying data by count
➢ Normalizing data
➢ Using ArcGIS Arcade expressions to make calculations
➢ Using ArcGIS Arcade expressions to label
➢ Add as needed

What you need

➢ Account required
➢ Estimated time: 2 hours

1. Open and save the map

1. Sign into your ArcGIS organizational account.
2. Open USA Opioid Usage.
3. Notice that you have three layers of data in the Contents pane:
   a. Opioid Related Deaths
   b. County Opioid Data
   c. Topographic basemap
4. Examine the data by turning the layers on and off and by zooming in and out on the map.
5. On the top of the menu, click Save and choose Save As.
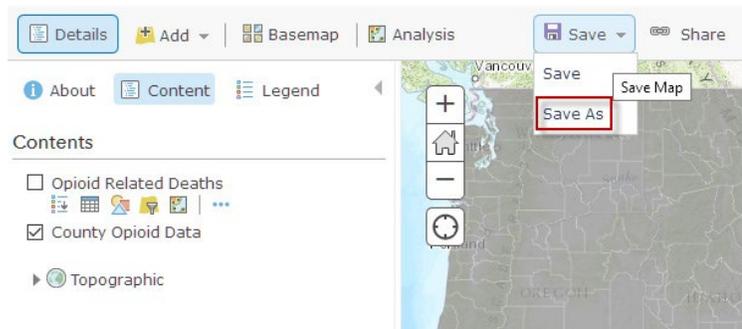
6. In the Save Map window, type **USA Opioid Usage_your initials**.
7. Remove the tag IGARC2_opioid and add your own individual tag OR add your initials to the IGARC2_opioid tag.
8. Type a brief description, such as USA opioid usage study at the county and state level.

9. SAVE MAP.

2.   Show table and examine attributes

To see information about features in a layer, you can display an interactive table below the map. Both the Opioid Related Deaths layer and the County Opioid Data layer have associated attribute tables.

1. Click the Show Table icon under the County Opioid Data layer.
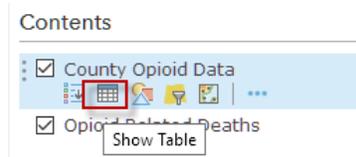
2. Examine the table. Refer to the data dictionary at the beginning of the lesson to understand the data.
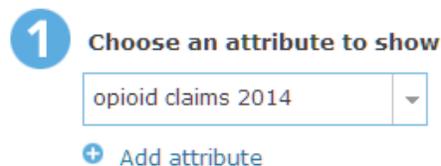3. Close the table by clicking the X in the upper right corner.

3.   Calculate opioid claims 2014 compared with opioid claim rates 2014 by color

The data can be displayed in color by any of the fields in the attribute table.

1. Click the Change Style icon under County Opioid Data.
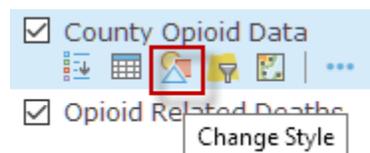
2. Under Choose an attribute to show select opioid claims 2014.

3. Click SELECT under Counts and Amounts (Color).
4. Click Done.

It would be easier to describe the map if the state outlines were shown on top of the county data.

5. Check Opioid Related Deaths to display states.
6. Click the Change Style icon under Opioid Related Deaths.
7. Click OPTIONS.
8. Click Symbols.
9. Click Fill and No Color.
10. Click Outline and Black.
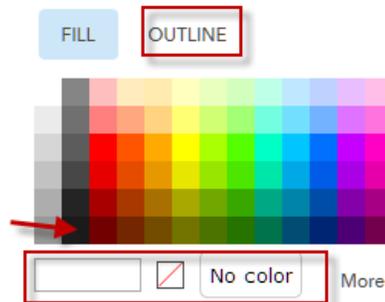
11. Click OK.
12. Click OK.
13. Click DONE.

This is not the best way to look at the data because the data has not been normalized. Normalization of data means to adjust the data to a common scale. For example. In this exercise if we classify the data by the number of claims, the states with the most people will invariably have the most. To standardize our data, we can divide the number of opioid claims by the total number of claims. This gives a percentage of claims and is a much better representation of the data.

14. Again, click Change Style under County Opioid Data.
15. Click Counts and Amounts (Color) OPTIONS.
16. Divide by overall claims 2014.
17. Click OK.
18. Click DONE.

19. Right-click and go to rename. Change the name of the layer to % of Total Opioid Claims.

Notice how the map has changed.
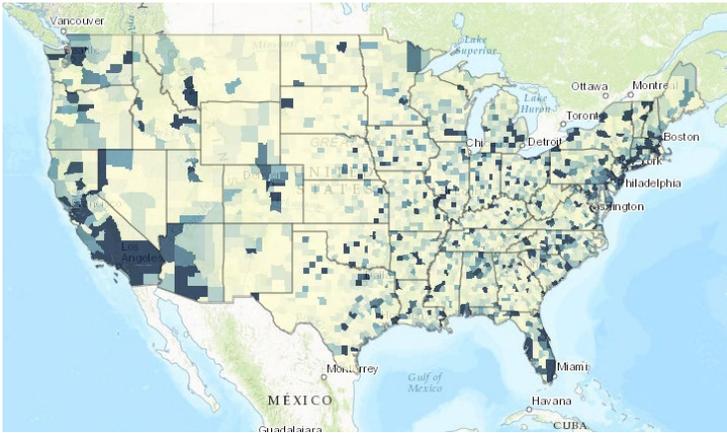
NOT NORMALIZED
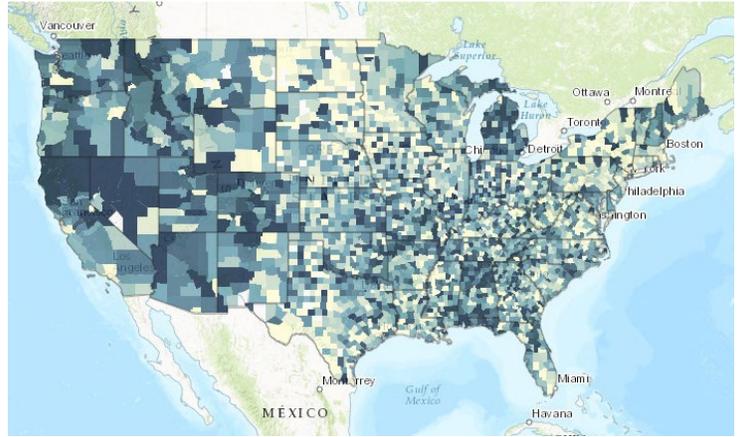
NORMALIZED

Q1 Write a paragraph comparing the data of opioid claims in 2014 with the opioid claims normalized (divided by the total claims) in 2014.

Q2 Write a sentence about the spatial display (normalized) of the data. Which states have the most opioid claims? Which have the least?

20. Zoom into your state.

Q3 Write a brief paragraph about the spatial display of the data within your state. Is there a pattern?

4. Calculate opioid claims 2014 compared with opioid claim rates 2014 by size

In the previous part of this exercise you have symbolized your data using graduated color. In this part of the exercise you will symbolize your data by size.

1. Click the Change Style icon under % of Total Opioid Claims. Be sure that the Choose an attribute to show is still opioid claims 2014.
2. Click Counts and Amounts (Size).
3. Click Select.
4. Click Counts and Amounts (Size) OPTIONS.
5. Divided by Overall claims 2014.
6. Click OK.
7. Click Done.
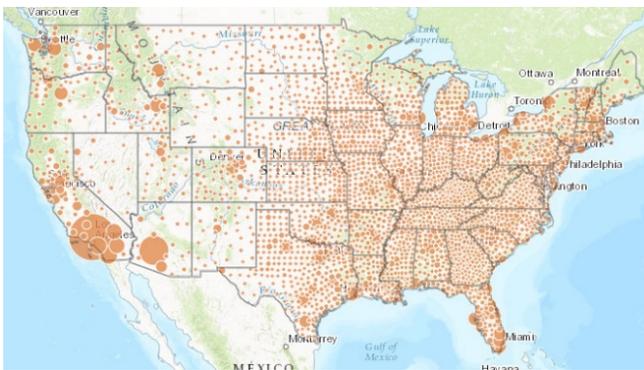
NOT NORMALIZED
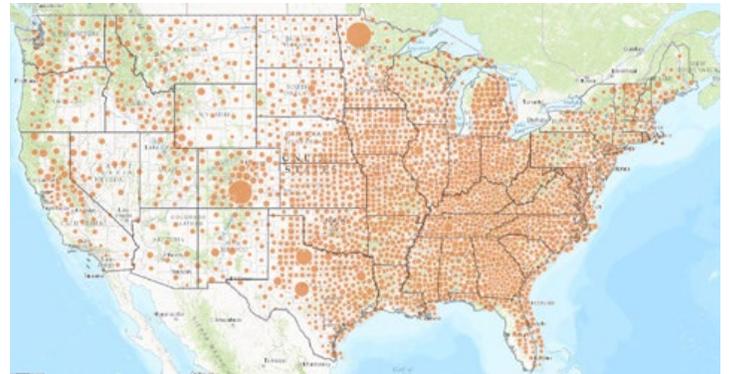
NORMALIZED

Q4 What are the advantages of using color symbolization? Size symbolization?

5.   Compare opioid related deaths from 2014 to 2015

The Opioid Related Deaths layer provides public data about opioid related deaths. It also provides the total population for 2014 and 2015. You know from the previous part of this exercise that if you display the opioid related deaths without normalizing them, the data will be skewed. In other words, the states with the most populations would most likely have the largest number of deaths. The deaths need to be normalized by population. You can create this custom attribute that you need by writing an ArcGIS Arcade expression in the New Expression tab. Arcade is a simple expression language that can be used across the ArcGIS Platform. You can use Arcade expressions to perform calculations and create labels.

1. Turn off County Opioid Data.
2. Click the Change Style icon beneath the Opioid Related Deaths layer.
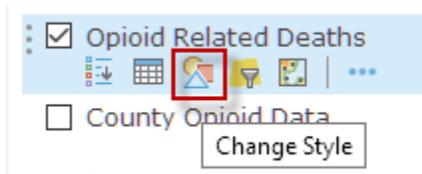
3. Under the Choose an attribute to show tab, select New Expression.
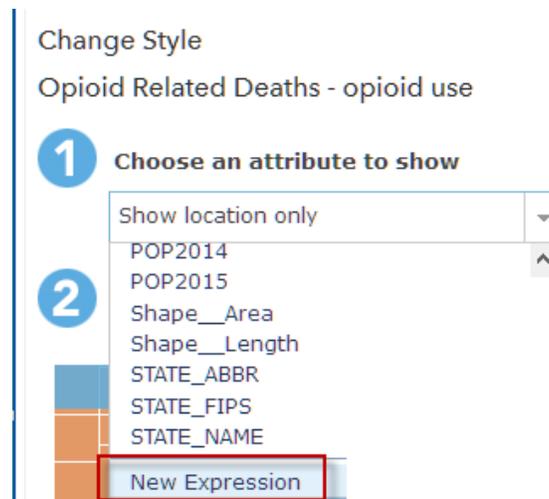
The expression or attribute that you need to show the change in opioid deaths from 2014 to 2015 is the following:
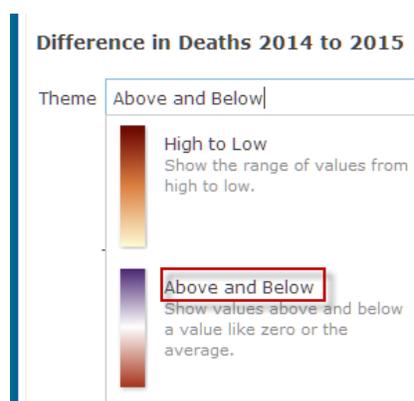
(($feature.no2015/$feature.POP2015-$feature.no2014/$feature.POP2014)*100)

This is a simple expression of normalized data. It starts off with two parentheses ((because we must do one function and then a second function. The first is **$feature.no2015**, the number of deaths in 2015, / is divided by **&feature.POP2015**, the population in 2015. You then subtract **$feature. no2014**, number of deaths in 2014 / divided by **$feature.POP2014**, population in 2014. You then close the first parenthesis). You multiply * by 100 to change to a percentage. Close the parenthesis). Once you work with these expressions, they become much simpler. You can copy the above expression and paste it into the expression box, but it is good practice to write the expression yourself.

4. Click Edit and change the name from Custom to Difference in Deaths 2014 to 2015.

Difference in Deaths 2014 to 2015 ✎ Edit

| Expression | Test |

1 | (($feature.no2015/$feature.POP2015-$feature.no2014/$feature.POP2014)*100)
2 |

5. SAVE.
6. OK.
7. Click Counts and Amounts (Color).
8. OPTIONS.
9. For Theme select Above and Below, which shows values above and below a specific value. In this case it would be above 0 to indicate an increase in deaths and below 0 to indicate a decline in deaths.

Difference in Deaths 2014 to 2015

Theme | Above and Below

High to Low
Show the range of values from high to low.

Above and Below
Show values above and below a value like zero or the average.

9

When you select the Above and Below theme you see three tabs. The middle one should be set to 0.
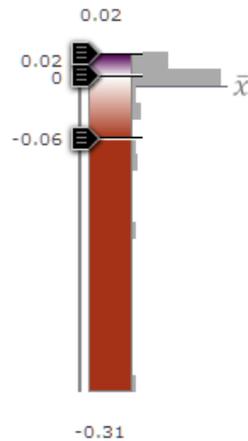
10.OK.

11.Done.

The states that have an increase in deaths are shown in purple and the states that have a decrease in deaths are shown in rust. The map would be more meaningful if the number of deaths gained or lost would be shown on the map. You can use another simple Arcade statement in the manage label menu to accomplish this.

12.Click the three dots at the end of the Opioid Related Deaths layer and choose Create Labels.

13.Under Text choose New Expression.
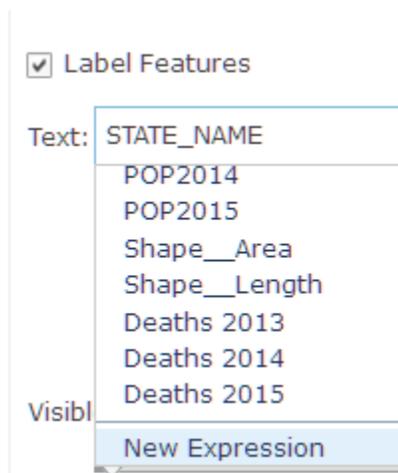
14. Write the expression **$feature.no2015-$feature. no2014**, which is Deaths 2015 – Deaths 2014.
15. Click edit and name the expression Change in Deaths.

Change in Deaths

Expression

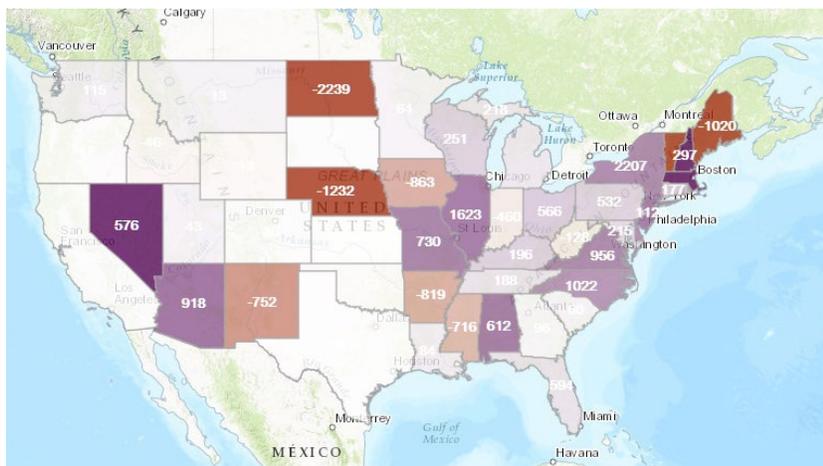1 $feature.no2015-$feature.no2014

16. SAVE.
17. OK.
18. Change the color to White and make the text Bold.
19. OK.
20. Save your map.

There are noticeable big increases and decreases between years.

Q5 Which states have decreased in deaths?

Q6 Which states seem to have the most increase in deaths?

In this lesson you have used different symbolization methods, and you have adjusted your data to a standard scale by normalization.

Learn more

ArcGIS Arcade

Using Arcade Expressions to Map Your Ideas

Mapping Is for Everyone
New ways to make, see, and use maps

Maps are among our oldest communication tools. They convey information with symbols, colors, lines, and words. They convey a "sense of place" in the broadest sense: the relationships and connections between places and the forces that shape social and physical characteristics. It does not matter what media delivers a map. Whether they are hand drawn, printed, digital, or online, maps deliver information to the viewer that is both analytical and artistic.

Cartography is the art of making maps, and in ArcGIS Online, you can easily access smart mapping tools to help you make the cartographic decisions that render your map informative. The tools suggest the best way to coordinate color and to represent and style your data. They allow novice users to gain experience with cartographic options and learn from practice. When any new data is added to your online map, you'll see the smart mapping tools available on the interface.

This chapter includes a broad range of instructional topics, starting with the investigation into the variety of ArcGIS Online basemaps and ending with a scenario-based lesson on the availability of farmers' markets. Within the topics, you'll find ways to add and display data to your maps, to analyze your data, and to better design your maps.

The chapter also includes questions that support reading comprehension, reflection, and a discussion of chapter 2 narratives in *The ArcGIS Book: 10 Big Ideas about Applying The Science of Where*.

Introductory activities

Video

These videos show the way maps can help us tell stories and solve problems. Teachers can use them to generate interest and stimulate discussion. *The Importance of Maps* provides an overview of the vast range of issues that GIS maps can address. *Esri UC 2017 User Map Submissions* demonstrates the extent of that diversity through the display of numerous maps created by professional GIS users.
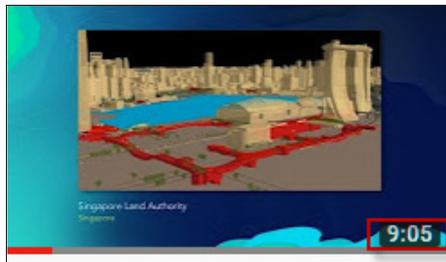
The Importance of Maps
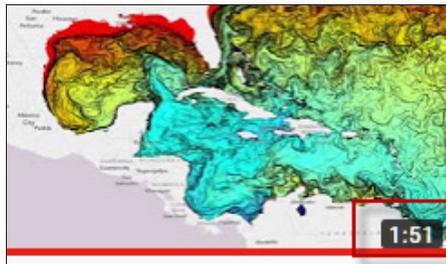
The Importance of Maps

Maps are everywhere! See how they help us tell stories, solve problems, and save the world.

1:51

Esri UC 2017 User Map Submissions

Esri UC 2017 User Map Submissions

User **map submissions** from Esri **UC 2017**

9:05

Activity 2-1
Scale and resolution
Mastering the difference between them

Maps have always been defined as a graphical representation of Earth's surface, so mapmakers have always dealt with scale. With the introduction of digital orthophotos, the property of resolution became equally important to consider. Resolution is a linear dimension on the ground that is represented by each pixel. If resolution is high, you will be able to see more detail in a digital photo as you zoom in; if resolution is low, you will be able to see less detail.

Low Resolution

High Resolution

Scenario

You have been asked to give a presentation to beginning teachers about the difference between map scale and resolution. The designated audience is middle school students.

1. Go to ArcGIS Online — Mapping Without Limits
2. On the top of the site, click Map.
3. Click Basemap and change the basemap to Imagery.

Where is the scale shown on the map?
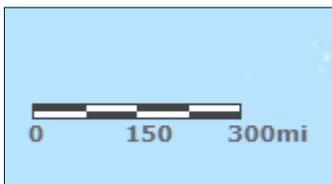
4. In the Find tab on the upper right, search for the following locations and zoom in as far as possible:

  - Washington, DC

  - Mount Kilimanjaro, Kilimanjaro, Tanzania

  - Moscow, Russia

  - Seattle, WA

Are there different zoom restrictions?
Are the images clear at the last zoom?

Resolution, by definition, is a function of the satellite or aerial imagery used. A detailed description of the imagery resolution is found at World Imagery Resolution.

In one or two sentences summarize what the resolution is after reading this description.

Verbalize to a small group the difference between scale and resolution. Feel free to use the maps as visualizations.

Activity 2-2
Predominant Mapping
US county crops 2007
The best maps are not only information products; they are visually interesting. In this exercise you will start with an unclassified layer and classify the data in several ways. Your assignment is to try to produce a map that is effective in showing county crop production in the US in 2007.

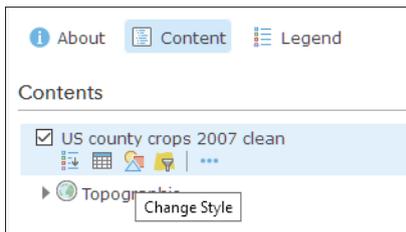## Open map and display multiple attributes

1. Open *US County Crops*.

The map opens without any symbolization. You job is to use two different types of symbolization (color and size).
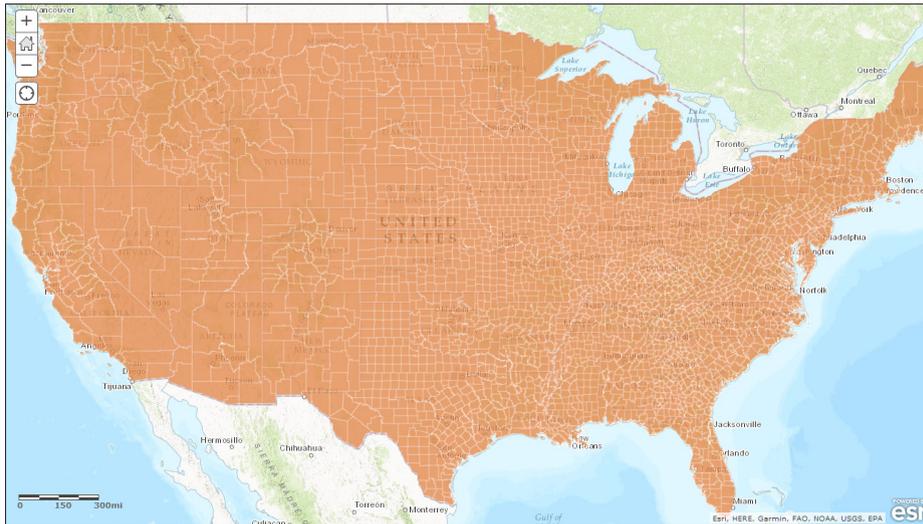
2. Click Content.

First you need to display the data by four unique attributes.

3. Click Change Style below US county crops 2007.

4. Under Choose an attribute to show, select Corn for grain, harvested acres.
5. Add Attribute.
6. Select All wheat for grain, harvested acres.
7. Add Attribute.

8. Select Soybeans for beans, harvested acres.

9. Add Attribute.

10. Select Upland cotton, harvested acres.

11. Add attribute.

12. Select Vegetables, acres harvested for sale.

The next part of this activity will introduce you to predominant mapping. A predominance map allows you to analyze multiple fields of related data and show the field that is predominant (has the most units). The multiple fields of data must share a common subject and unit of measurement. The predominant map can either be displayed by Predominant Category or Predominant Category & Size.

Display by Predominant Category

1. Select Predominant Category.

2. Click OPTIONS.

Change the colors to represent the crop types.

3. Click the square for corn and select yellow. Click OK.

4. Click the square for wheat and select dark tan. Click OK.

5. Click the square for soybeans and select dark brown. Click OK.

6. Click the square for cotton and select gray. Click OK.

7. Click the square for vegetables and select green. Click OK.

You can apply transparency to each feature based on the strength of the predominant attribute (percentage of total).

8. Click Set from Predominant Percentage.

9. Click OK to dismiss Predominant category.

What is dominant in the Midwest and why? Why does the West Coast have a majority of vegetable production?
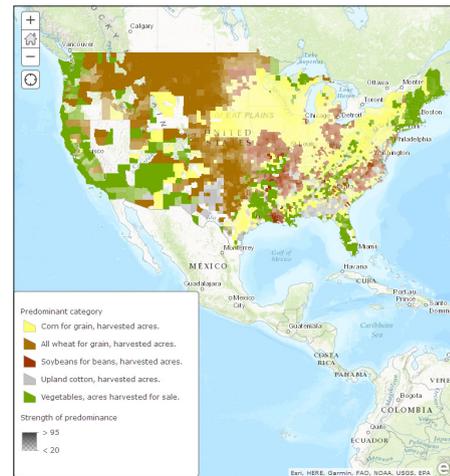
Display by Predominant Category & Size.

You will now display your data by Predominant Category & Size with color showing the predominant category, size showing the sum of the categories and transparency showing the relative strength of the predominance.

1. In Change style dialog, click SELECT under Predominant Category & Size.

2. Zoom into the county level.
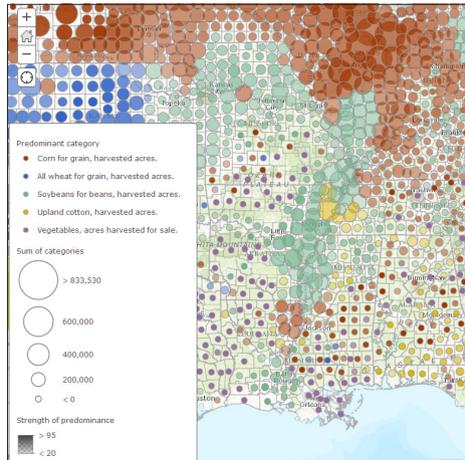
List the advantages and disadvantages of the two predominant category styles.
List the three variables displayed in predominant category and size maps.

In this activity you have explored predominant mapping by using both category and category and size styles.

The ArcGIS Book, chapter 2
Questions for reading comprehension, reflection, and discussion

Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

Online mapping is transforming GIS

What are three advantages of online maps over traditional printed maps?

Basemaps and operational layers

What is the difference between a basemap and an operational layer?

Additional resources

Web map properties

Besides being scalable and fluid, name two other advantages of online maps.

Learning to smart map

What does smart mapping give to the online user?

Map design 101: Drawing your audience into the story you're telling

What makes looking at maps a rewarding experience?

Maps into the third and fourth dimensions

What are the third and fourth dimensions?

Smart Mapping in ArcGIS Online — Predominance

Smart Mapping in ArcGIS Online - Predominance

In the March 2016 release of ArcGIS Online, you can now **map predominance** with two new smart **mapping** styles. Watch this ...
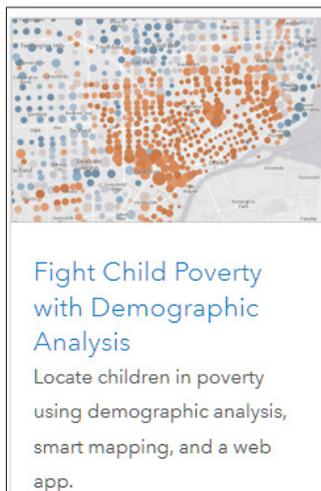
CC

2:04

Learn ArcGIS
Guided lessons based on real-world problems

Learn ArcGIS: Guided lessons based on real-world problems

Bridging the Breast Cancer Divide

Learn about the disparity in breast cancer mortality rates.

Bridging the Breast Cancer Divide.

Exploring maps and performing visual analysis.

Adding fields, selecting features, and calculating values.

Symbolizing the values.

Performing hot spot analysis.

Interpreting findings.

Fight Child Poverty with Demographic Analysis

Locate children in poverty using demographic analysis, smart mapping, and a web app.

Fight Child Poverty with Demographic Analysis

Adding layers to a map.

Enriching layers with demographic data.

Styling layers with smart mapping.

Configuring pop-ups.

Editing item details.

Configuring a web app.

Adding point data

Find patterns in mountains of data

You begin to get a strong sense of what maps can do from this lesson. The image shows a total of 58,000 airline routes on one map. The Web Mercator projection transforms the straight fight paths into curves. You are going to use this map to solve a spatial problem while also learning how GIS software deals with point data. Locational information contained in point data adds the spatial component that the map needs to locate the information. Point data can get its locational information from latitude and longitude or from a street address.

The International Federation of Air Traffic Controllers' Associations (IFATCA) wants to investigate fights going in and out of three of the busiest places in the world: London, New York, and Atlanta. The federation wants a visual representation of the fight routes to each of the airports within the three cities.

Build skills in these areas

- ➢ Opening and modifying an existing online map
- ➢ Filtering
- ➢ Adding x,y data
- ➢ Geocoding data
- ➢ Creating bookmarks

What you need

- ➢ Account required/not required
- ➢ Estimated time: 30 minutes – 1 hr

Publication Date: Feb 2019

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1. Open the map, add and filter data

1. Click Airflow Pro.
2. In the upper right corner, click Modify Map.

Modify Map   👤 Sign In

3. In the top menu, under Details, click Content. You should see two layers in the Content Pane: World Dark Gray Base and flight routes.

You have been asked to map three individual cities that have the largest air traffic: London, New York, and Atlanta. You need to add a layer to obtain that information.

4. Click Add on the Top menu and choose Search for layers.

Home ▾   Airflow Pro

📄 Details   ⊞ Add ▾ | 🔲 Basemap

ⓘ About

Search for Layers

Add Layer from Web
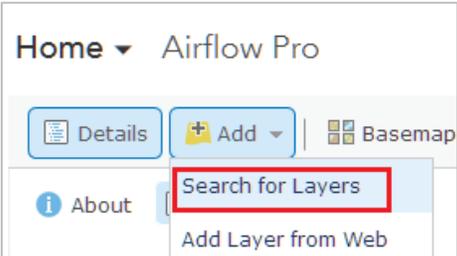
5. The search pane opens.
   a. In the search box, type World Cities.
   b. In ArcGIS Online

←   ArcGIS Online ▾

🔍 "World Cities"owner:esri

1 layers   ≣ ⋮≣ ⇅ ☰

World Cities
📒 by esri
Updated: 2/7/17
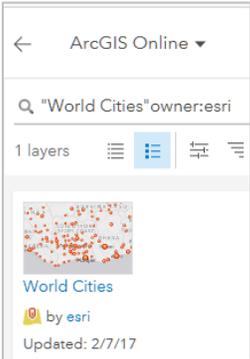
6. Add World Cities by esri.
7. Click the back arrow to go back to the Contents Pane.

As you zoom out, the flight routes disappear. This is because a visibility range has been set. Visibility range is used with multiscale maps and allows you to view geographic data across a range of scales or zoom layers. The next two steps set the visibility range to be at all scales.

8. Click the three dots under flight routes to access More Options and select Visibility Range.
9. Change the slider to go from World to Building. (You can specifically set the scale to be 1:18,000,000 or you can move the right to buildings and leave the left on world.)

You now want to narrow down the cities to London, New York, and Atlanta. You do this by applying a filter, which presents a focused view of the feature layer World Cities.
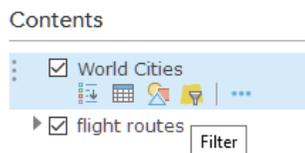
10. Point to World Cities and click Filter.
11. Created your definition expression. Be sure to select: "Display features in the layer that match **any** of the following expressions."
    a. CITY_NAME is London. (Type London.)
    b. Be sure to click Unique.
    c. + Add another expression.
    d. CITY_NAME is New York. (Type New York.)

e. + Add another expression.
f. CITY_NAME is Atlanta. (Type Atlanta.)
g. Click Apply Filter.

Once again at the top of the Filter Menu be sure you change the setting from All to Any.
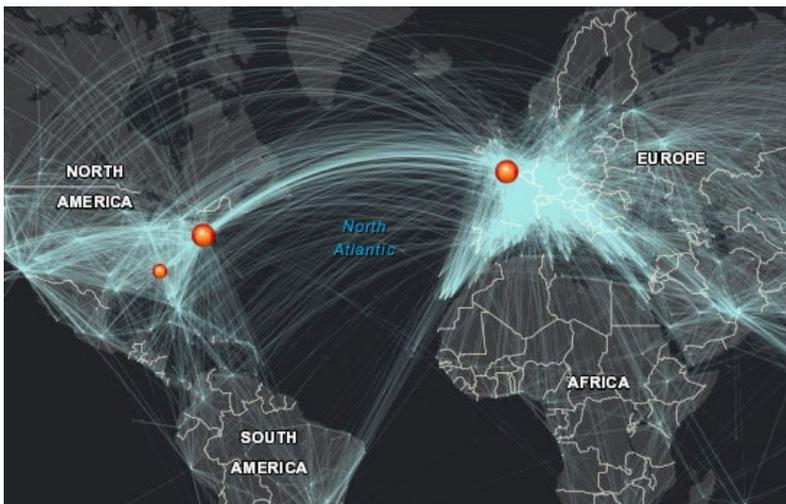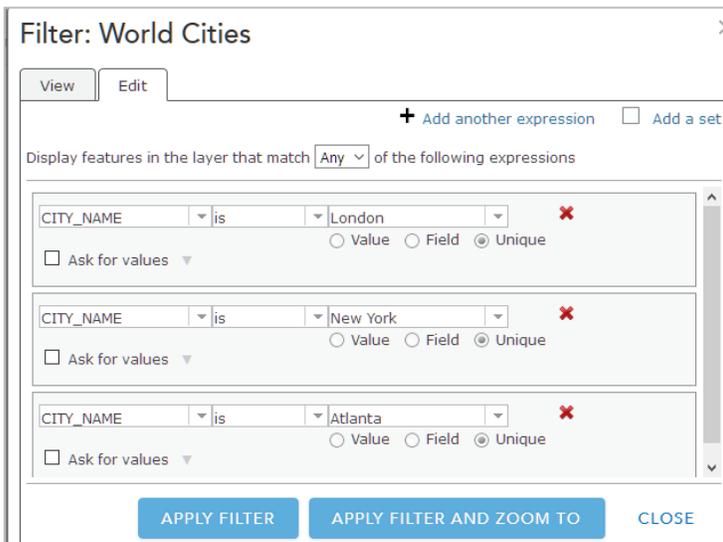
2. Locate and map airports

Now that the three cities are isolated, it is time to locate and map the individual airports. To add the location of the individual airports you will deal with two types of point data.

Type 1: Add the first set of airports to the City of London by using latitude and longitude (x,y) data.

Type 2: Add the second two cities (New York and Atlanta) with address information.

Add this feature data from a delimited text file (.txt) or a comma-separated values text file (.csv) that includes the locational information (latitude and longitude or address) along with any other attributes. What follows is an example of a delimited text file for the London airports with latitude and longitude data. Notice how the headers are separated by commas with no spaces. That is why it is called a comma delimited text file. The name of the airport is the only attribute attached to the locational information. Notice that the latitude and longitude are in decimal degrees. These must be exact and on one line and with no spaces.

Long,lat,name
-0.45361,51.47196,Heathrow
-0.17899,51.15518,Gatwick
-0.37557,51.8798,Luton
0.23985,51.88516,Stansted
0.70171,51.56612,Southend

1. Copy the text above exactly as shown into a simple text application. Notepad is a great application to use for this. Be sure to copy the top line: long,lat,name.
2. Save the file on your computer and name it airports_x_y.
3. Drag the airport_x_y file to your map.
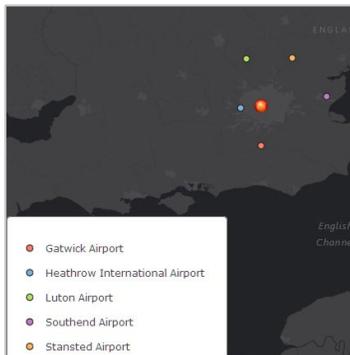
This is the power of GIS. You have taken a table of data and mapped it. If you click on any of the points, you can see the locational information as well as the name of the airport.

3. Change symbology

1. The airports are displayed by Types (Unique symbols) with the attribute as the name. Click legend to see airports displayed by name. You can switch back and forth from Contents to Legend.
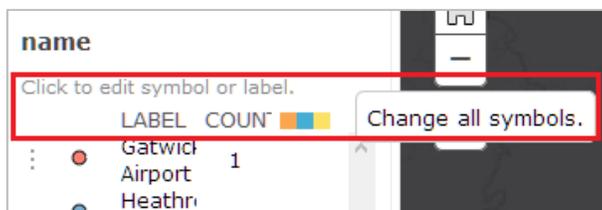
2. Click the change style icon under airports_x_y.
3. Click OPTIONS
4. Click the color ramp to activate the change symbol menu.
5. Move the Symbol Size to 15 and choose a shape.

6. Click OK, OK.
7. DONE.

4. Geocode

Add the second two cities (New York and Atlanta) with address information. Geocoding is the proper term for converting an address to an x,y coordinate. By default ArcGIS Online uses the World Geocoding Esri service. Below is what you need for a comma-delimited text file for New York and Atlanta.

Name,address,city,zipcode
Laguardia,LaGuardia Rd,Flushing,NewYork,11371
John F Kennedy Int'l Airport I 678 S,Jamaica,New York,11430
Hartsfeld-Jackson,6000 N.TerminalPkwy,Atlanta, GA,30320

1. Copy the above lines exactly as shown into a simple text application (like Notepad).
2. Save the file on your computer and name it airports_addresses.
3. Drag the airport_addresses file to your map and ADD layer.
4. Match the symbology of the UK airports as set previously.

5. Create bookmarks

To get quickly from airport to airport on your map, as the map author, you need to create bookmarks. Bookmarks are based on the current location and scale of the map. When others click a bookmark, the map zooms to that location.

1. Zoom to the location and scale that you want to look at for London and its airports. You might want to change the basemap.
2. On the top of the site, click Bookmarks.
3. Click Add Bookmark.
4. Name the bookmark **London**.
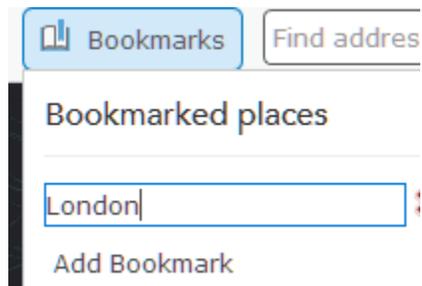
5. Click the X in the upper right corner to close the bookmark.
6. Zoom to New York and create a bookmark. Name the bookmark **New York**.
7. Zoom to Atlanta and create a bookmark. Name the bookmark **Atlanta**.

By completing this map, you have given the IFATCA a visual representation of the fight routes to London, New York, and Atlanta. To do that, you used the following GIS skills:

- Searching for ArcGIS Online layers
- Filtering layers
- Mapping table data with an x,y coordinate
- Mapping tables with an address
- Creating bookmarks

Displaying crime data with heat maps: Washington, DC, July 2016

Esri has a smart mapping mission to enable anyone to visually analyze, create, and share professional- quality maps. In this lesson, you will analyze point data using heat maps within smart mapping. To begin your journey, explore the How to Smart Map: Heat Map.

The Washington, DC, police department is planning the deployment of its resources for the month of August. The department would like to see different geographic patterns of criminal behavior on a map. The GIS staff has been given the July data on Friday afternoon and has been tasked with analyzing the data by the Monday morning briefing. The police chief is particularly interested in auto theft and burglary. The chief has asked for the following maps to be produced:

- A map showing total crime concentration
- A map showing auto theft
- A map showing burglary
- Two individual maps of auto theft and burglary for Ward 8

Build skills in these areas

➢ Finding and downloading a CSV file
➢ Uploading a CSV file
➢ Filtering
➢ Changing basemaps
➢ Using heat maps at different scales
➢ Comparing two variables

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hr
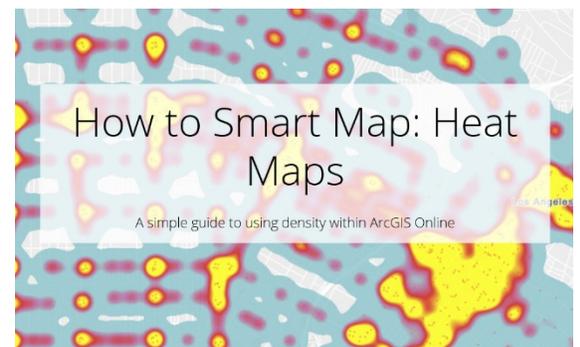
1. Find and download a prepared CSV file of July 2016 Washington, DC, crime

1. Click Crime Incidents in 2016 July.

2. Download.
3. Save the file to an appropriate.

2. Log into your organizational account, create a new map, and save

1. Log into your ArcGIS organizational account.
2. Click Map.
3. Click Show Map Contents under Details.
4. On the top menu click Save As.
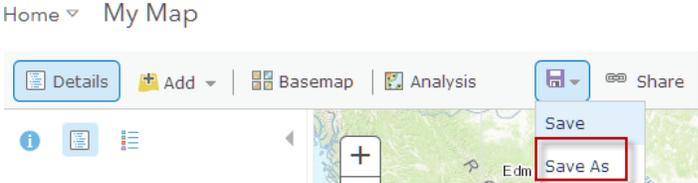
5. In the Save Map menu enter the following information:
   a. Title: Crime in Washington, DC
   b. Tags: IGARC2_crime_your_initials
   c. Summary: Crime in Washington, DC, displayed by heat maps.
6. Click Save Map.

3. Upload and publish a prepared CSV file of July 2016 Washington, DC, crime

1. In the upper left corner click Home and Select Content.
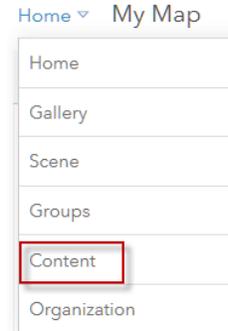
2. Click Add Item>>From my computer.
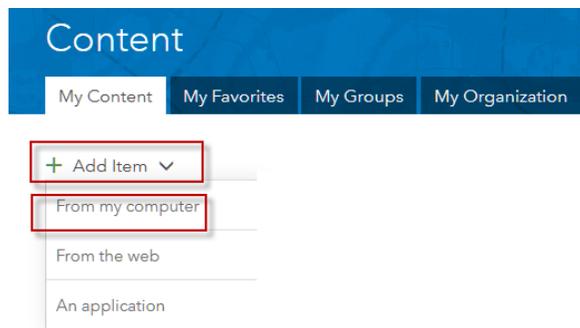
3. Browse your computer and find the Crime_Incidents_in_July CSV file.
4. Add Tags: IGARC2_crime_your_initials.
5. Check Publish this file as a hosted layer.
6. Check Coordinates.
7. Under Location Fields select Longitude and Latitude.
8. Add Item.
9. Open in Map Viewer.
10. Change Choose an attribute to show location only.
11. DONE.
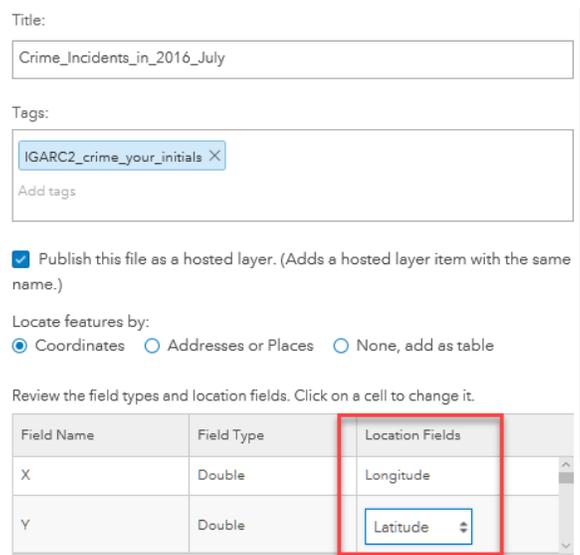
12. Change Choose an attribute to show location only.
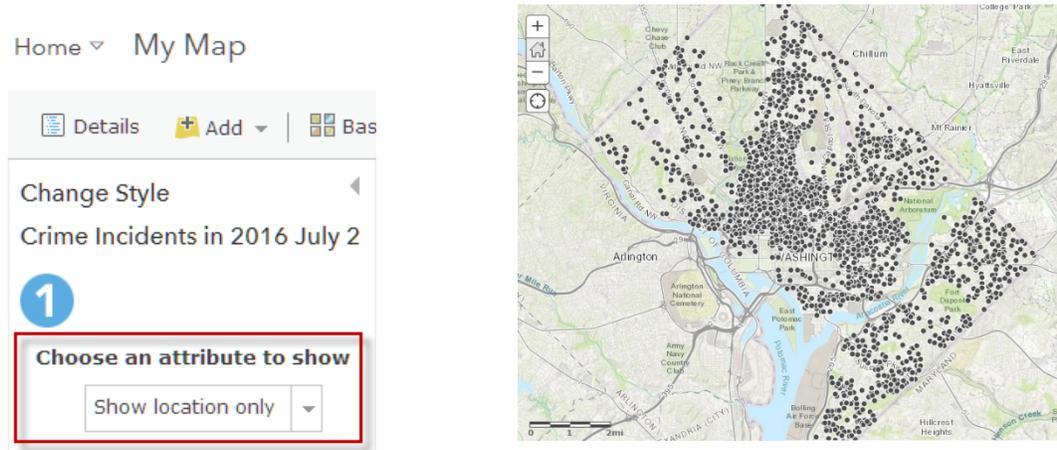
13. DONE.

4. Open the attribute table and examine the Attributes

1. Click Open Table under Crime Incidents in 2016 July.
2. Click Change style and change color to red.

3. Examine the table of attributes.
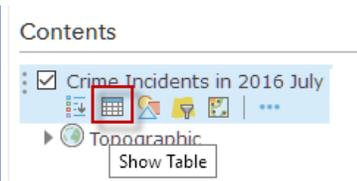
X	Y	CCN	REPORT_DAT	SHIFT	METHOD	OFFENSE	BLOCK	XBLOCK	YBLOCK
-76.97958804	38.93262247	16,108,398	7/1/2016, 3:23 PM	EVENING	OTHERS	THEFT F/AUTO	3400 - 3499 BLOCK OF 18TH STREET NE	401,770	140,526
-76.97015496	38.92953059	16,173,968	10/13/2016, 9:01 AM	DAY	OTHERS	THEFT/OTHER	3100 - 3199 BLOCK OF 26TH STREET NE	402,588	140,183
-76.94175668	38.87807317	16,107,983	7/1/2016, 2:16 AM	MIDNIGHT	OTHERS	BURGLARY	4200 - 4299 BLOCK OF HILDRETH STREET	405,054	134,472

Q1 How many total crimes are there?
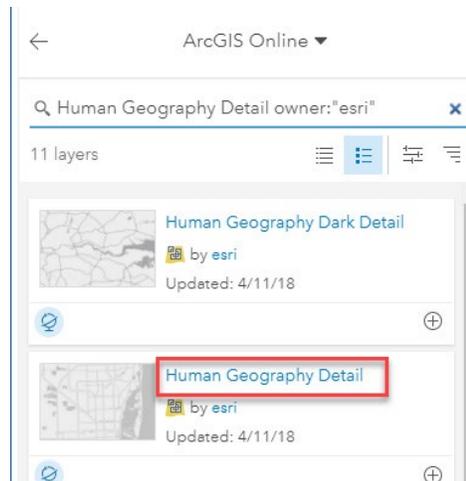
Q2 How many wards?

4. Close the table by clicking X in the right corner.

5. Another Basemap

1. On the top menu bar select Add>>Search for Layers.
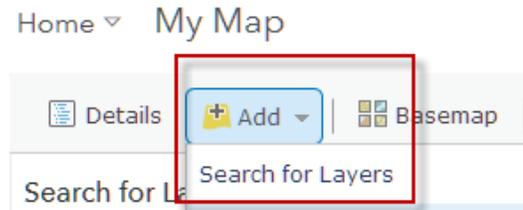
2. Search for: Find **Human Geography Detail** in ArcGIS Online.
3. Add **Human Geography Detail**.

The Human Geography Detail map provides a monochromatic style with a detailed reference layer including administrative boundaries, roads, and highways.

4. Click Use as Basemap.
5. Click back arrow to go to the Contents Pane.

6. Set Human Geography Detail as Reference Layer. The reference layer is not only a visual layer; you can click on a feature in the reference layer and view data associated with that layer.
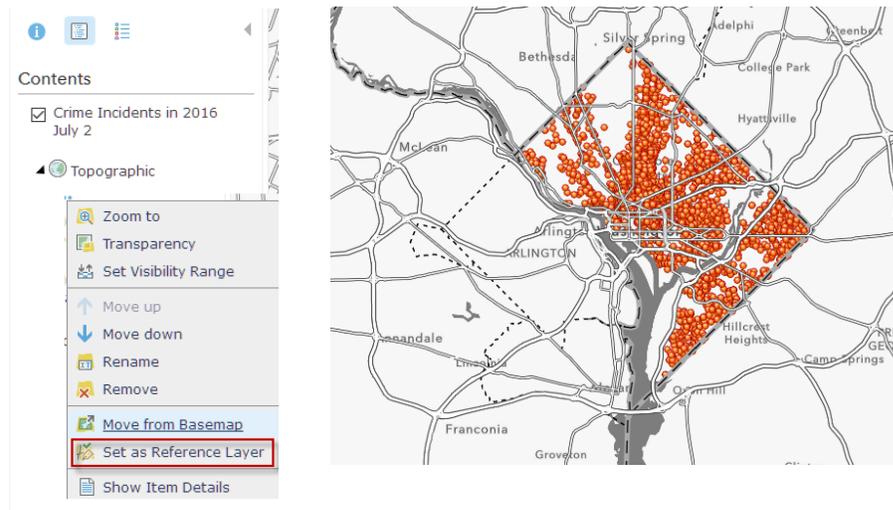
6. Produce a multiscale heat map of total crime in 2016 July

1. Click the Change Style icon under Crime incidents in 2016 July.
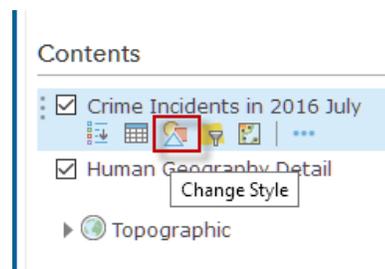
2. Select Heat Map.
3. DONE.

Q3 Write a description of where the crime is concentrated.

Q4 Does the heat map change as you zoom in and out.

Q5 Why is a heat map effective to display this crime data?

7. Produce multiscale maps of auto theft and burglary

For this section of the exercise you first want to isolate auto theft, which is represented in the attribute table as THEFT F/AUTO. After analyzing the auto theft map you will then isolate burglaries.

1. Click Filter under the Crime Incidents in 2016 July.
2. Create the following expression: OFFENSE is THEFT F/AUTO.

Filter: Crime_Incidents_in_2016_July

3. Create APPLY FILTER to select only the Auto Thefts.
4. Open the table.

Q6 How many crime incidents are theft auto?

5. Select the Change Style Icon.
6. Select Heat Map.
7. DONE.

This gives a very different visualization of the data.

Q7 Where would you direct your personnel to crack down on auto theft?

8. Repeat steps 3-7 for Burglary. (Remove old expressions first.)

Q8 How many crime incidents are burglary?

Q9 Where would you direct your personnel to crack down on burglary?

8. Produce maps for ward 8 of auto theft and burglary

In this section of the exercise you are going to concentrate your police effort in ward 8. This requires a double filter.

1. Filter for ward 8.
2. Add an expression.
3. Filter for THEFT/AUTO. (Don't forget to remove previous filter.)

4. Click Change Style.
5. Select Heat Map.

Q10 How many auto thefts are there in ward 8?

Q11 Where is the auto theft most concentrated in ward 8?

6. Repeat steps 1-5 for burglary.

Q12 How many burglaries are there in ward 8?

Q13 Where are burglaries most concentrated in ward 8?

In this exercise you have analyzed crime data using heat maps. You have examined both total crime and specific offenses as well as crime within a specified ward

Educational levels in the USA: a closer look

Educational achievement varies throughout the US. The US Department of Agriculture's Economic Research Service Division has compiled data for 2011–2015 (a five-year average) of educational achievement at the county level. The data used by the USDA was obtained from the US Census Bureau's American Community Survey (ACS). The data is shown by normalized values (a percentage of county population). The data is comprehensive and is divided into numerous categories. For this exercise academic achievement is divided into the following categories:

- No high school diploma
- High school diploma
- Bachelor's degree

The National Education Association is interested in patterns and trends of academic achievement in the US. The association has asked for maps that illustrate academic achievement at a county level.

Build skills in these areas
➢ Using filters
➢ Mapping by quantities
➢ Mapping multiple fields
➢ Using predominance maps
➢ Describing trends and patterns

What you need
➢ Account required
➢ Estimated time: 30 minutes – 1 hr

1. Open and save an academic achievement county map

1. Open United States Educational Achievement.
2. Sign into your ArcGIS organization account.
3. Click Save As on the top ribbon.
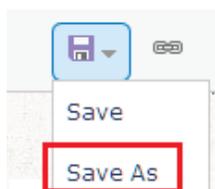
4. Save your map with the following information:
   a. Title: United States Educational Achievement_Your_Initials
   b. Tags: Remove IGARC2_educational and insert individualized tags
   c. Summary: United States Educational Achievement

Save Map

Title:	United States Educational Achievement_Your Initials
Tags:	IGARC2_ed_your initials
Summary:	United Stated Educational Achievement
Save in folder:	

SAVE MAP   CANCEL

2. Represent data by quantities

1. Switch to Content.
2. Uncheck USA States.
3. Open the attribute table by clicking the Show Table icon beneath **USA counties ed 2011 2015**.

   Notice the three fields that show academic achievement. These are the fields that need to be mapped.

4. Click the Change Style icon under the **USA counties ed 2011 2015** layer.
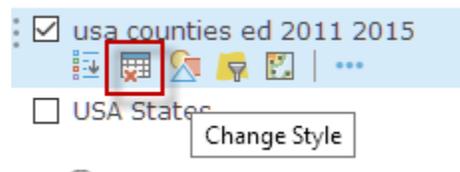
5. Choose an attribute to show select % No Educational Degree.
6. Select Counts and Amounts (Color): SELECT.
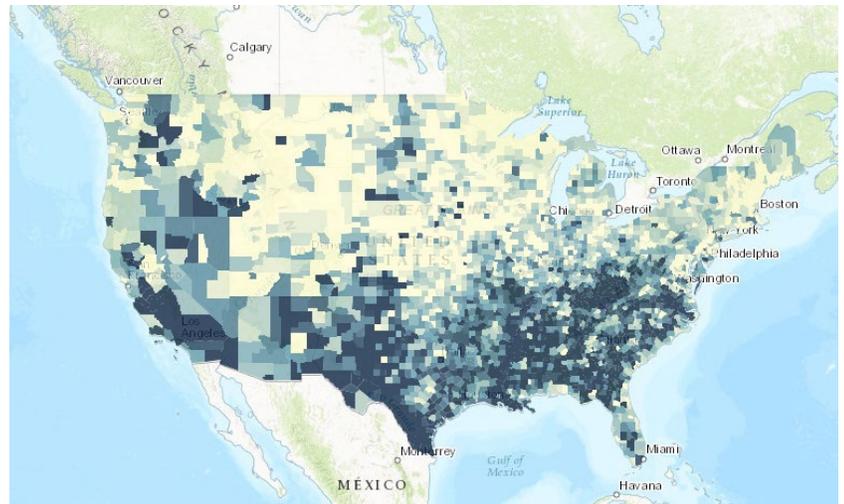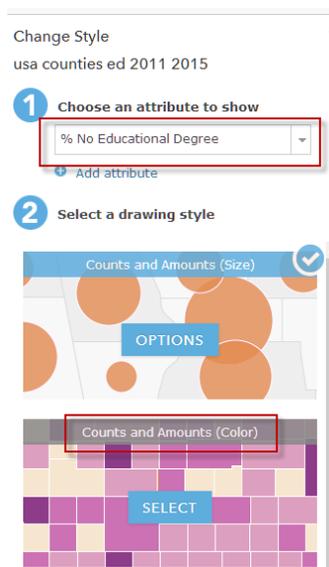
7. DONE.

   To perform analysis of the data, you need to show the state boundaries.

8. Turn off **USA counties ed 2011 2015**.
9. Turn on **USA States**.
10. Click the Change Style icon under **USA States**.
11. Click OPTIONS.
12. Symbols.
13. Change the Fill to No Color.
14. Change the outline to red with a pt 2.
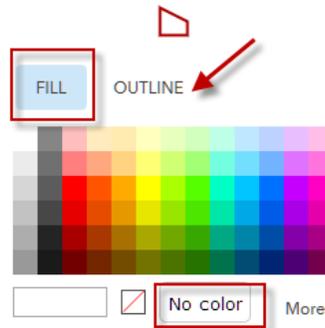
15. OK and OK again.
16. DONE.

Q1. What states have the highest percentages of students with no degree?

Q2 Do you see any regional trends?

Q3 What is represented along the Mississippi River from Minnesota to Mississippi?

Q4 Explain the spatial distribution in Texas.

17. Repeat steps 4, 5, and 6, changing the attribute to % College Degree.

Q5 What is the spatial distribution of counties with the highest percentage of college degrees of lowest?

Q6 Do you see any regional trends?

3. Filter the data

It would be interesting to know which counties are in the top 10 of both percentage with a degree and percentage with a college degree. You can find this out by filtering.

1. Open the Show Table.
2. With the table open click the field % College Degree and choose Sort Descending.

usa counties ed 2011 2015 (Features: 3142, Selected: 0)					
	STATE_NAME	CNTY_FIPS	% No Educational Degree	% High School Degree	% College Degree
irch	Virginia	610	2	7	Sort Ascending
	Virginia	013	6	8	Sort Descending
los	New Mexico	028	3	10	Σ Statistics

You see that the highest percent of the population with a college degree is in Falls Church, VA. You will now select all the counties that have above 50 % with a college degree.

3. Choose Filter under the **USA counties ed 2011 2015 layer**.
4. Write the expression: % College Degree is greater than 50.

Filter: usa_counties_ed_2011_2015

Create

+ Add another expression   ☐ Add a set

Display features in the layer that match the following expression

% College Degree ▼ greater than ▼ 50 ▼
○ Value ○ Field ◉ Unique
☐ Ask for values ▼

APPLY FILTER   APPLY FILTER AND ZOOM TO   CLOSE

5. APPLY FILTER

5

Q7 What states have more than two counties with above 50 percent college degrees? Hint: you might want to show the table.

6. Click Filter.
7. REMOVE FILTER.
8. Click Filter.
9. Write the expression: % No Educational Degree is greater than 20
10. APPLY FILTER.
11. Consider changing the basemap to Light or Dark Gray Canvas to better see the filtered counties.
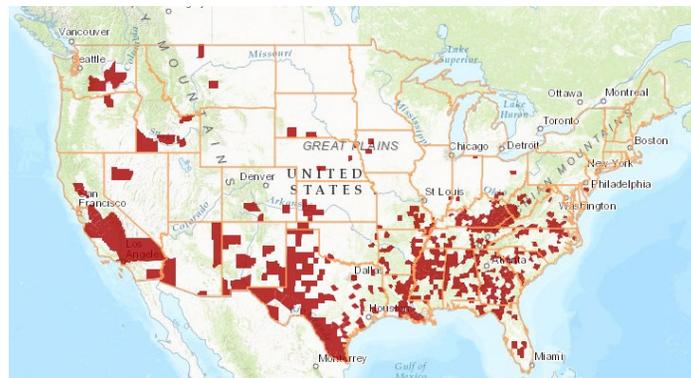

Q8 What states have the greatest number of counties with 20 percent with no degrees?
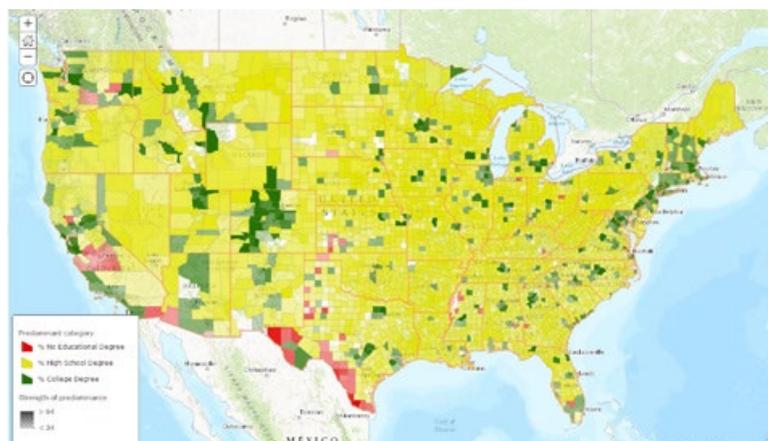
Q9 Is there a regional trend?

4. Create a predominance map of academic achievement in predominant category

A predominant category map allows you to map multiple related attributes to compare and show which attribute is predominant—that is, has the highest value—and the degree of its predominance compared with the other attributes in the layer. In this example, you would map % no degree, % high school degree, and % college degree. Each attribute is drawn with a different color, and transparency shows the relative strength of the attribute.

1. Remove the previous filter.
2. Click the Change Style Icon under **USA counties ed 2011 2015**.
3. For Choose an attribute to show, choose % No Educational Degree.
4. Click Add attribute.
5. Choose % High School Degree.
6. Click Add attribute.
7. Choose % College Degree.
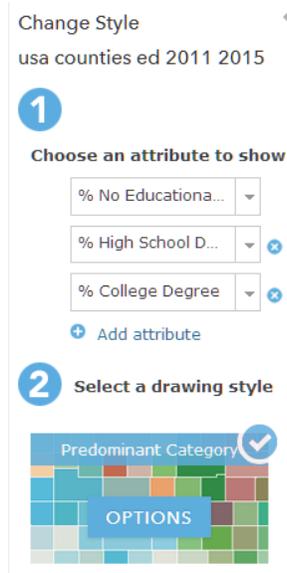
8. Click Predominant Category>>OPTIONS.
9. Click the square by % No Education Degree.
10. Select Fill>>Red.
11. OK.
12 Repeat for % High School Degree and choose Yellow.
13. Repeat for % College Degree and choose Green.
14. To set Transparency click Set from Predominant Percentage.
15. OK and OK.

5. Create a predominance map of academic achievement in predominant category and size

A predominant category and size map not only allow you to map multiple attributes with color and transparency, it also adds the third element of size, with size representing the sum of the attributes for each feature.

1. Before clicking DONE, select Predominant Category & Size>>SELECT.
2. OPTIONS.
3. Click Predominant Category>>OPTIONS>
4. Manually change the color to same as above in predominant category.
5. Click Transparency>>Set from Predominant Percentage.
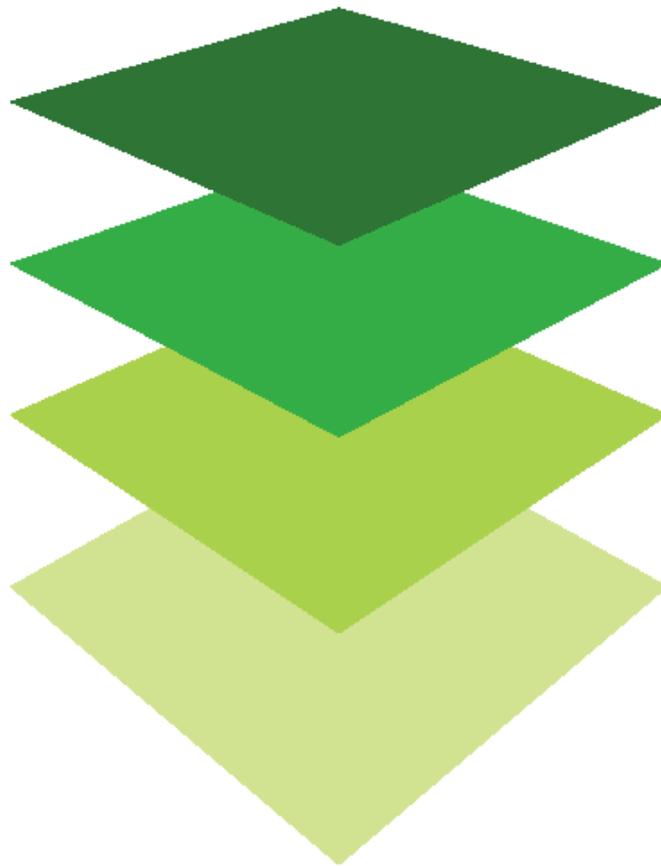6. OK and OK.
7. DONE.
8. SAVE.

   This type of mapping is good for looking at individual counties.

9. Zoom to your county.
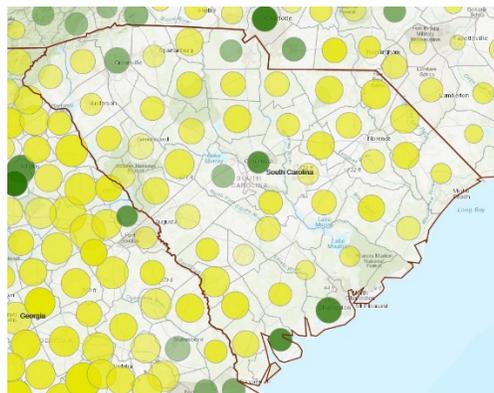
Q10 Describe the spatial distribution of academic achievement within your state.

In this lesson, you have displayed academic achievement data by counties using predominant category and predominant category and size styling.

Tell Your Story Using a Map
Inform, engage, and inspire people
with story maps

Esri launched story maps in 2012. Since that time, a "virtual explosion" of story maps has occurred. Online GIS has progressed from being a pioneering tool for online spatial visualization and analysis to a ground-breaking tool for *sharing* maps, data, and the *results* of spatial analysis online. Story maps have described places, revealed change over time, broken news, and recounted history. They have affected change, influenced opinion, created awareness, and sounded the alarm about impending threats. Story maps represent nothing short of a communication revolution with their ability to combine the spatial visualization of maps with text, photographs, audio, and video data. They use the tools and analysis capability of GIS but don't require the user to be skilled or knowledgeable in those areas.

This chapter will provide practice in the creation of several types of story maps through four scenario-based lessons. Each includes step-by-step instruction for creating one or more story maps while simultaneously building and reinforcing fundamental ArcGIS Online skills. The chapter also includes questions that support reading comprehension, reflection, and discussion of the chapter 3 narrative in *The ArcGIS Book.*

Introductory activities

Videos

In 2010 a devastating earthquake nearly leveled Haiti's capital city of Port-au-Prince. Ushahidi stepped into the information void by using crowdsourced information to create a near real-time map of the city. The other video identifies six important map powers: to engage, to reveal, to protect, to educate, to transform, to inspire. Watch the video several times, pausing it as necessary, to look at the range of data displayed on individual maps.

Ushahidi Haiti

The Power of Maps

The Power of Maps

Activity

The power of story maps

Story maps reflect the same powers identified in the *Power of Maps* video. Go to the Story Maps Gallery

Find a story map that, to you, reflects each of these powers.

Power	Story Map
to engage	
to reveal	
to protect	
to educate	
to transform	
to inspire	

The ArcGIS Book, chapter 3
Questions for reading comprehension, reflection, and discussion

Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

Story maps: The fusion of maps and stories come to life

List components that can be incorporated into a story map.

Story maps "use the tools of GIS, and often present the results of spatial analysis, but don't require their users to have any special knowledge or skills in GIS." Identify two maps from the Story Maps Gallery that illustrate this idea.

Maps tell stories. What kinds of stories can you tell?

This section identifies eight kinds of stories that might be told with a story map. List and describe two more possibilities for this format.

Thought leader: Allen Carroll: Why maps are so interesting

Maps organize information spatially. What does this mean?

What kind of story do you want to tell?

Based on your own interests and knowledge, briefly describe two or more "stories" you'd like to tell with a story map.

QuickStart: Things to consider when creating a story map

Planning is very important when creating a story map. Pick one of the stories you just indicated you would like to tell with a story map and develop a plan for creating it by briefly writing the answers to the following questions:

> What is your purpose and goal in telling the story and who is your audience?
> Go to the Story Maps Gallery and identify two or more story maps whose subject matter is similar to the story you'd like to tell.
> Browse story map templates on the Story Maps Apps and identify the one that seems best for your story map project.

Learn ArcGIS: Guided lessons based on real-world problems

Tell the Story of Irish
Public History

Gain historical insight by
mapping fatalities from
Ireland's 1916 Easter
Rising.

Tell the Story of Irish Public History
Adding layers from CSV files.
Creating a web app.
Creating a story map.
Drawing conclusions from maps and data.

Creating a basic story map

Dr. John Snow is regarded as one of the founding fathers of modern epidemiology. During a major cholera epidemic in 1854 London, he collected and mapped data on the locations (street addresses) where cholera deaths occurred. His process was laborious and slow, but ultimately very informative. His painstaking and detailed analysis led to the identification of the epidemic's source—a contaminated public water source. Today, John Snow's data has been geocoded, making it accessible in a GIS. In this lesson, you will create a heat map showing the locations that experienced the highest number of cholera deaths in the epidemic. You will share this heat map as a basic story map. [Note: You can watch a short overview of John Snow's work in Episode 4 of The Geospatial Revolution.]

As part of a pre-med curriculum, you are taking a course in the history of epidemiology. Your first assignment is to prepare a presentation about Dr. John Snow's investigation of cholera during an 1854 outbreak in London. Luckily for you, John Snow's 19th century data has been georeferenced and can be explored in a GIS. You have decided to include a web map in your presentation that reflects Dr. Snow's conclusion that contaminated public water pumps were responsible for the outbreak.

Build skills in these areas

➢ Opening a map
➢ Changing the style of point data to create a Heat Map
➢ Creating a basic story map
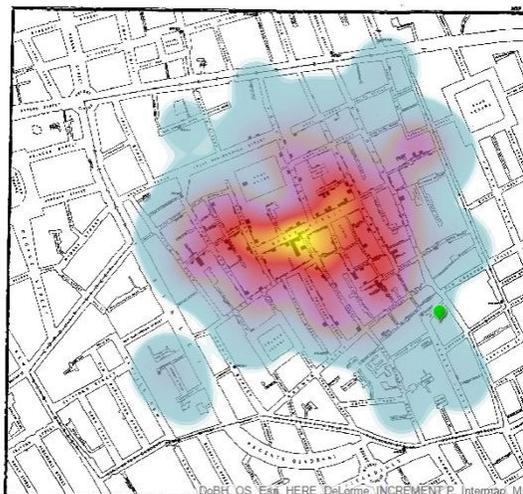
1. Open the map

1. Sign into your ArcGIS organizational account.
2. Open Disease Investigations: Cholera.
3. Use Save As to save the map to the Content section of your organizational account. Replace the word Copy with your initials in the map title (e.g., Disease Investigations: Cholera_LM). It's good practice to save again each time you modify the map
4. Click the Contents tab to see the map's layers. Turn on John Snow's 1854 map of cholera cases (Snow Map). Zoom in until you can see the little hash marks at points along the streets. These marks indicate the number of cholera cases at an address. As you can see, some addresses had only one or two cases, but many addresses had more.
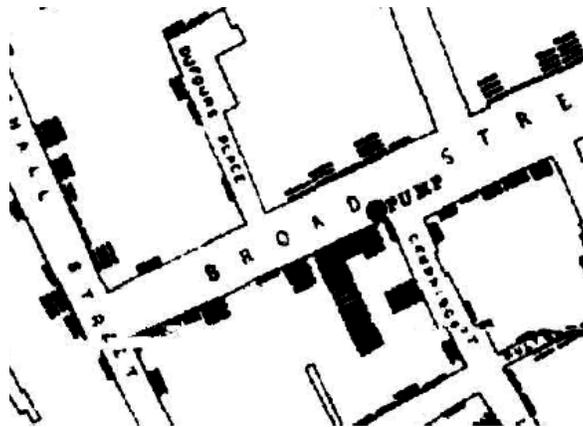
5. Use the Soho bookmark (click Bookmarks, then select Soho).
6. Now turn on Cholera cases by address. These are the same addresses Snow mapped, but they have been geocoded to be accessible in a GIS. Each red dot is an address and has data associated with it called attributes. One of the attributes for this point layer is num_cases. This is the number of cholera cases that Snow recorded at this address with his hand-drawn hash marks.
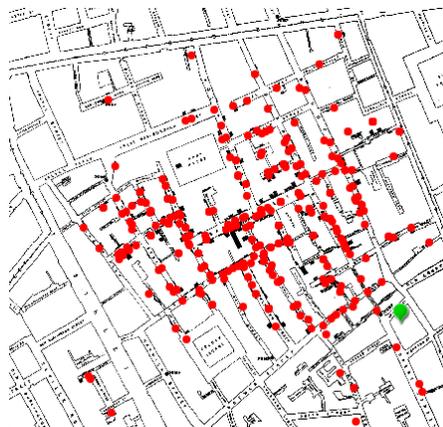
7. Create on any red dot to see its attributes in a pop-up window. The pop-up provides the address and the number of cases at that address.

2. Create a heat map

Snow collected data and recorded it on his map so he could determine where the greatest number of cholera cases and deaths occurred. This was a laborious process for Snow, but GIS provides tools that help us answer this question quickly. Geocoding the addresses and cholera data opens the door to many analysis processes in GIS. We'll employ only one of these analysis processes today. We'll analyze the location of cholera cases by creating a heat map. Heat maps use point layer data to calculate and display relative density. The colors are most intense where the most points are concentrated together. Here, we don't want to locate where the greatest number of dots is but rather the greatest number of cases.

1. Turn on Public water pumps.
2. Hover your cursor over the name of the layer, Cholera cases by address. When you do this, you will see a series of icons appear beneath the layer name. If you hover over an icon, you will see what it does. Click the Change Style icon.

Contents

☑ Soho

☑ Cholera cases by address

☐ Public water pumps

▶ ☑ JohnSnow's 1854 map of cholera cases

◉ Topographic
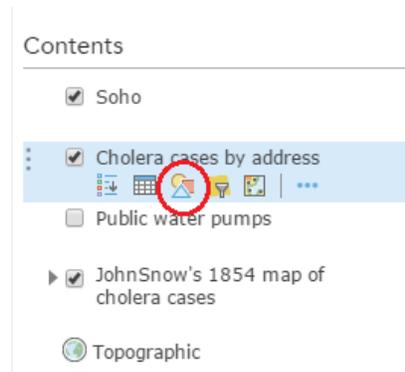
3. Now you will change the map style to a heat map. Under Choose an attribute to show select Num_Cases. In other words, we are telling the program that we want to create a map that focuses on the number of cases at any location.

1

Choose an attribute to show
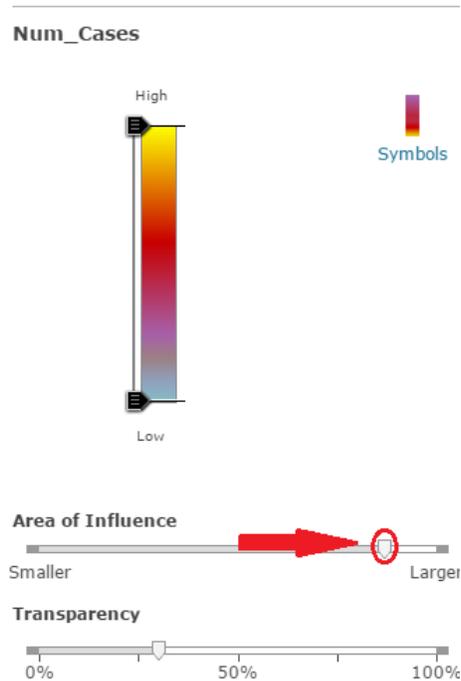
Num_Cases ▼

Show location only

Address

Num_Cases

3
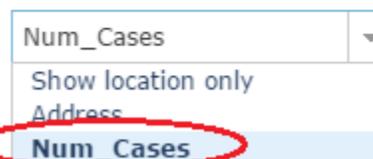
4. Under Select a drawing style, select Heat Map, then Options.
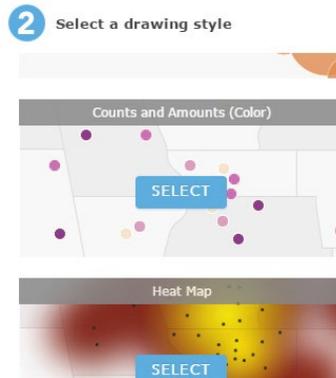
5. Move the Area of Influence slider slightly to the right to enlarge the area of highest density on the map.

6. Click OK, then Done. Your map now looks like this. The yellow area indicates the part of Soho where the greatest number of cholera deaths occurred. As you move through orange, red, and purple to blue areas, the density of cholera cases drops off.
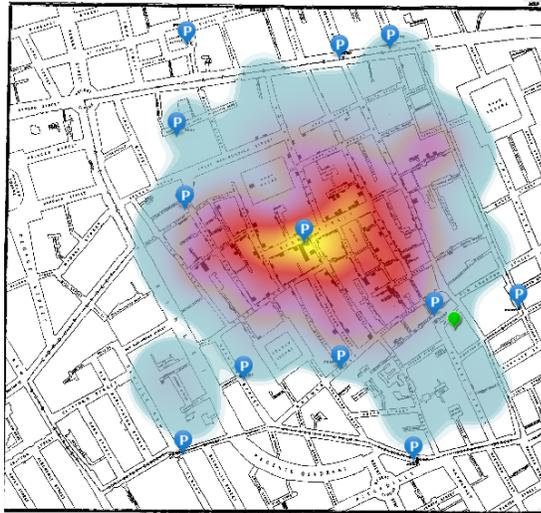
7. Click on the pump symbol in the center of the yellow area to learn its name. This is the famous Broad Street pump. Snow's painstaking analysis of the same data led him to the conclusion that the Broad Street pump was the source of the Soho epidemic. When the pump handle was removed, preventing people from using it, the epidemic came to an end. Through spatial analysis, many lives were saved, and cholera was confirmed as a water-borne disease.

8. Before you create your story map, make the following adjustment to your map. Click the dots below John Snow's 1854 map of cholera cases and select Hide in Legend. This will simplify the legend in the story map you are about to create.
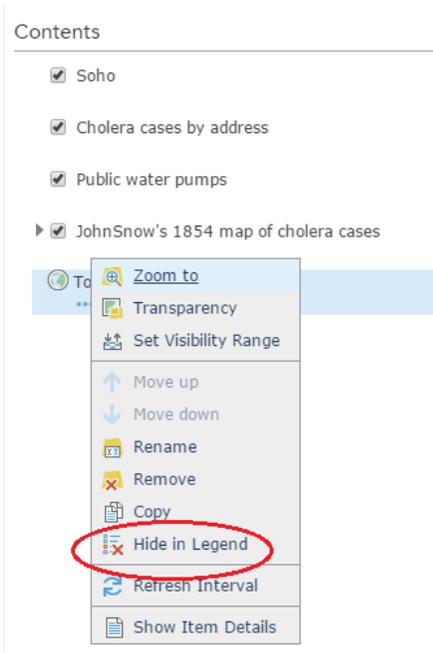
9. Save the map.

3. Create a basic story map

1. To create a story map, click Share (above the map) then click Create a Web App under Embed this map.

2. Click Build a Story Map.
3. Select Story Map Basic, then Create App.
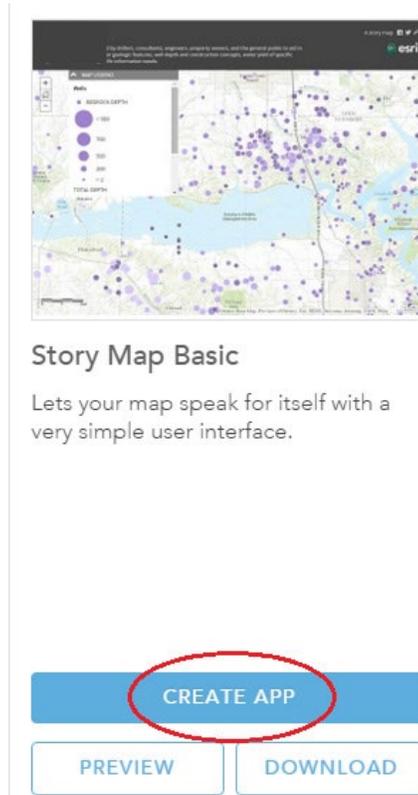
4. In the web app dialog box, fill in the following information for your map.
   a. Title: London Cholera Epidemic 1854, (your initial)
   b. Summary: Heat map of Cholera cases in the Soho District of London
          1854.
5. Click Done.
6. You now see a configurable version of your new story map. Under
   Settings, type in the title you just used when creating the story map.
   Title: **London Cholera Epidemic 1954**
7. As you can see, you can change the subtitle (it defaults to the map
   summary), create links from the headers, set the color theme, and
   choose whether to include a legend or a search tool in your map.

8. Experiment with different settings. Click Save to see what your map will look like. You can continue to make changes to the Settings. Click save to see the result of each set of changes. When you are satisfied with your story map click Done.
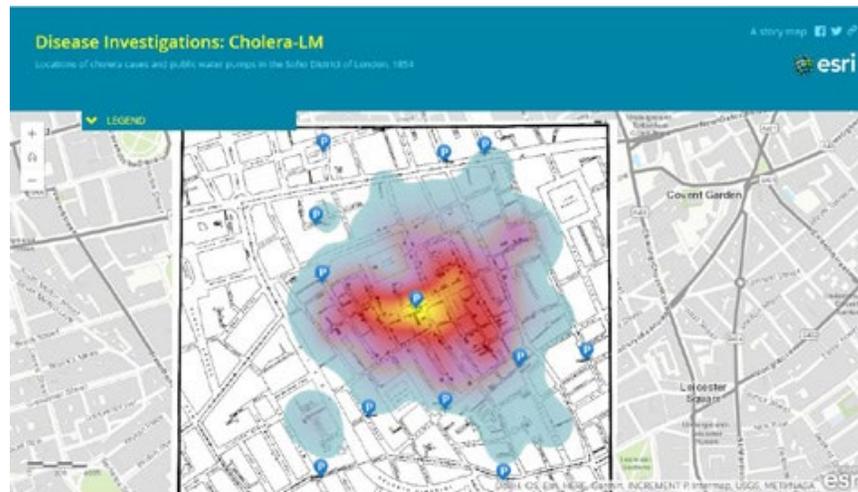
Congratulations! You have created a basic web map of the 1854 John Snow cholera investigation using the Story Map Basic template.

Creating a swipe story map

In the effort to answer questions and solve real-world problems, it is frequently necessary to explore the relationship between different variables. For example, to answer a question about whether there is a relationship between diabetes and obesity, the investigator needs to compare the rates of these two conditions. Spatial data—data tied to a specific location—is essential in this. Mapping rates of diabetes and obesity reveals patterns of distribution that suggest a definite connection between the two. Beyond visual observations of patterns, exploring this data in a GIS means it is also possible to query the data and employ a range of analysis tools to further explore the relationship.

Story maps provide different ways to compare maps and data. The Story Map Swipe and Spyglass apps enable users to interact with two web maps or layers simultaneously in a single scalable view. In this lesson you will create a Story Map Swipe map to compare high school graduation rates with unemployment rates.

How important is it for future members of the workforce to complete high school? What is the relationship between graduation rates and unemployment? A national education advocacy group focused on reducing high school drop-out rates has hired your data visualization company to produce a web map that compares high school graduation rates with unemployment rates.

Build skills in these areas

➢ Opening a map
➢ Creating bookmarks
➢ Creating a Swipe Story Map

What you need
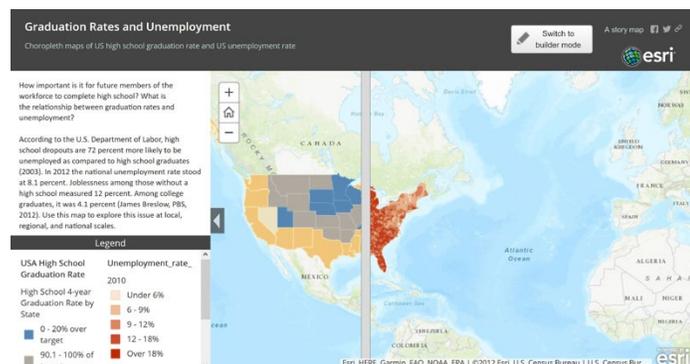
➢ Account required
➢ Estimated time: 30 minutes – 1 hour

1. Open the map

1. Sign into your ArcGIS organizational account.
2. Open Graduation Rates and Unemployment.
3. **Use Save as to save it to your own account as Graduation Rate and Unemployment_yourinitials.**
4. The two layers in this map are the ones you will use in your Swipe Story Map. Be sure both are turned on.

2. Create a Swipe Story Map

1. To create a story map, click Share (above the map), then click Create a Web App under Embed this map.

Share

Choose who can view this map.
Your map is currently shared with these people.

☑ Everyone (public)
☑ Learn ArcGIS

Link to this map
http://arcg.is/1PFy7rN   f Facebook   🐦 Twitter
☑ Share current map extent

Embed this map

EMBED IN WEBSITE   CREATE A WEB APP

2. Under Build a Story Map select Story Map Swipe and Spyglass.

Create a New Web App

What do you want to do?

Select a configurable app.

All
Build a Story Map
Collect/Edit Data
Compare Maps/Layers
Explore/Summarize Data
Map Social Media
Provide Local Information
Route/Get Directions
Showcase a Map

Combine maps with narrat story

Story Map Basic

Story Map Swipe and Spyglass

3. Click Create Web App.
4. Type the following in the summary box: Choropleth maps of US high school graduation rate, 2008 and US unemployment rate, 2010.
5. Click Done.
6. In the Swipe/Spyglass Builder, notice that the Vertical bar is the default selected layout. This is the one you want. Click Next.
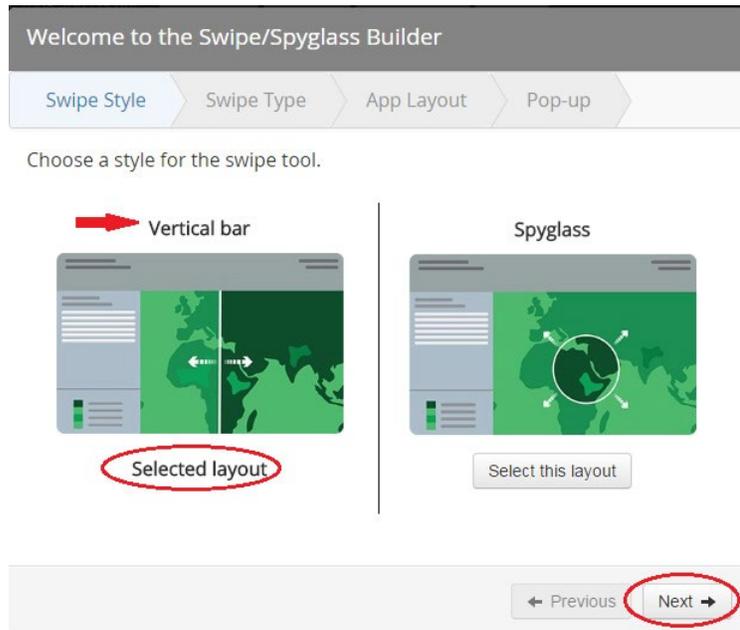
7. In the next window, notice that A layer in a web map is the default selected layout. Again, this is the one you want. Click Next. Note: The Builder has identified Unemployment rate 2010 as the layer to be swiped. This just determines which of the two layers will be on the bottom and which on the top.

3
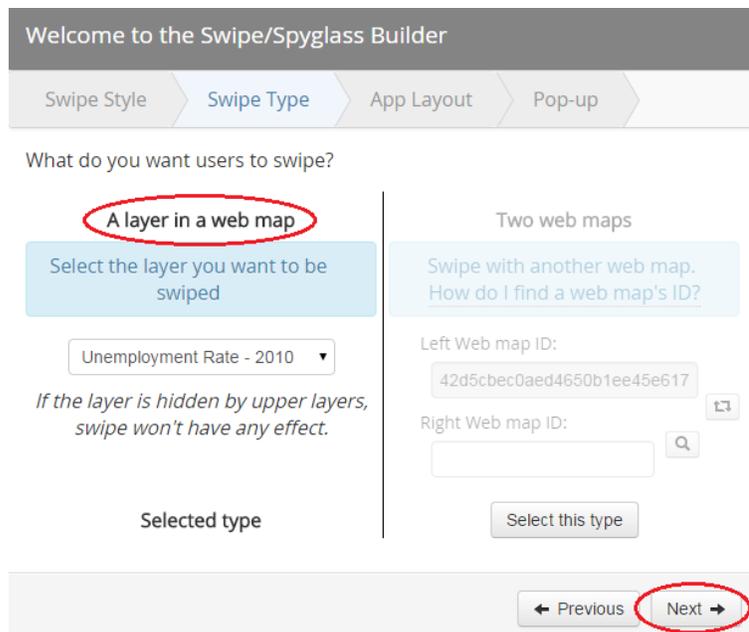
8. Accept the default layout settings and click Next.
9. Select colors for your map headers and give each header a title. Note: The Right Map will be the same as the one Builder identified as the map to be swiped.

10. Click Open the app.
11. Add a description of the swipe map in the box that says Edit me. Here is some example text:
   "According to the US Department of Labor, high school dropouts are 72 percent more likely to be unemployed as compared to high school graduates (2003)."
12. If you wish to modify the title or the subtitle (this is the map summary) you may do so.

13. When you have finished click Save.

Your completed swipe map opens like this:
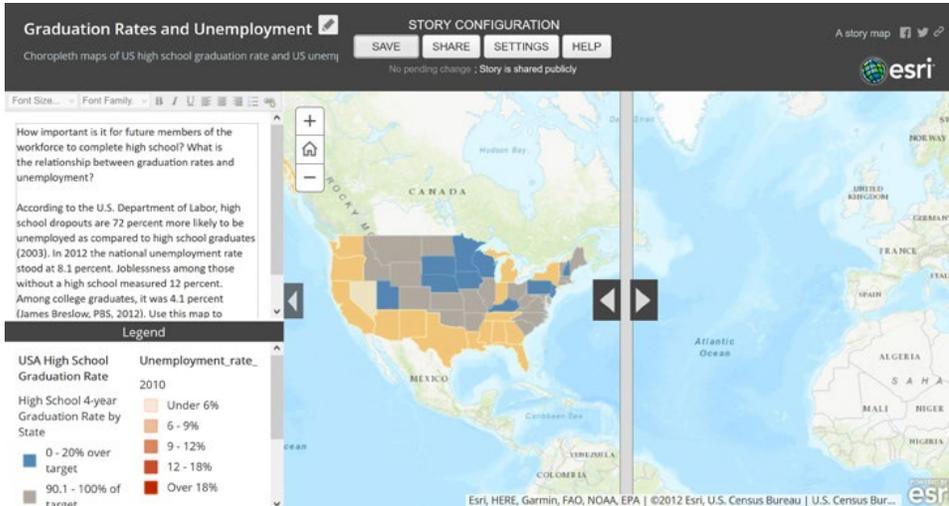
If you zoom in and move the swipe bar you can observe relationships at both the regional and local scales.
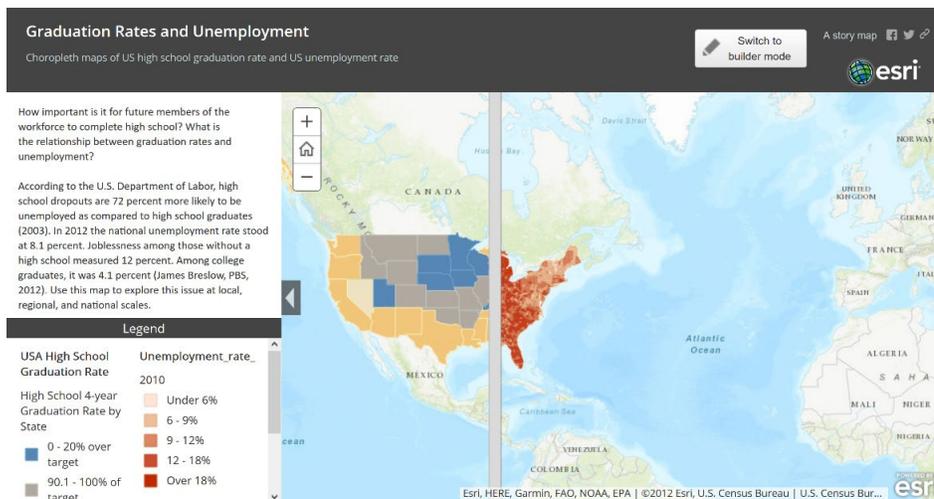
In this lesson, you created a Swipe Story Map using the Swipe and Spyglass template.

Extended Activity

Create another Swipe Map using census and/or health data to explore possible relationships among variables, e.g., race and income, infant mortality rate and poverty.

Creating a map series web app

ArcGIS Online story maps provide an excellent vehicle for portraying events over a span of time. Changes in land use, the spread of disease, the growth of US railroads, and urban sprawl are but a few topics that lend themselves to such story map presentations. The Story Map Series telling a story that evolves over time. In this lesson, you will create a tabbed Story Map Series to show the 10 largest world cities in different periods of time.
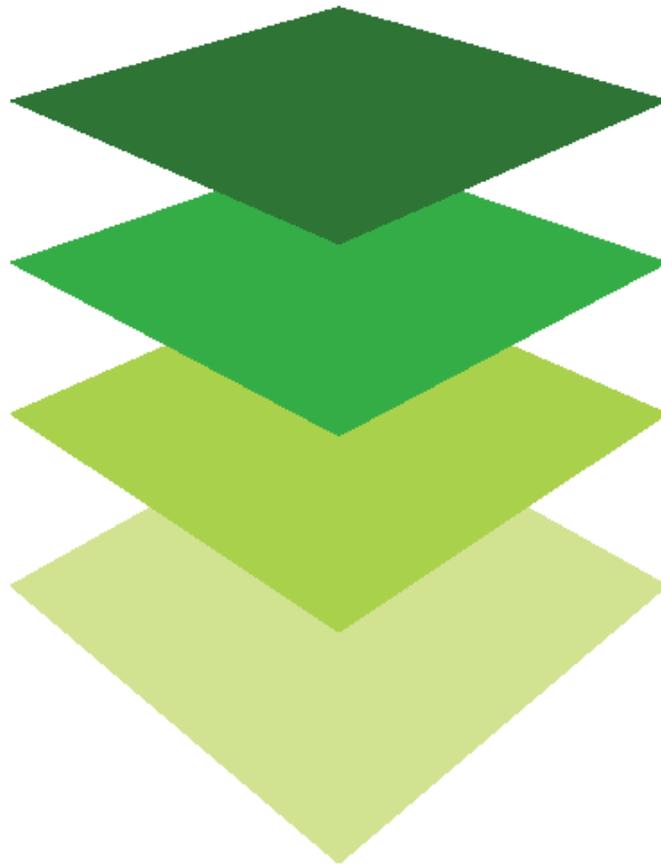
You have been hired to teach Urban Studies at your university. You plan to begin your course with a broad overview of the growth of cities through time. You have already created a series of web maps and data showing the top 10 cities (in population) in 100, 1000, 1500, 1800, 1900, 1950, and 2000. Now you need to convert those maps into a Map Series Story Map that tells the story of urban growth and distribution over this span of centuries.

Build skills in these areas

➢ Using the online library of Builder templates to select a template for your story map
➢ Searching ArcGIS Online for maps
➢ Creating a map series web app using the Map Series Builder

What you need

➢ Account required
➢ Estimated time: 1 hour

Create a map series web app from within the app template

1. Go to Story Maps Apps page and select Story Map Series- Tabbed Layout, then click Build.

2. Sign into your ArcGIS Online organizational account.
3. Name your tabbed series map now.
4. Give your Tabbed Map series a title: World's Largest Cities 100 – 2000 CE (put your initials at the end of the title) and click the arrow.
5. This is where you will create your first tab. Title it 100 CE, and in the Map drop-down list choose Select a map.
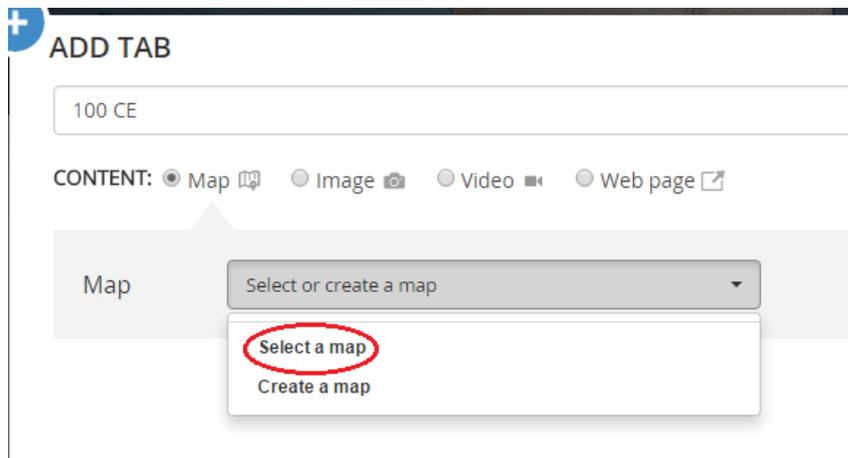
6. In the Select a Map box Search in ArcGIS Online for a map titled city pop 100. Select the map by that name.

7. Check Legend next to Extras.

8. Enter the following in the empty text box:

Click a city icon to learn its modern name, ancient name (if different), population, and its rank amount the top 10 cities at that time.

9. Zoom to an extent that includes the Western and Eastern Hemispheres.
10. Click Save in the upper right corner.
11. Click Add to add another tab.
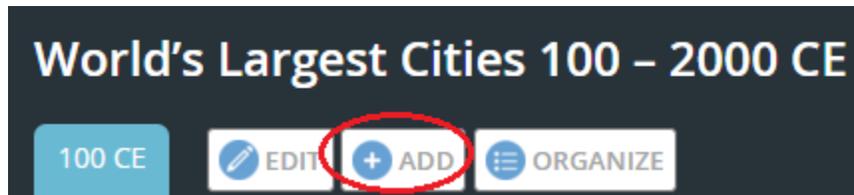
12. Name the tab 1000 CE.
13. Once again choose to select a map and this time in ArcGIS Online for a map titled citypop 1000.
14. Add the same text to the empty text box that you added in step 8.
15. Click a city icon to learn its modern name, ancient name (if different), population, and its rank among the top 10 cities at that time.
16. Click Save and then Add to Add your third tab. This one will be titled 1500 CE. The map you should search for is citypop 1500.
17. Continue in the same manner to create the remaining tabs: 1800 CE, 1900 CE, 1950 CE, and 2000 CE.
18. The maps you will search for are citypop 1800, citypop 1900, citypop 1950, and citypop 2000.

19. Add the same content to the text box each time.

You finished map looks like this:

Each tab displays the top 10 cities for a particular year.

In this lesson, you created a Tabbed Series Story Map using the online Story Map Builder.

Extended activity

Create a similar Map Series focused on US cities between 1700 and 2000.

Resources

Four Thousand Years of Urban Growth: An Historical Census (St. David's University Press, 1987), Tertius Chandler.

Creating a spyglass story map

Story maps provide several ways to compare maps from different dates. The Story Map Swipe and Spyglass apps are two of these, enabling users to interact with two web maps simultaneously in a single scalable view. In this lesson, you will create a spyglass story map to compare Washington, DC, in 1851 with imagery of the modern capital city. You will add Map Notes to the map to show the three locations for scenes in a play.

This fictitious scenario will provide you with practice creating your spyglass story map. A new play, set in 1851 Washington, DC, is scheduled to open in that city in six months. The theater owner wants to attract attention to the play and enhance theatergoers' experiences by providing a way for them to relate the city they know to the city that is the setting for the play. They have hired your data visualization company to produce a web map that facilitates easy comparison between the 1851 city and its current configuration, shows key locations in the city that are portrayed in the play's three scenes (National Hotel, Naval Observatory, US Patent Office), and enables users to search for specific addresses.

Build skills in these areas

➢ Opening a map
➢ Adding map notes to the map
➢ Creating a story map spyglass web app

What you need

➢ Account required
➢ Estimated time: 1 hour

Washington, D.C. 1851 and 2016- screenshots

This is a spyglass map which enables users to compare contemporary imagery of Washington, D.C. withwith an 1851 map of the city.

Switch to builder mode

A story map

Explore this map to compare Washington, DC in 1851 with the modern capital city. You can use the Search box to find a specific address and observe differences at that location. The location of the National Hotel, US Naval Observatory, and US Patent Office are identified by popup markers 1,2, and 3. You can click a marker to learn more about that location.

David Rumsey Historical Map Collection | USDA FSA, Microsoft | USDA FSA, Microsoft | So...

2. Open the map

1. Sign into your ArcGIS organizational Account.
2. Open Washington, D.C. 1851 and 2016
3. Use Save as to save it to your own account as Washington, D.C. 1851 and 2016 and replace the word Copy with your initials (e.g., Washington DC 1851 and 2016_yourinitials.
4. Click the Contents tab to see the map's layers, if you turn off the World Imagery layer, you will see the 1851 map beneath it.

2. Add map notes

1. Follow the steps below to create three map notes to show the locations of the National Hotel, Naval Observatory, and US Patent Office in 1851. The steps are the same for each note, but the information about each location will differ. Use the table that follows to fill in the information for each note.

   a. Enter −77.0193, 38.8931 in the search box above the map and click Enter.
   b. Choose Add Map Notes (under Add).
   c. Name the map notes National Hotel and click Create. Click on the map note in the map and choose Edit to do this.
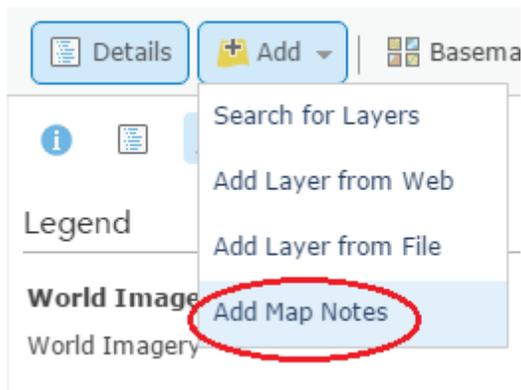
d. Click the Pushpin tool and click the map at the location identified in step a. Explore symbols and choose an appropriate one for a national landmark.
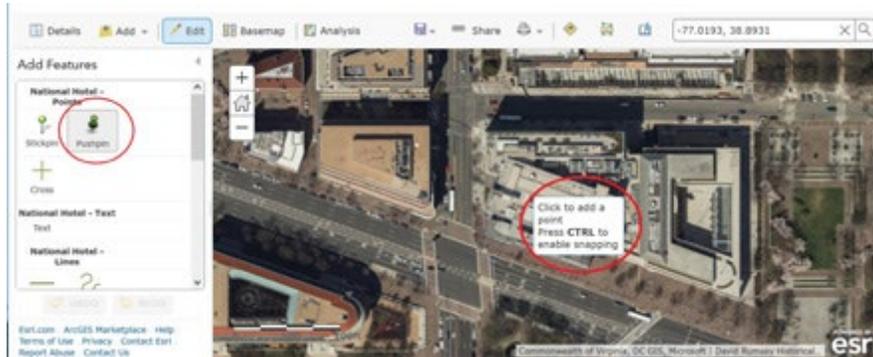
e. Use the information in the following table to fill in the map note information options:

Location	-77.0193, 38.8931
Title	National Hotel
Description	[none]
URL to an image	https://img.washingtonpost.com/wp-apps/imrs.php?src=https://img.washingtonpost.com/blogs/local/files/2014/10/Pennsylvania-Posh.jpg&w=1484
Image Link	[none]
Change symbol	Numeral 1, 📍 (accept the defaultl symbol size)

f. When you have completed filling in the information, click Close
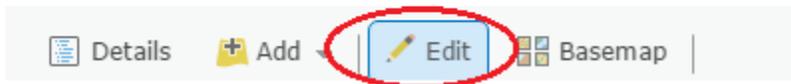
and then click Edit.

Your map should now look like the following. You can click on the map note to see a historic image of the National Hotel.
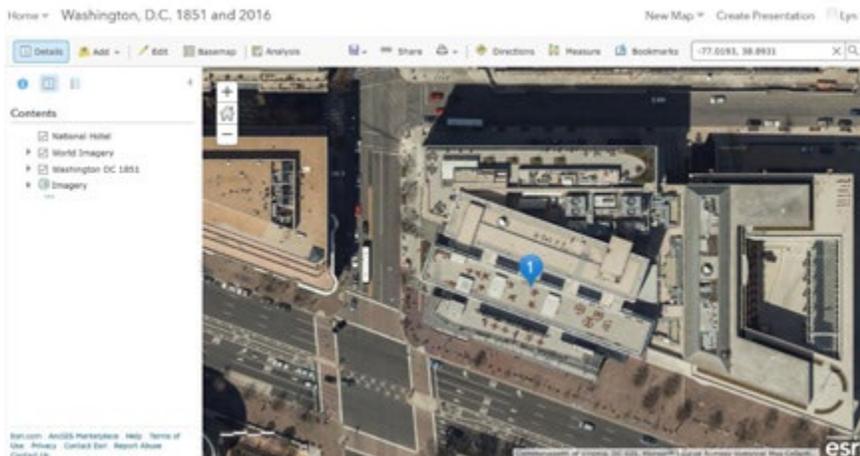
g. Create two more map notes in the same way using information in the tables below.

Note: Use the coordinates next to Location to Create each new map note.

Location	-77.05145, 38.8951
Title	US Naval Observatory
Description	[none]
URL to an image	http://earlyradiohistory.us/1905tim1.jpg
Image Link	[none]
Change symbol	Numeral 2,

Location	-77.0297, 38.8971
Title	US Patent Office
Description	[none]
URL to an image	https://www.census.gov/history/img/PatentOffice.jpg
Image Link	[none]
Change symbol	Numeral 3,

When you have finished, you will see the three map notes listed in your map Contents.

Contents

☑ US Patent Office
☑ US National Observatory
☑ National Hotel
▶ ☑ World Imagery
▶ ☑ Washington DC 1851
▶ ◯ Imagery
  •••

Zoom your map to an extent like the following (you just see the three map notes), then save the map.

3. Create a story map spyglass web app

1. To create your story map, click Share (above the map) then click Create a Web App under Embed this map.

2. Click Build a Story Map.
3. Select Story Map Swipe and Spyglass, then Create Web App.

Story Map Swipe and Spyglass

Compares layers in one web map, or
compare two different web maps,
using a vertical swipe bar or spyglass.

4. Fill in the New App information box as follows, then click Done.

5. Click Select this layout under Spyglass, then click Next.
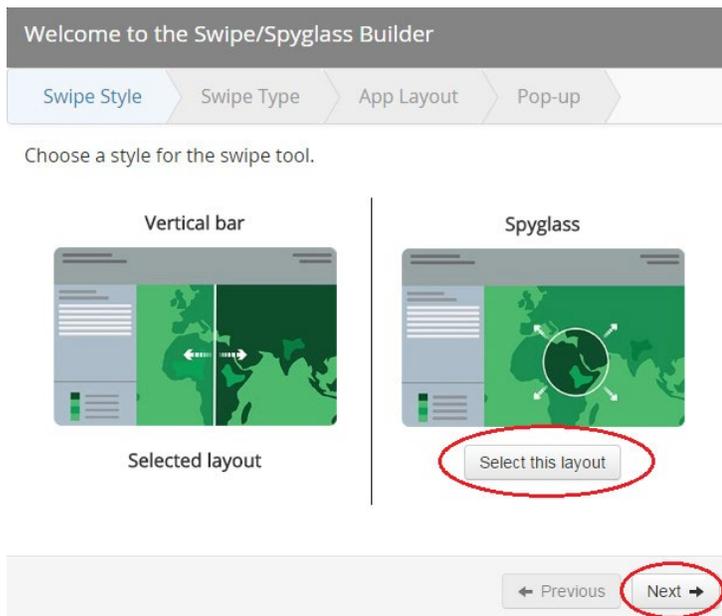
6. In the next window of the Swipe/Spyglass Builder, use the drop-down list to select World Imagery as the layer to appear within the spyglass, then click Next.
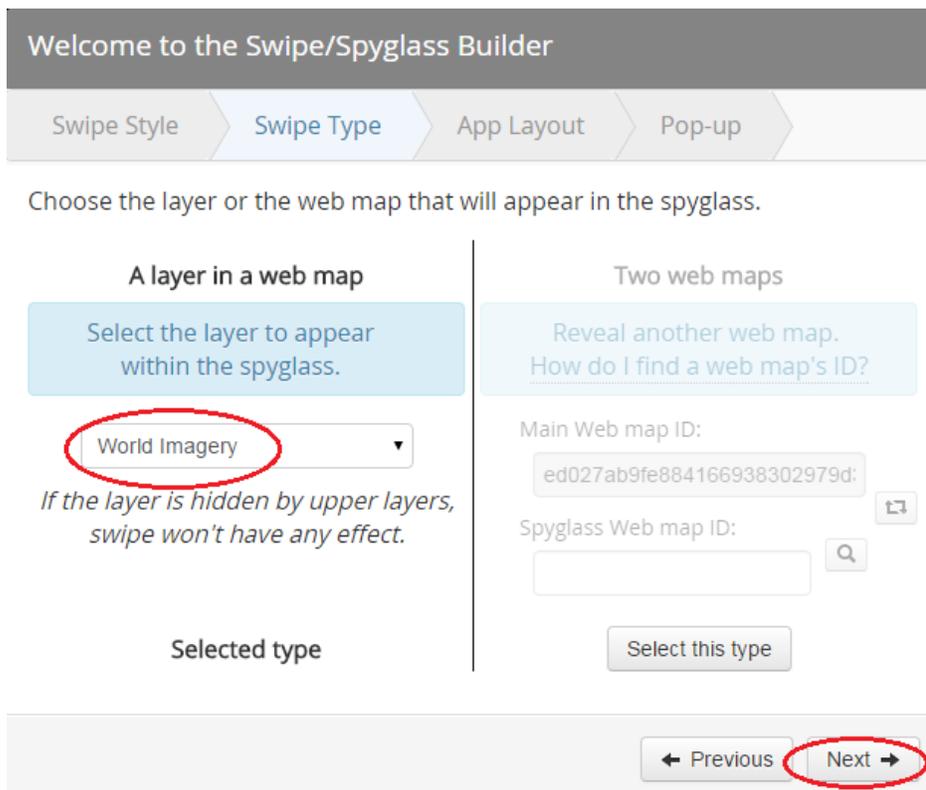
7. Select the following layout settings (enable description, pop-up, and address search tool), then click Next.
8. Uncheck enabled legend.
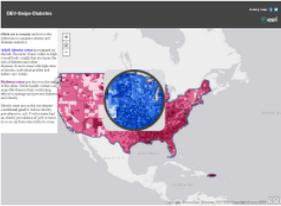
9. Enter the following headers on the next Swipe/Spyglass Builder window:
   a. Main Map Header Title: Washington, DC 1851
   b. Spyglass Header Title: Washington, DC Today
10. Click Open the app.
11. Your app previous looks like this image.

4. Configure your story map swipe web app

1. Enter the following text in the Edit me! Box:

   Explore this map to compare Washington, DC in 1851 with the modern capital city. You can use the Search box to find a specific address and observe differences at that location. The location of the National Hotel, US Naval Observatory, and US Patent Office are identified by pop-up markers 1, 2, and 3. You can click a marker to learn more about that location.

2. You can experiment with different font sizes and families.
3. Before you save, you can edit the app's Title and Subtitle as well.
4. When you are satisfied with the changes you've made, click Save under Story Configuration.
5. If you go to My Content and open the saved app from there, it looks like this:

6. Click on one of the pop-up icons to see the pop-up appear on the side of the map.
7. Search for a modern street address in the search box.

Extended activity

Create a spyglass map to compare two historic maps or imagery from two different dates.

Great Maps Need Great Data
The Living Atlas of the World
provides the foundation

You're meeting friends at a restaurant you've never been to, so you do an internet search, click on its map location and the "Get directions" link to see how to get there, and in less than a minute, you're good to go! We don't think twice about this because it's such an everyday thing. Yet it's an indication that we're in the midst of a remarkable era of transformation. Not so long ago you would have had to consult a phone directory and a local map to determine where the restaurant was and how to get there, and call your friends to relay the directions. You'd speak to them, and they'd take notes. That was what using and sharing data meant in the relatively recent past. But now, though there's less to do, there's so much more to it and so much more to do with it.

The transformative medium of "cloud" data storage means we now have immediate access to data, and not just about local restaurants and streets but also data about demographics, land cover, urban infrastructure, and much more. This is the kind of information that, when you think about it (which GIS also helps you do), becomes knowledge with which to solve problems and make decisions about vital issues. With such widely available "open" data, anyone can ask and answer geographic questions quickly. We can create and share maps integrating authoritative with local or regional data. ArcGIS Online is rapidly emerging as the technology of choice for using spatial data to explore and work out solutions for real-world problems. It truly is a whole new world.

This chapter provides guided practice in strategies for using open data to answer geographic questions and solve problems. Two scenario-based lessons demonstrate the power of open data to support informed decision making. Additionally, the step-by-step lessons build and reinforce fundamental GIS skills. Use the questions at the end of this chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 4 of *The ArcGIS Book*.

Introductory activities

Video

The following videos run the gamut from showing the new ArcGIS Online capability, Smart Mapping, to explaining the basic concept of GIS to looking at local governments and businesses using geospatial technologies.

Smart Mapping

Smart Mapping
esri

Smart Mapping is an exciting new capability in ArcGIS Online that will change how you make maps.

What Is GIS?

What Is GIS?

Geographic information systems (**GIS**) technology is a computerized framework for gathering, managing, and analyzing data.

Geospatial Revolution: Episode 2

Geospatial Revolution / Episode Two
wpsu

Produced by **Penn State** Public Broadcasting This **episode** looks at how local governments and business use **geospatial** ...

CC

Welcome to MapQuiz by Esri

One component of ArcGIS Open Data, now accessible via the web, is imagery: photographic, satellite, and multispectral. This engaging quiz utilizes photographic imagery to test your geographic literacy. Sign in with a Facebook account to get started.

The ArcGIS Book, chapter 4
Questions for reading comprehension, reflection, and discussion

Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

The Living Atlas: The ArcGIS platform provides rich content

How have open data repositories such as the Living Atlas changed the way GIS users plan and implement projects?

The ArcGIS data community: A global network for creating and sharing authoritative geographic information resources

The work of organizations that make up the global GIS community has changed with the emergence of web GIS. Explain how this GIS work has changed.

What kind of data is available? Definitive, authoritative basemaps

There are several key concepts to understand about basemaps: they are multiscale, provide global coverage, and are continuous. In your own words, briefly define each of these concepts:

multiscale
global coverage
continuous

Demographics

Explain the concept of data enrichment.

Opening data to the world of possibilities

What are open data sites and what benefits do they provide?

Imagery

In your own words, briefly compare these types of imagery: photographic, satellite, and multispectral.

Landscapes: Landscape analysis layers

What are ELUs?

Thought leader: Richard Saul Wurman

A map is a pattern made understandable
In your own words, explain what the phrase "understanding precedes action" means to you.

Explore the Urban Observatory and explain how it reflects the concept that "understanding precedes action."

Learn ArcGIS: Guided lessons based on real-world problems

Map Voter Data to Plan Your Campaign

Map Voter Data to Plan Your Campaign
Identify political advantages to help your candidate win the election.

Geocoding addresses from a spreadsheet.
Enriching layers using Tapestry data.
Mapping US Census data.
Creating a presentation.

Get Started with Tapestry
Using the Zip Lookup tool.
Finding key information.
Identifying the best Tapestry segments for each scenario.

Get Started with Tapestry
Use ZIP Codes to learn how Americans think, feel, and live.

Where Does Healthcare Cost the Most?

Where Does Healthcare Cost the Most?
Find hot spots in the cost of United States medical care.

Displaying and classifying data.
Analyzing hot spots.

Exploring and creating basemaps

Introduction to more, better, and unique basemap

You have been tasked with showing your GIS colleagues new and different ways to customize basemaps. You are to reproduce various scenarios in which unique basemaps would be needed and give explicit instructions on creating these basemaps. You have decided to do a presentation highlighting the following:

- Basemaps created from multiple layers
- New Firefly basemap with custom halo icons
- Basemaps created by Mapstyler app
-

Build skills in these areas

➢ Combining multiple layers to create basemaps
➢ Use the basemap Firefly
➢ Using Mapstyle to create basemaps

What you need

➢ Account required
➢ Estimated time: 1 hour

esri | THE SCIENCE OF WHERE

1. Scenario #1: Create basemap from multiple Layers

Your team has been assigned a project on world hydrology. The following will produce a basemap that can be used as a standard for the project.

1. Sign into your ArcGIS organizational account.
2. Click Map to open a new map.
3. Click Add>>Browse Living Atlas Layers.
4. Search for Tinted Hillshade.
5. Click the + to add the layer.
6. Click the back arrow to return to the Contents Pane.
7. Click the More Options icon (three dots) beneath the layer name, Terrain: Elevation Tinted Hillshade
8. Click Move to Basemap.
9. Click Add>>Browse Living Atlas Layers.
10. Search for the Esri Hydro Reference Overlay.
11. Add to the map and click the back arrow to return to the contents pane.
12. Move World Hydro Reference Overlay to Basemap. This layer provides a reference overlay highlighting water features for use with layers related to the natural sciences.
13. Zoom in and out on the map. Notice how more or less detail changes as the scale changes by zooming in and out.
14. Click Add>>Browse Living Atlas Layers.
15. Search for Human Geography Dark Label.
16. Click the + button to Add.
17. Click the back arrow to return to the Contents Pane.
18. Move Human Geography Dark Label to Basemap.

You should now have a basemap composed of four different layers to use as your customized basemap for your world hydrology map.
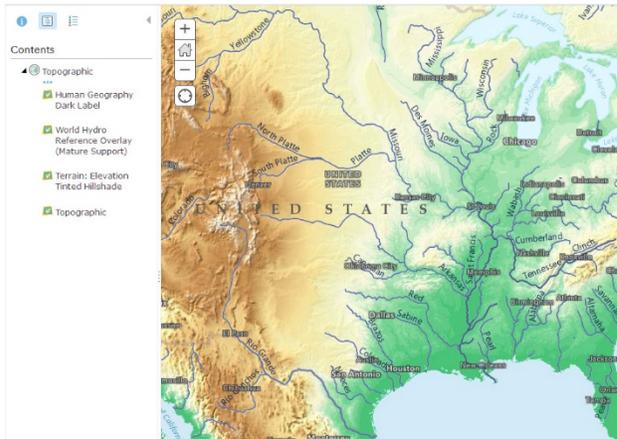
19. On the top menu, click Save As.
20. Enter the following information in the Save As Menu:
    a. Title: World Hydro Map__Your Initials
    b. Tags: IGARC2_YourInitials
    c. Summary: World Hydro Basemap
21. Save Map.
22. You can share your map with your organization or specific groups by selecting Share on the top ribbon.

2. Scenario #2: Use Firefly cartography

World Imagery Firefly is an alternative view of the default World Imagery Basemap. This map is designed to be used as a neutral imagery basemap, with desaturated colors, that is useful for overlaying other brightly styled layers. You will use this basemap with some custom images to create a map of college attendance of students of the senior class in a high school.

Firefly Cartography is a wonderful resource to read before doing this exercise.

Prepare the Firefly basemap with basic state outlines and labels

1. Sign into your ArcGIS organizational Account.
2. Click on Map to create a new map.
3. Click Add>>Browse Living Atlas Layers.
4. Search for Firefly and click the + to add to the map.
5. Click the back arrow to return to the Contents Pane.
6. Click the three dots at the end of Firefly and move to basemap.

You notice immediately how subdued the Firefly basemap is compared to the standard imagery basemap. You will now add states and labels.

7. Click Add>>Browse Living Atlas Layers.
8. Search for USA States (Generalized)
9. Click + to add to the map.
10. Click the back arrow to return to the Contents Pane.
11. Click the Change Style icon under USA States.
12. Click OPTIONS.
13. Click Symbols.
14. For Fill, click No Color. For Outline click Dark Gray.
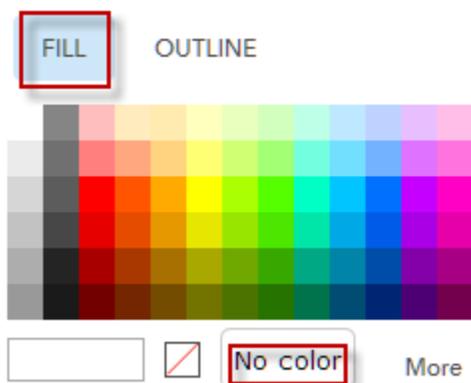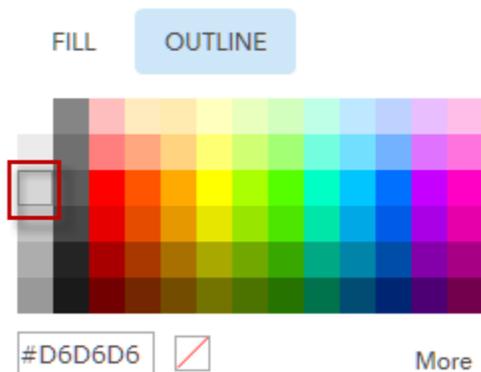
15. Click OK and OK.
16. Click DONE.
17. Click the three dots at the end of USA State and go to Create Labels.
18. Choose Abbreviation.
19. Choose Bold.
20. Choose Light Gray.
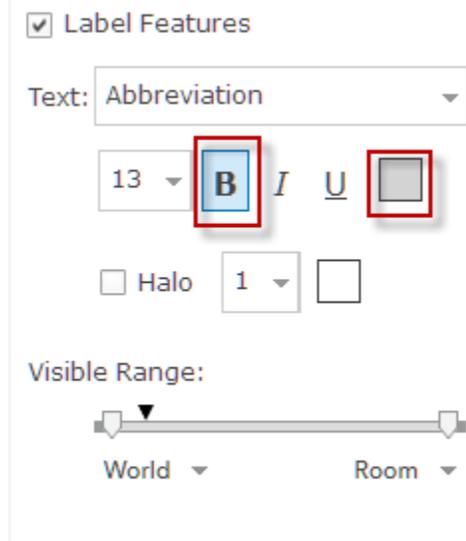
21. Click OK.
22. Click Save As on the top of the Menu.
23. Use the following parameters in the Save Map menu:
    a. Title: Firefly University Attendance
    b. Tags: Remove tags and use individualized tags
    c. Summary: Attendance of universities from VA high school.

You have now constructed a map using a Firefly basemap with labels.

Add layers to the map

To complete the next part of the exercise you will add two layers; the layer for Fairfax High School and the layer for the universities attended by the senior class.

1. Click Add and search for IGARC2_fhs in ArcGIS Online.
2. Add Fairfax_High School and FHS_Universities.

Search for Layers

Find: IGARC2_fhs   GO

In: ArcGIS Online ▾

☑ Within map area

2 Results Found

Fairfax_High_School
by Kathryn_Keranen_LearnArcGIS

FHS_Universities
by Kathryn_Keranen_LearnArcGIS

3. Click DONE ADDING LAYERS.
4. Click the three dots to the right of Fairfax High School and move up to the top of the Contents.
5. Change Style in Fairfax High School.
6. Click OPTIONS.
7. Click Symbols.
8. Change the symbols size to 40.
9. Change to Color to Green.
10. Click OK and OK.
11. Click DONE.
12. Save the map.
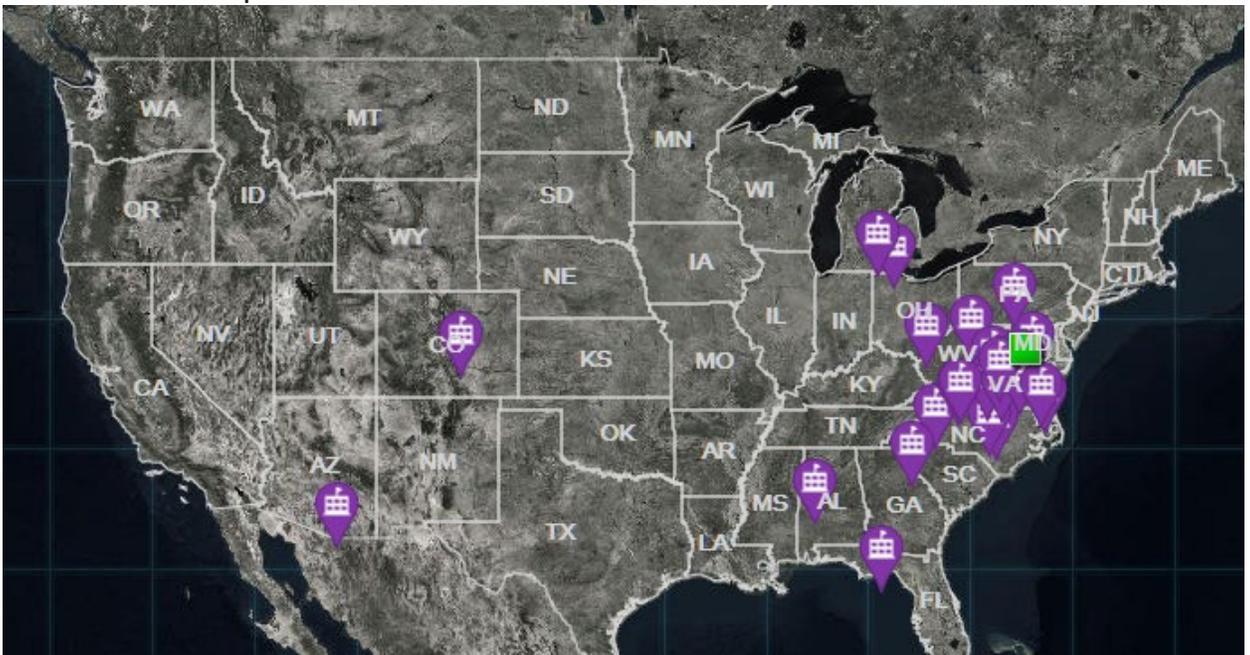
Connect origin to destinations

You can illustrate university attendance by creating lines from Fairfax High School to all the different universities. This can be done by using the analysis tool Connect Origins to Destinations. The tool can report straight-line distances from the origin to the destinations. Diagrams such as this are referred to as spider diagrams.

1. Click Analysis on the top menu.

2. Click Use Proximity.
3. Click Connect Origins to Destinations. This uses a straight-line distance.
   a. Fairfax_High School is the point layer.
   b. FHS_Universites is the Route to destinations.
   c. Line distance is Measure. This tool connects origins to destinations using straight-line distance.
   d. Result layer is Fairfax_High_School to FHS_Universities_yourinitials.
   e. Save the result in your folder.
   f. Uncheck Use current map extent.
   g. Renew credit usage. Remember analysis is not free but uses credits.
4. Click RUN ANALYSIS.
5. Click Change Style under Fairfax High School to FHS Universities_Fairfax School to FHS.
6. Change Choose an attribute to Show Location Only.
7. Click OPTIONS.
8. Click Symbols.
9. Make the Symbol a purple/burgundy with a Line Width of 3.
10. Click OK and OK.
11. Click DONE.

You can now see a line drawn from Fairfax High School to each individual university.

Symbolize universities by attendees.

Of course, there are some universities that more than one student attended. The universities need to be symbolized by quantity of attendees.
1. Click Change Style under FHS Universities.
2. Under Choose an attribute to show select FHS_Attendees.
3. Click Counts and Amounts (Size) OPTIONS.
4. Click Classify Data.
5. Change the size to be 15 Min to 50 Max.
6. Click OK then DONE.
7. Click Save.

Use custom glow effect symbols

Point symbols with a glow effect are ideal for a Firefly basemap.
1. Click Change Style under FHS Universities.
2. Move FHS Universities layer above the lines layer.
3. Counts and amounts OPTIONS.
5. Click Legend.
6. Click >12 – 20.
7. Search for Firefly and choose the bright green firefly symbol.
8. Click > 6 – 12 and choose the dark green firefly symbol.
9. Click >2 – 6 and choose the light blue firefly symbol.
10. Click 1 – 2 and choose the dark blue firefly symbol.
11. Click OK and OK.
12. Save.
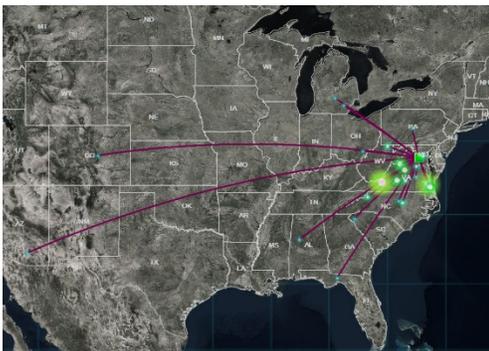
In this exercise, you have displayed student attendance data at universities on a Firefly basemap with custom halo symbols. This gives you knowledge of how to use more cartographic options.

3. Scenario #3: Produce Mapstyler basemap

As chief cartographer for a major university you have been tasked with producing three basemaps: one representing historical colors, one oceanic color, and one that represents emergencies. You have chosen the app Mapstyler.

Mapstyler has been designed by Esri UK to make vector tile color editing simple. There are two methods of selecting colors for a new basemap. You can use a random color shuffle button, or you can select an image that has a color scheme that is appealing to you and drag the image onto the map and let the vector tile basemap adopt the colors in the image. After you have selected a basemap of your choice you save the basemap to your content by clicking the heart in the upper right corner.

Basic Map

1. Open Mapstyler. (The opening default map varies, and you may have to zoom in to trigger the display.)
2. Examine the three tabs: SAVE, SHUFFLE, and UPLOAD.
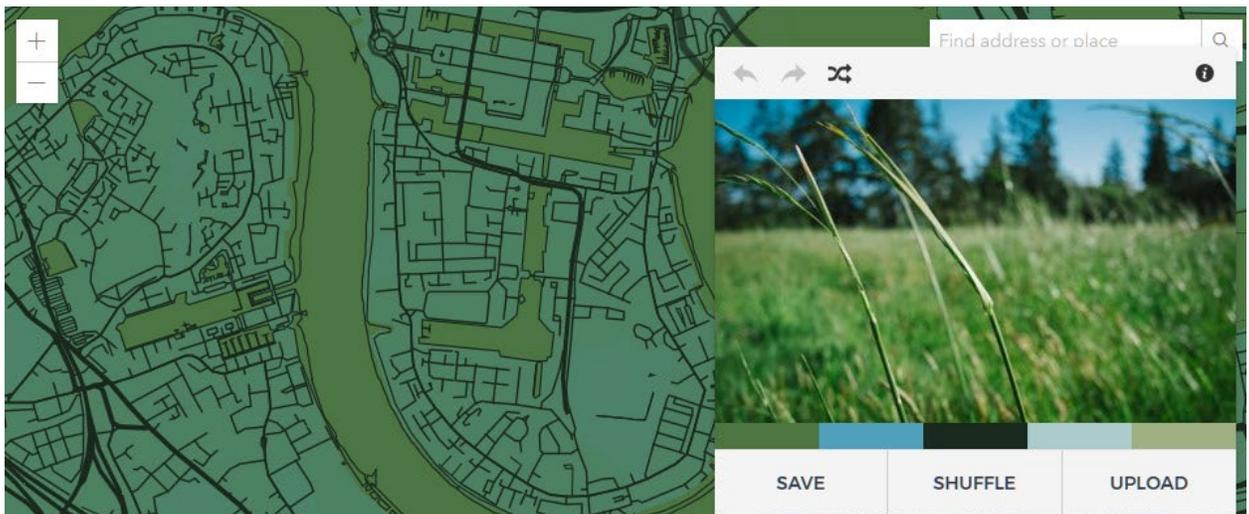
3. Click SHUFFLE to cycle through examples.
4. Or click on a color and pick a specific color and click APPLY.
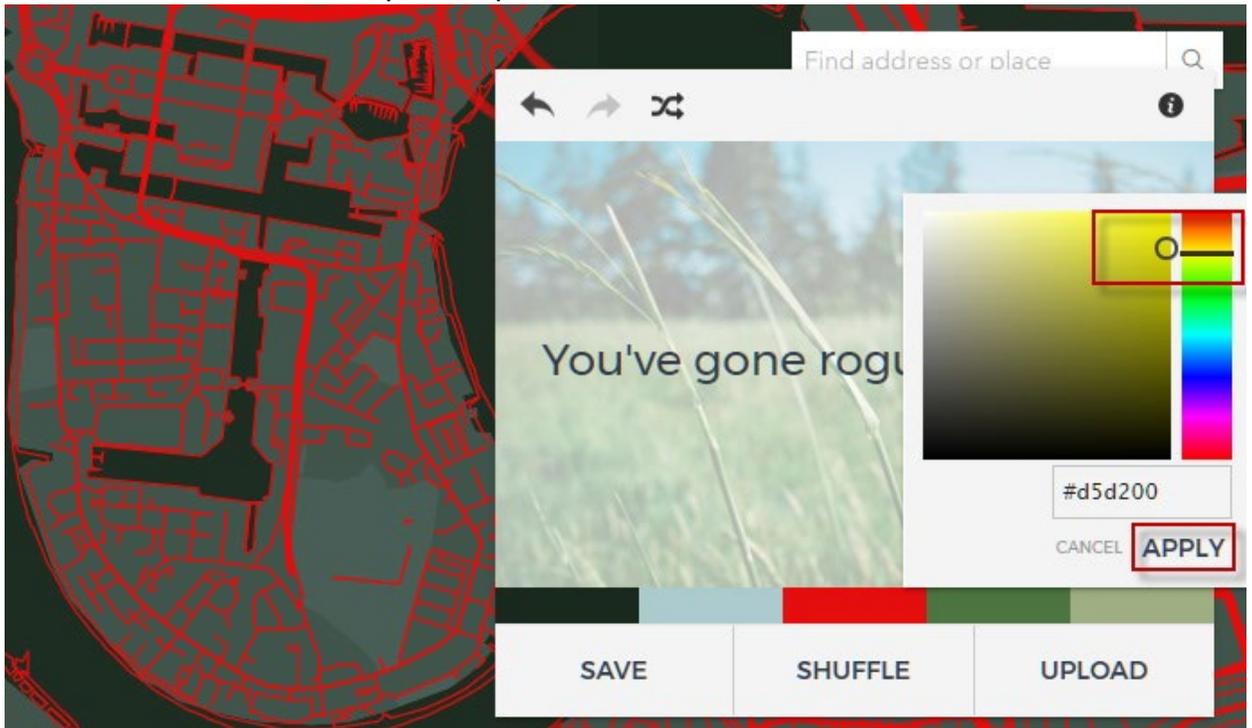
Remember your task is to pick a color that represents a historical cartographic look.

5. Click Save to save your map into your organizational Contents.
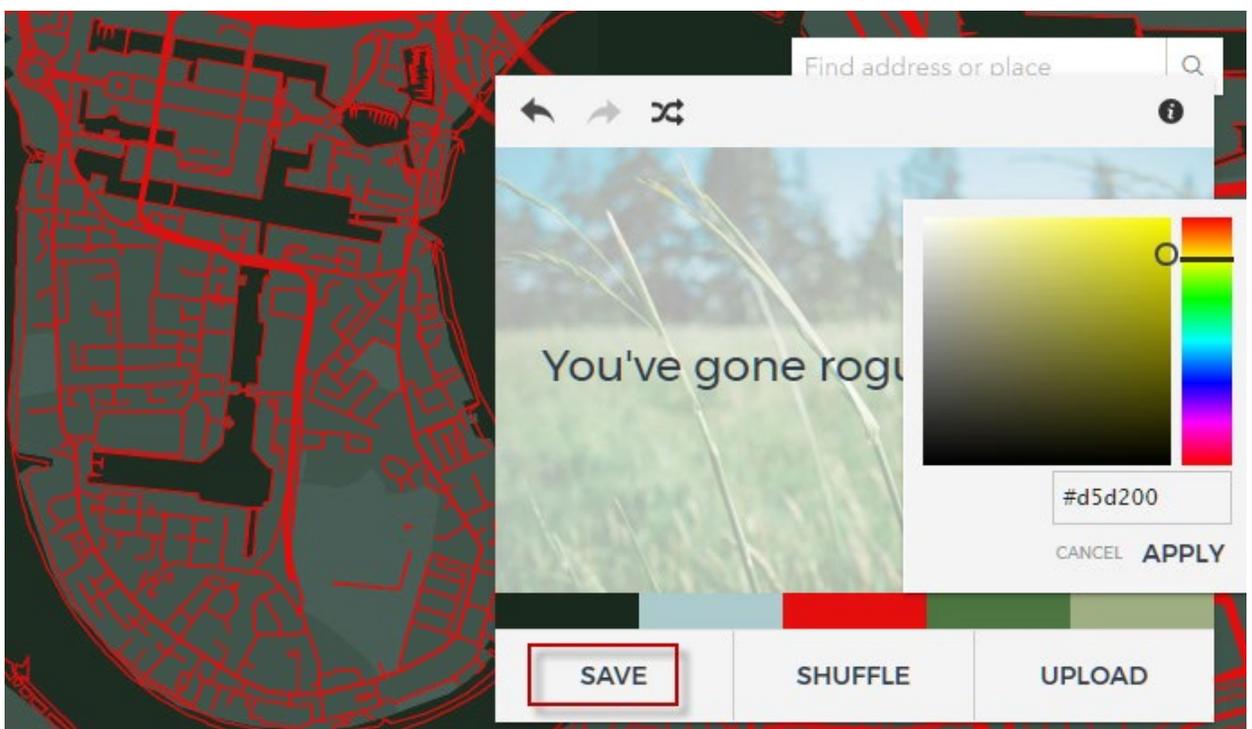
6. Go to your Contents.
7. Click the map.
8. On an Overview page for your map, click the edit to the right of the title and rename your basemap.
9. Click Save.

Upload an image

Using the Upload mode, you can select a jpeg or png image and drag it onto the map. The vector tiles will adopt the color palette of the image. You can then use the shuffle button to reorder the colors.
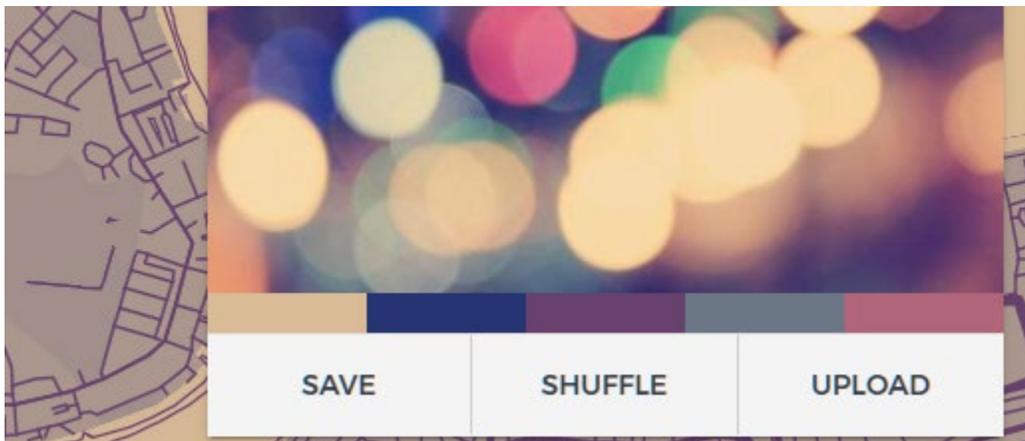
1. Open Mapstyler.
2. Do some research and find a map that stylistically represents your ideas. Make an image of the map (jpg or png format). Tiffs cannot be used.

3. Drag the map to the area designated below.
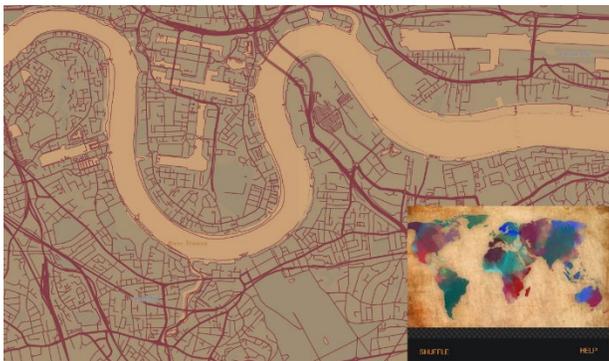
4. Click Save at the top right to save your new basemap into your content.
5. Rename your basemap.

Make your new map the basemap

1. Create a new web map.
2. Search for the name of your new basemap.
3. Click and Use as Basemap.
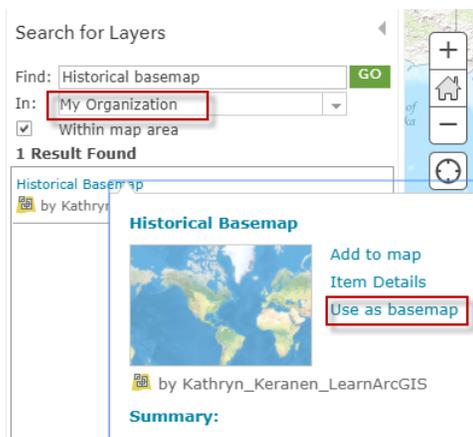
4. Click Done Adding Layers.
5. Add more layers to your map.

Create a custom historical, ocean, and emergency map.

Deriving accessibility
Can you stroll to the farmers' market?

Farmers' markets provide people with access to healthy food. The Supermarket Access Map shows the location of farmers' markets. The map is designed for learners to use to answer the question: "How many Americans live within a reasonable walk or drive to a farmers' market?" Exploring the Supermarket Access Map gives insight into the following lesson.

Many county chambers of commerce have been asked to sponsor farmers' markets. In this lesson, you will provide maps for county officials showing the location of markets within their counties and reasonable drive and walk times from the markets. For analysis purposes, a 10-minute drive time and a 1-mile walk time will be used to determine what is reasonable. Once you have created these proximity drive areas you will add an Esri World Traffic Service. The World Traffic Service presents near real-time traffic information for different regions in the world and is updated every 5 minutes. The Traffic Service can be used to provide even more information about market choices.

You will map three different counties that represent different geographic areas. The three counties are as follows:

- Fairfax, VA
- Fulton, GA
- Dallas, TX

After deriving drive and walk times of markets with the specified counties, you will clarify the legend and publish as an app showing the availability of markets with the three different counties. It is your plan to present your map and analysis to the individual chambers of commerce.

Build skills in these areas

- Opening a map
- Filtering a layer by county
- Deriving drive times
- Deriving walk times
- Symbolizing data
- Adding a live World Traffic feed
- Publishing a web app that compares three different counties

What you need

- Account required/not required
- Estimated time:
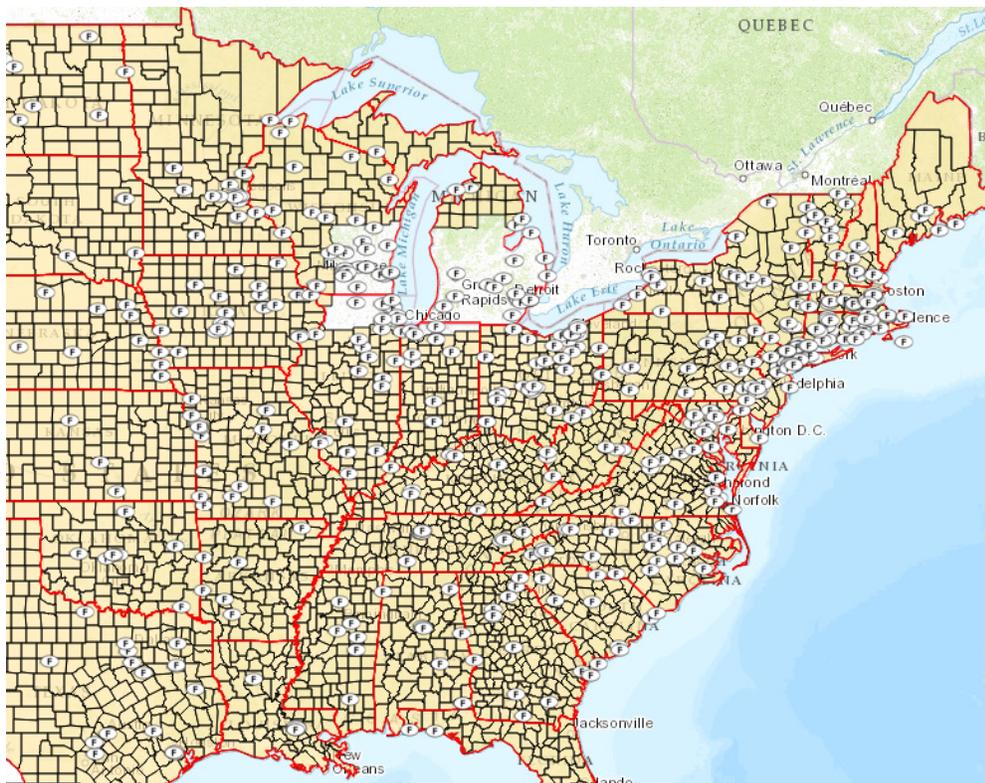
Publication date: February 26, 2019

1. Open the map and save into your organization

1. Sign into your ArcGIS organizational account.
2. Open Farmers' Markets.
3. On the ribbon click the Save button and choose Save As.
4. In the Save Map window, type Farmers' Markets_yourinitials.
5. Tags: Remove tags and add your individualized tags.
6. Write a brief description of the map's content.

Save Map

Title:	Farmers Markets_Your_Initials
Tags:	drive_time ✕ walk_time ✕ IGARC2_your_initials ✕
	Add tag(s)
Summary:	Analysis of drive time and walk time from farmers markets in
Save in folder:	▾

SAVE MAP   CANCEL

2. Select and filter a specific county (Fairfax, VA)

A filter presents a focused view of a feature layer in a map. In this case, you only want to view and analyze the farmers' markets that are in Fairfax, VA. Fairfax County is the most populous county in the Commonwealth of Virginia and contains 13.6 percent of Virginia's population.

1. Move the farmers' market layer to be above USA counties.
2. Click on the feature layer Farmers' Market and click Filter.

Contents

☑ Farmers Markets

☑ US states   Filter
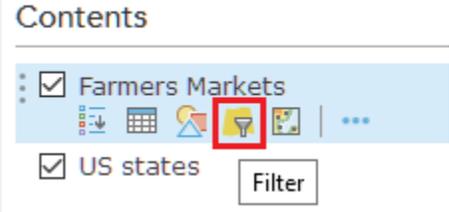
3. Create your definition expression.
   a. County is Fairfax.
   b. Add another expression.
   c. State is Virginia.

4. Click APPLY FILTER
5. Zoom to the filtered area.
6. You should now see only the farmers' markets in Fairfax County, VA.
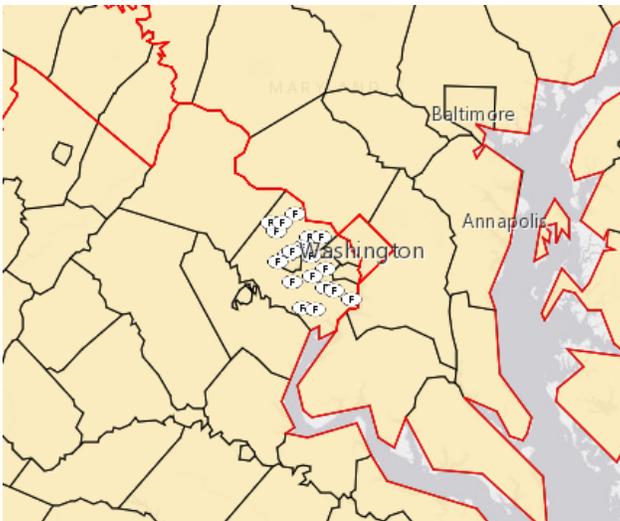
7. Display the table for Farmers' Markets. You will see that there are 19 markets within Fairfax County, VA.
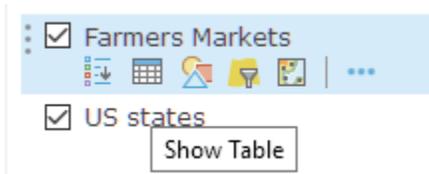
Farmers Markets (19 features, 0 selected)

MarketName	street	city	County	State	zip
Annandale Farmers Market	6621 Columbia Pike	Annandale	Fairfax	Virginia	22,003
Burke Farmers Market	5671 Roberts Parkway	burke	Fairfax	Virginia	22,315
Government Center Farmers Market	12011 Government Center Pkwy	Fairfax	Fairfax	Virginia	22,035
Great Falls Community Farmers Market	778 Walker Road	Great Falls	Fairfax	Virginia	22,066

3. Calculate 10-minute drive time

You are now ready to perform analysis and derive the 10-minute drive time and the 1-mile walking distance from each of the farmers' markets.

1. Click the Perform Analysis Tab under the Farmers' Markets layer.
2. Click Use Proximity.
3. Click Create Drive-Time Area and use the following parameters:
   a. Choose point layer to calculate drive-time areas around = Farmers' Markets.
   b. Driving Time = 10 Minutes.
   c. Areas from different points = Split. The split tool takes areas from different input locations that would overlap each other and splits them in the middle so they abut one another instead. This is useful when you want to see which areas are within g given time or distance of the input points and, at the same time, determine which input point is closest to that area.

5
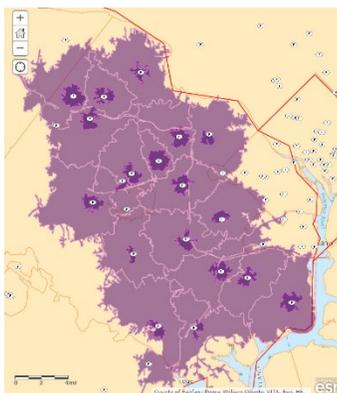
4. Click RUN ANALYSIS.
5. Click filter under Farmers' Markets.
6. REMOVE FILTER. All the Farmers' Markets are visible.
7. Move Farmers' Markets to the top of Contents.
8. Save as Fairfax Farmers' Market.
9. Share with Everyone. You will have to update sharing.
10. Click DONE.

4. Select and filter a specific county (Fulton, GA)

Next you will make a map of the farmers' markets in Fulton, GA. You will be making maps of several different locations. These maps will be used to make a story map at the end of the exercise. Fulton is the home of Atlanta, which is the capital and the most populous city in the state of Georgia.

1. Click on the feature layer Farmers' Market and click Filter.
2. The definition expression should be:
   - "County is Fulton."
   - Add another expression.
   - State is Georgia.

     There should be 10 farmers' markets.

3. Repeat steps 3-6 as you did for Fairfax County walking distance.

There are two farmers' markets very close together at the northernmost point of the county.
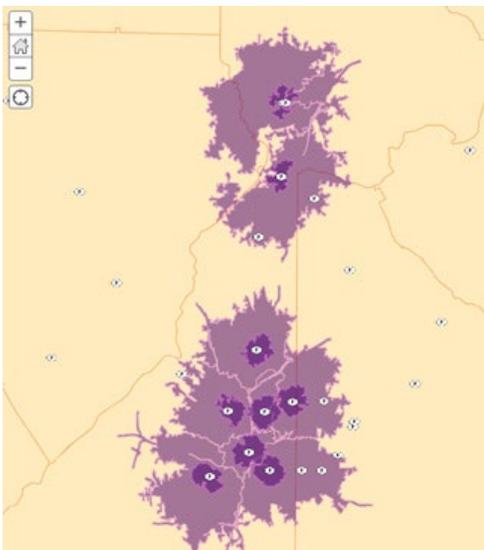
4. Save as Fulton, GA Farmers' Markets.
5. Share with everyone. You will have to update sharing.

5. Select and filter a specific county (Dallas, TX)

Dallas, TX is the second-most-populous county and the third largest city in Texas.

1. Click on the feature layer Farmers' Market and click Filter.
2. The definition expression should be:
   - "County is Dallas."
   - Add another expression.
   - State is Texas.
3. Repeat steps 3-6 as you did for Fairfax County walking distance,

   There should be 6 farmers' markets. There are two farmers' markets very close together.
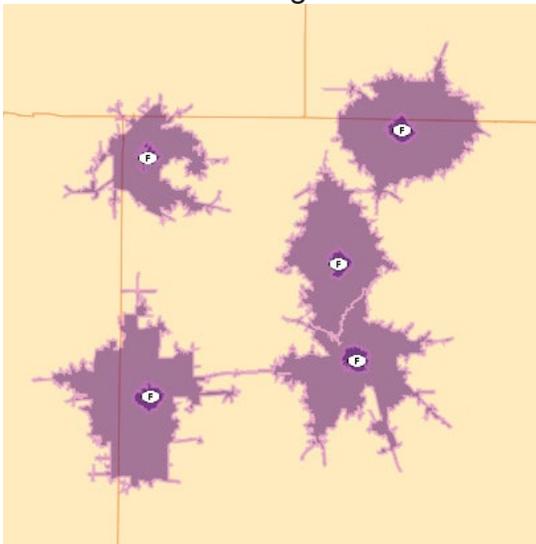
4. Save as Dallas, TX Farmers' Markets
5. Share with everyone. You will have to update sharing.

6. Add live World Traffic Service

Esri has published a set of "live feeds" layers featuring frequently updated data from several sources, including NOAA, NASA, and USGS. This group includes this set of live feeds as both ready- to-use web map and map layers. The World Traffic Service live feed presents near real-time traffic information for different regions in the world. The data is updated every 5 minutes. This live traffic feed can provide additional information about market accessibility.

1. Click on Home and go to Content.
2. Open Fairfax Farmers' Market_yourinitials.
3. Go to Add and search for World Traffic Service in ArcGIS Online.

4. Click DONE ADDING LAYER.
5. Turn off USA Counties.
6. Turn off 1 mi walk Fairfax.
7. Filter Farmers' Markets again for County = Fairfax and State = VA.
8. Click Perform Analysis.
9. Click Proximity.

10. Click Create Drive-Time Areas.
   - Driving Time = 10 Minutes
   - Check Use Traffic.
   - Click Traffic based on typical conditions.
   - Pick Current Date (if day of the work week).
   - Time is 4:30 PM (Rush Hour).
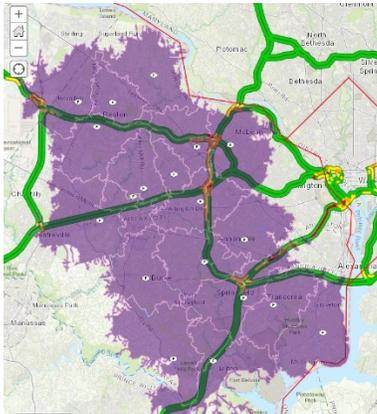
11. Areas from different points = Split.
12. Result layer name = 10min_fairfax_traffic_yourinitials.
13. Run ANALYSIS.
14. Compare the results for the original 10-minute drive time with the new drive time with traffic service used.
15. Click Save.
16. Click Share.
17. Repeat for Fulton, GA.
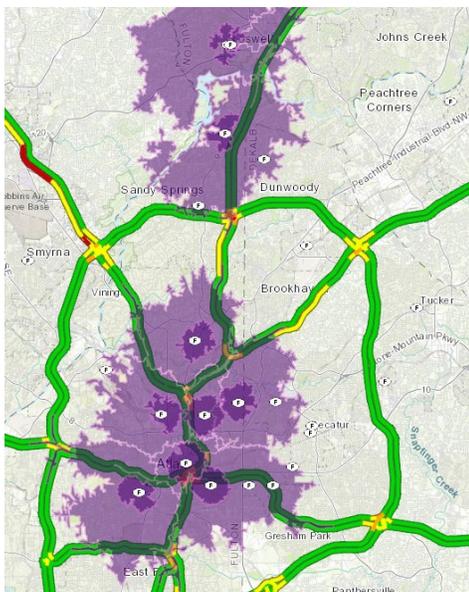
18. Repeat for Dallas, TX.
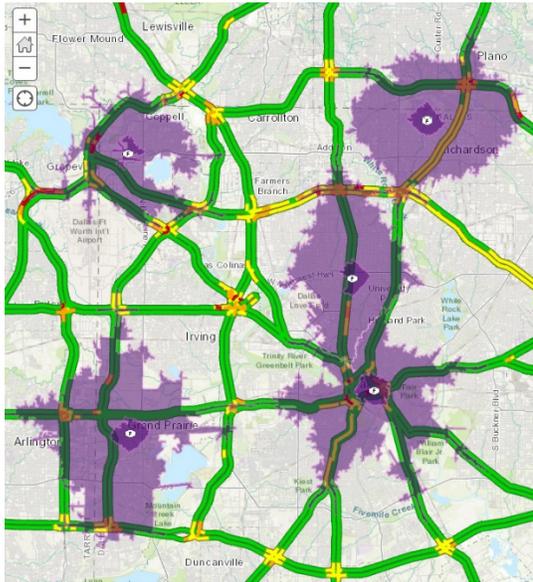
Q1 Are the drive time areas different when live traffic feed is added?

Q2 How does this live traffic feed help you make decisions about market accessibility?

7. Create a web app

You can create a web app from your map using a configurable app template. Your client has asked that the population rate change map you have built be displayed as a web app. Your client has asked you to use the configurable Story Map Series web app.

1. Click Save again to be sure your work has been saved as Dallas, TX Farmers' Markets.
2. Click Share. Share with your Individual Organization or with Everyone.
3. Click CREATE A WEB APP.
4. Select Build a Story Map.
5. Select Story Map Series.
6. Click CREATE WEB APP.
7. Specify a title, tags, and a summary for the new web app. Title the web app: Farmers' Markets Accessibility.

8. Click DONE.
9. Select Tabbed on the Welcome to Map Series Builder.

What do you want to call your Tabbed Map Series?

Farmers Markets Accessibility

10. Click START.

ADD TAB

Dallas, TX

CONTENT: ● Map ○ Image ○ Video ○ Web page

Map   Dallas, TX Farmers Markets Newly selected map   ▼   ☑ Edit
Location   Inherited from the first map ⓘ
Content   Map default Custom configuration ⓘ
Pop-up   Map default Custom configuration ⓘ
Extras   ☐ Legend ⓘ

ADD   CANCEL

11. Click SETTINGS on the top ribbon.
12. Click Map Options.
13. Uncheck Synchronize map locations.
14. Click APPLY.
15. Click the Arrow.
16. Tab title = Dallas, TX.
17. Dallas, TX, Farmers Market for your map.
18. Click ADD.
19. Write an analysis of the map in the text box such as "The Dallas, TX, area has four areas of access to farmers' markets. There is considerable area that has no access."
20. Click Add.
21. Add Fulton, GA Farmers' Markets to the tab.
22. Select a Map.
23. Choose Fulton, GA Farmers' Markets.
24. Write an analysis of the map in the text box.
25. Repeat steps 18-22 for Fairfax, VA.
26. Click SAVE in the upper right corner.
27. Click SHARE on the Top Ribbon; the Organization Tab is highlighted.
18. Click View Story.

Farmers' Markets Accessibility

No issues detected × A story map

Dallas, TX | Fulton, GA Farmers' Markets | Fairfax, VA

Fairfax County is the most populous county in the Commonwealth of Virginia. It is surrounded on the north and northeast by the Potomac River and is to the west of Washington, DC. The county has a great spatial distribution of farmers markets with perhaps a slight decline in the western part of the county.
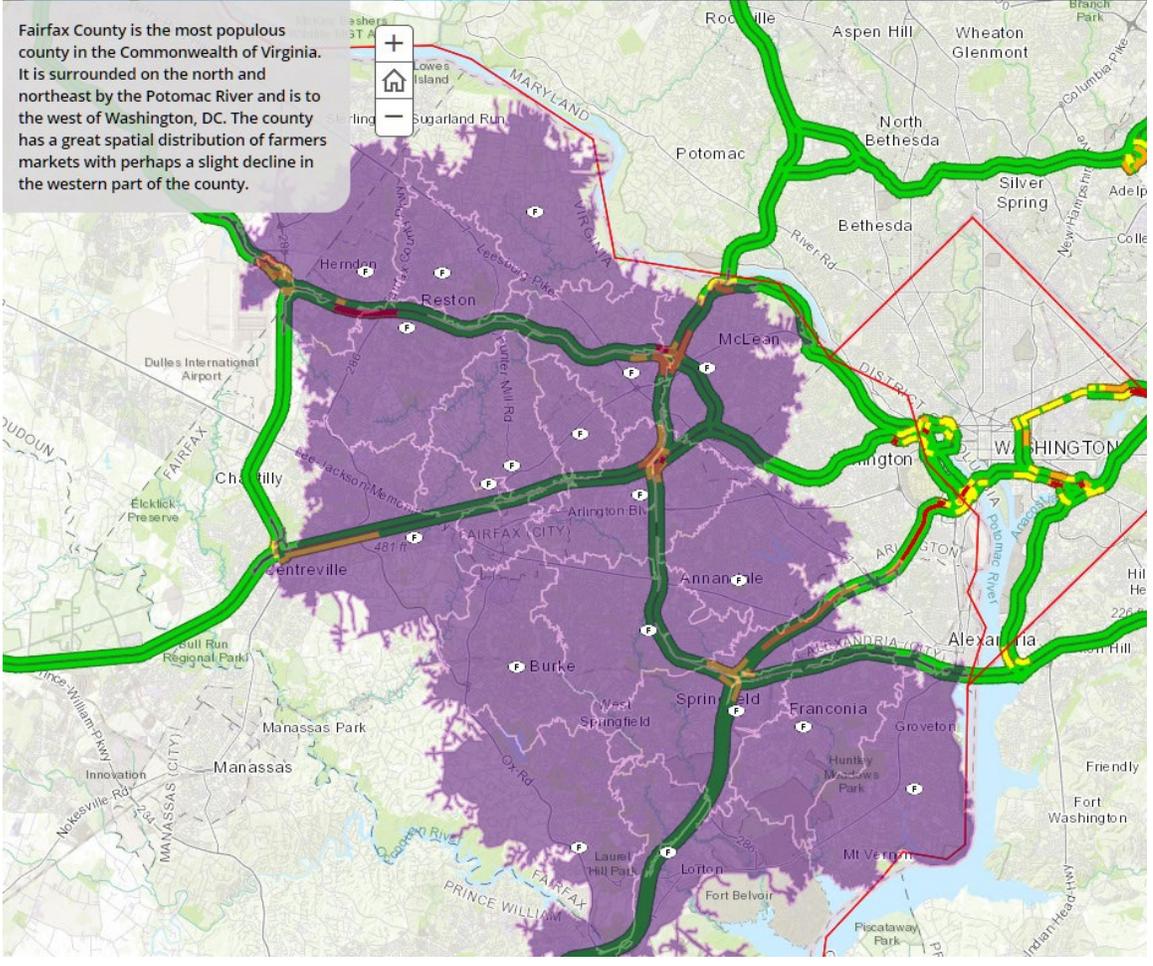
Helping restore a watershed

Chesapeake Bay states land-use enrichment

The Chesapeake Bay is the largest estuary in the contiguous US. The watershed covers 64,000 square miles and is fed by 50 major rivers and streams. Everything always flows downstream. Because of this downstream flow, all the results of human habitation run into the ocean. Human habitation includes farms and developed lands. As the land is farmed and developed more, there is less land to absorb and filter the water. Restoration efforts have made modest ecological gains, but they have been largely offset by rapid population growth. Agriculture and developed land are one of the land-use classifications that are used to study the health of the bay.

The Chesapeake Bay Foundation is interested in correctly assigning funds and resources to the seven states that make up the Chesapeake Bay watershed. To do this, the foundation asked for both quantitative and qualitative information from its GIS department. The foundation wants to know what percentage of land use is in each designated state's watershed area and presented in a compelling way to present to the community.

Build skills in these areas

- ➢ Opening a map
- ➢ Enriching a layer
- ➢ Configuring pop-ups
- ➢ Using pop-up media
- ➢ Calculating percentage
- ➢ Publishing as a web app

What you need

- ➢ Account required
- ➢ Estimated time: over 1 hour

1.   Open and save the map

1. Sign into your ArcGIS organizational account.
2. Open Chesapeake Bay Landuse.

   The map opens showing the Topographic basemap and the outline of the Chesapeake Bay showing the section of each state that is in the bay.

3. On the ribbon click the Save button and choose Save As.
4. In the Save Map window, type Chesapeake Bay Landuse_yourinitials.
5. Tags: Remove the tags and add individualized tags
6. Write a brief description of the map's content.

2. Display the Bay Area by state abbreviation

The Bay Area by State layer is displayed without any cartographic styling.

1. Click Contents.
2. To open the Change Style pane click the Change Style icon, which opens the Change Style Pane.
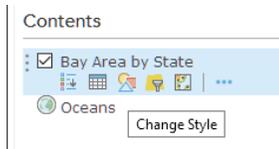
3. The states are shown by location only. Choose STATE_ABBR in the Choose an attribute to show tab.
4. Click DONE.

The states are now displayed by individual colors.
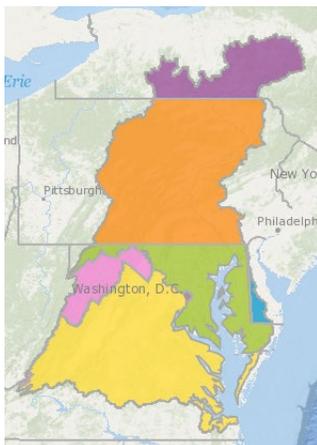
Write several spatial observations about the Chesapeake Bay watershed. Include in your observations a discussion of political vs natural boundaries. The observations that are written here will be used later in the exercise when you construct your story map.

3. Use the data enrichment tool

The data enrichment tool helps you explore the character of areas. Detailed information is returned for the chosen area. For this area, you would like to know information about the percentage of land use or landcover in each of the states represented in the Chesapeake Bay.

1. Click the Perform Analysis icon.

Contents

☑ Bay Area by State

◉ Oceans

Perform Analysis
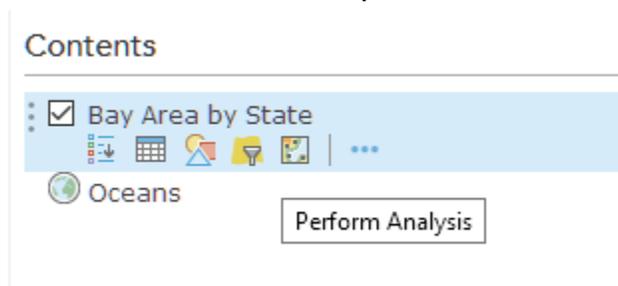
2. Click Data Enrichment.
3. Click the Enrich Layer tool to activate the Enrich Layer menu.

Perform Analysis

> Summarize Data

> Find Locations

▼ Data Enrichment

        Enrich Layer

> Analyze Patterns

> Use Proximity

> Manage Data
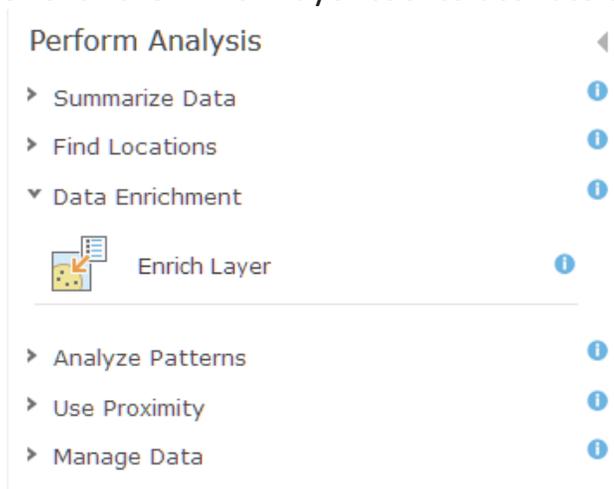
4. The Bay Area by State is selected by the layer to enrich. Click SELECT VARIABLES to pick the land cover information that you want to retrieve.
5. In the Data Browser in the upper right corner be sure that United States is selected.
6. Click the arrow to show the next page.
7. Click Landscape.
8. Click LANDCOVER.

9. Select all seven variables by selecting the Landscape Analyst Variables.
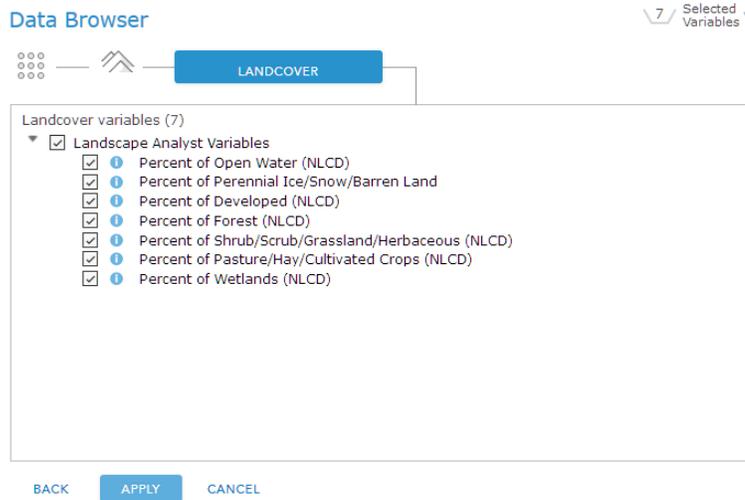
10. Click APPLY.

11. The Result layer name = Enriched Bay Area by State_your initials.
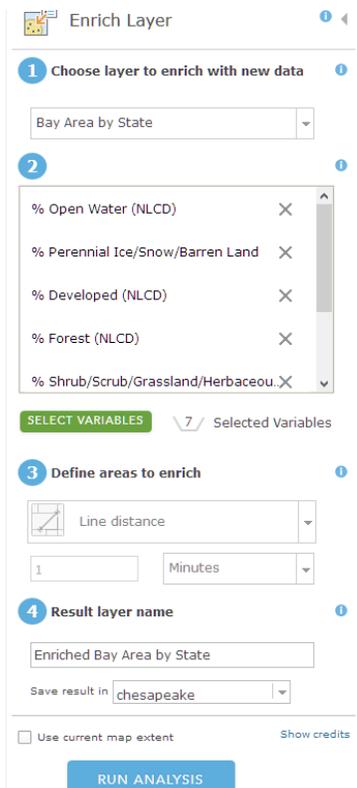
12. Uncheck Use current map extent.
13. Click RUN ANALYSIS.

    The Enriched Bay Area by State layer will be added to the Content Pane.

14. Click on the Show Table icon.
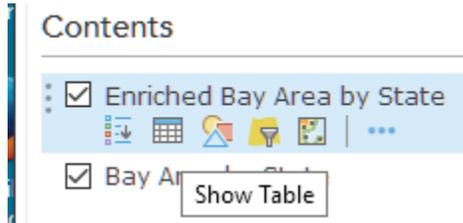
    When you open the table, you will see that each bay state has been
    populated with percentage of land use.

15. When you examine the table you will see several fields that are not
    necessary for the analysis. Click Table Options in the right corner and
    click Show/Hide Columns. Uncheck the fields listed below:
    - STATE_Name
    - ID
    - ENRICH-FID
    - sourceCountry
    - HasData
    - Aggregationmethod
16. Close the table by clicking the X in the right corner.

Enriched Bay Area by State (7 features, 0 selected)												
STATE_NAME	STATE_ABBR	ENRICH_FID	ID	sourceCountry	HasData	% Open Water (NLCD)	% Perennial Ice/Snow /Barren Land	% Developed (NLCD)	% Forest (NLCD)	% Shrub /Gras /Herb (NLCD		We CD
Maryland	MD	6	5	US	1	6.73	0.31	17.65	31.29	1.96		96
Virginia	VA	7	0	US	1	3.55	0.18	10.93	56.55	3.34	20.57	4.89

17. Uncheck Bay Area by State in the Contents Pane.
18. Display Enriched Bay Area by State by STATE_ABBR.
19. Click DONE.

4. Configure attributes and show charts

You can display the bay states by land use percentage, but the amount of information that you portray is neither compelling nor quantitative. A better way to present your data is to create a chart. A chart will graphically display the values of numeric attribute fields, in this case, percentage of land use.

Before you chart your data, you need to configure your pop-ups.

1. Click the three small dots after Enriched Bay Area by State and go to Configure Pop-up.
2. Enter a title for your pop-up. Title = Enriched Bay Area by State.
3. Display: A list of field attributes.
4. Click Configure Attributes and uncheck the following:
   - STATE_Name
   - ID
   - ENRICH-FID
   - sourceCountry
   - HasData
   - Aggregationmethod
5. Click within the attributes and change to the following. Ensure the following stay on:
   - STATE_ABBR
   - % Open Water
   - % Barren Land
   - % Developed
   - % Forest
   - % Herbaceous
   - % Pasture/Crops
   - % Wetlands

Configure Attributes

Check the fields you want to display. Select a field to change its alias, order it, and format it.

☐ Display	Field Name	Field Alias
☑	{NLCDoH2OPt}	% Open Water
☑	{NLCDsnIcPt}	% Barren Land
☑	{NLCDDevPt}	% Developed
☑	{NLCDfrstPt}	% Forest
☑	{NLCDssgPt}	% Herbaceous
☑	{NLCDAgPt}	% Pasture/Crops
☑	{NLCDWetPt}	% Wetlands

Format

2 decimal places

☑ Use 1000 Separator

6. Click OK.

7. Under Pop-up Media click ADD and add a Pie Chart.

8. Configure Bar Chart as follows:
- Title= Chesapeake Bay Land Use
- Caption = % of Land Use by State
- Check
  - % Open Water
  - % Barren Land
  - % Developed
  - % Forest
  - % Shrub/Scrub/Grassland/Herbaceous (NLCD)
  - % Pasture/Hay/Cultivated Crops (NLCD)
  - % Wetlands

9. Click OK.

Now when you click on each of the states it shows the percentages of

% Forest	56.55
% Herbaceous	3.34
% Pasture/Crops	20.57
% Wetlands	4.89

Chesapeake Bay Land Use

% of Land Use by State
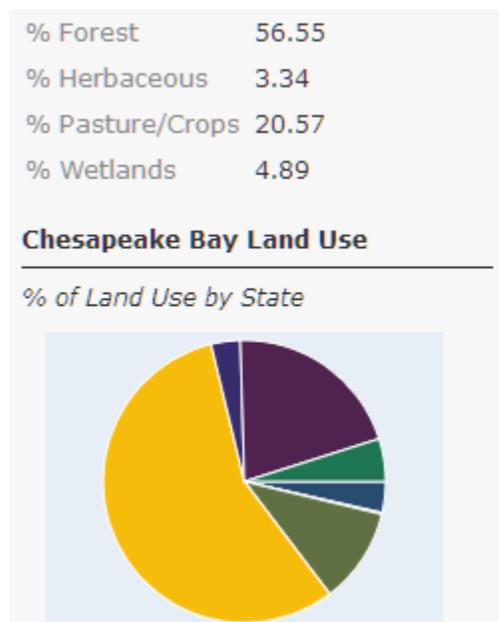
land use in both a table and a pie chart.

5. Use the table

Don't forget the interactive table is a quick way to analyze information and make decisions. Sorting by a specific attribute is always useful.

1. Show the table.
2. Click the field % Developed.
3. Choose Sort Descending. That puts the values in order from highest to lowest, and you can see that DC is by far the most developed state, followed by MD and VA.

STATE_ABBR	% Open Water	% Barren Land	% Developed	Sort Ascending	
				Sort Descending	
				Σ Statistics	
				Calculate	
DC	3.47	0.08	80.76	Delete	
MD	6.73	0.31	17.65		
VA	3.55	0.18	10.93	56.55	3.34

You can also sort the table to arrive at more quantitative data.

4. Close the table.
5. Click Save.

6. Create a web app

The Chesapeake Bay Foundation asked you to show the percentage of land use area in the bay by each state in a compelling way to present to the community. You have decided to make a story map to fulfill this task. You have selected a story map that presents a series of maps and other content organized using tabs.

1. Click Save to be sure your work has been saved.

You have decided that the individual state maps that you want to use in your story map will look better if the basemap is Imagery with Labels.

9

2. Change the basemap to Imagery with Labels.
3. Save the map as Answers: Chesapeake Bay Landuse 2.
4. Click Share and Share with Everyone.

Answers: Chesapeake Bay Landuse 2 is the beginning map for your story map series.

You will also need individual maps of each watershed.

5. Filter the map by STATE_ABBR and select NY.
6. Save the map as NY.
7. Share with everyone.
8. Repeat steps 5-7 for all the states.

You should have seven maps.

9. Choose Answers: Chesapeake Landuse.
10. Open Answers: Chesapeake Landuse2.
11. Click Share.
12. Click CREATE APP.
13. Click Build a Story Map.
14. Click Story Map Series.
15. Click CREATE WEB APP.
16. Specify a title, tags, and a summary for the new web app.
17. Click DONE.
18. Select Tabbed on the Welcome to Map Series Builder.
19. Type Chesapeake Bay Watershed as the title for your Tabbed Map Series.
20. Click the Arrow.
21. Add Land Use Analysis for the ADD TAB.
22. Select or create a map pull-down and pick Chesapeake Bay Landuse.

23. Click ADD.
24. At the Top Ribbon click SETTINGS.
25. Click Map options.
26. Uncheck Synchronize map locations.
27. Click APPLY.
28. Add some appropriate text about the Chesapeake Bay to the text box such as:

The Chesapeake Bay is the largest estuary in the contiguous US. The watershed covers 64,000 square miles and is fed by 50 major rivers and streams. Everything always flows downstream. Because of this downstream flow, all the results of human inhabitation run into the ocean. Human inhabitation includes farms and developed lands, and as the land is farmed and developed more, there is less land to absorb and filter the water. Restoration efforts have made modest ecological gains, but they have been largely offset by rapid population growth. Agriculture and developed land are one of the land use classifications that are used to study the health of the bay.

29. Click ADD.
30. Select a map. Select NY.
31. Click ADD.
32. Click on the bay part of New York and copy the percentages and add to your text box.
33. Repeat steps 28-30 for the other six states.
34. Click SAVE in the upper right corner.
35. Click VIEW LIVE to review your story map.

Wayback Imagery:
Fluctuating Lakes

Lake water levels fluctuate. The fluctuation of lakes depends on both the time of the year and the global decline of water. You have been tasked with presenting imagery from the past 5 years to show the fluctuation of the following lakes:

- Poyang Lake, China

- Lake Faguibine, Mali

- Aral Sea (South Aral Sea), Karakalpakstan

- Lake Assal, Djibouti

Build skills in these areas

➤ Use temporal images

➤ Make a Swipe Story Map

➤ Use a URL in a Story Map

What you need

➤ Account required

➤ Estimated time: 30 mins

Publication Date: November 2018

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Use World Imagery Wayback App

Wayback imagery is a digital archive of the World Imagery basemap, enabling users to access different versions of World Imagery captured over the years. Each record in the archive represents World Imagery as it existed on the date new imagery was published. Wayback currently supports all updated versions of World Imagery dating back to February 20, 2014.
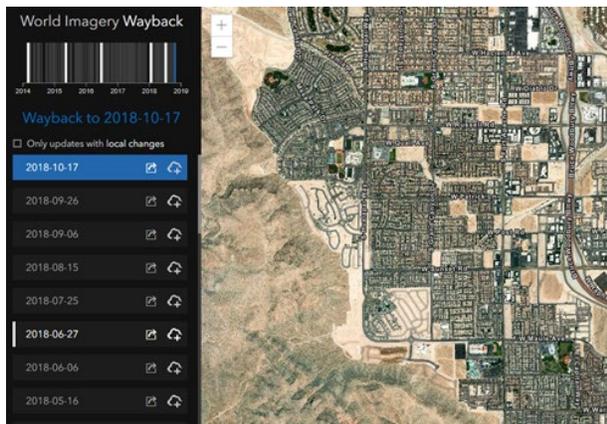
Find available temporal images of Poyang Lake, China.

1. Open World Imagery Wayback App.
2. Search for Poyang Lake, China in the upper right location tab.
3. Check on **Only updates with local changes**.
4. Click on the **Add this update to an ArcGIS online Map** next to each layer *(a checkmark will appear when it's selected)*.

5. Click the **Choose updates from the list to build a set of Wayback layers for use in a new web map** button on the top left corner of the interface. *(Looks like a cloud with the number of layers).*
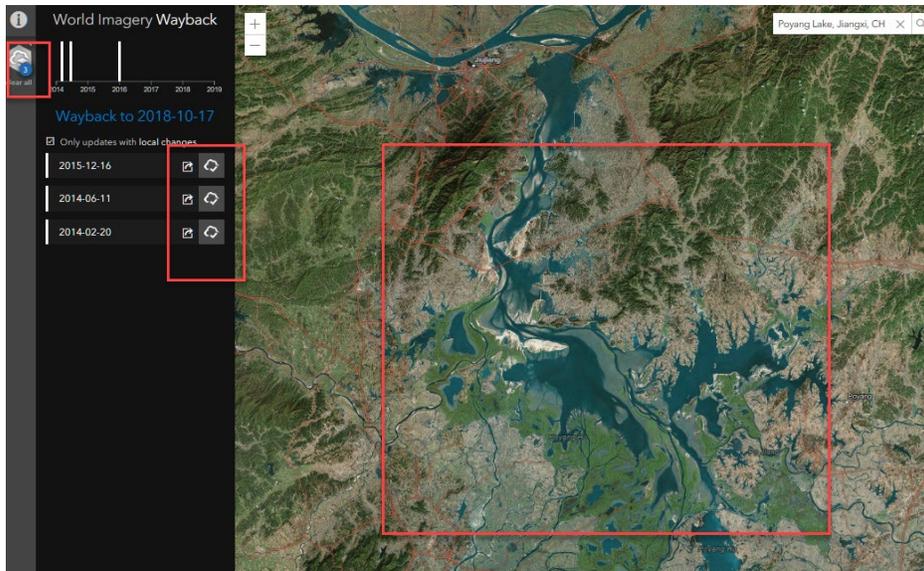
6. Sign in using your ArcGIS online account credentials.
7. If necessary, click **Choose Updates** again.
8. Add the appropriate metadata: Title, Tags, Description.
9. Create Wayback Map.
10. Open Wayback Map.
11. Sign into your ArcGIS account again.
12. Select images that are appropriate.

Tip: The layers load over top the Imagery basemap. Any layers that are the same as the basemap should be removed.

13. Remove **Wayback 2015-12-16** and **Wayback 2014_06-11.**
14. Save.

Note: The last image shown is usually the same as the Imagery basemap. If change is not visible do not add the date.

Wayback 2015-12-16 and Wayback 2014-06-11 seem to be nearly the same as the basemap. Since the latest image 2015-12-16 seems to be the same it has already been incorporated in the original basemap.

Constructing a Pre and Post Swipe Map

Compare images from 2014 to 2016

1. Turn on Wayback Image 2014.
2. Save the map as **Poyang 2014** with appropriate metadata.
3. Turn off Wayback Image 2014.
4. Save the map of just the original Imagery basemap, and title it **Poyang 2016** with appropriate metadata.
5. On the top ribbon click **Share**.
6. Click **CREATE A WEB APP**.
7. Click **Build a Story Map** >> **Story Map Swipe and Spyglass**.
8. Click **CREATE WEB APP**.
9. If necessary, add a Title: **Poyang 2014**
10. Add a summary description: **Comparison of 2014 and 2016 Poyang Lake**
11. Click **DONE**.
12. Choose **Vertical bar style** and **Next**.
13. Select the **Two web maps** option type.
14. For the Right Web map ID: select **Poyang 2014**.
15. Click **Next** >> **Next**.
16. **Open the app**.

Optional Task: Do some research on your own and add text describing each map.

17. Click **Save**.
18. Click **Share**.

19. Click **Preview.**

Poyang Lake is subjected to seasonal water-level fluctuations. These fluctuations are caused both the natural seasons and can be intensified by irrigation, drought and upstream development.
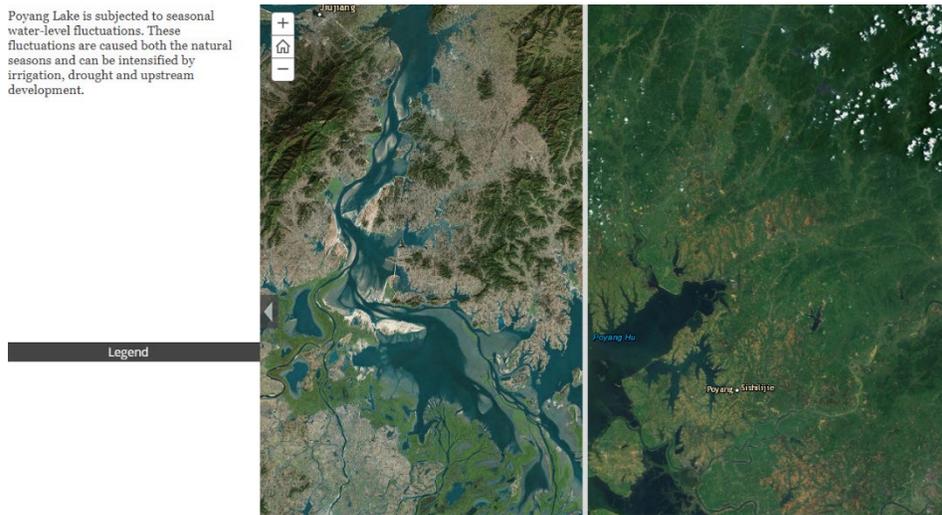
Combine Maps into a Cumulative Story Map

1. Following the above steps make a swipe story map for Lake Faguibine, Mali.
   a. Save the **Imagery with Labels** basemap which is 2015-12-16 as Faguibine 2015 and the 2014-02-20 Wayback as Faguibine 2014.
   b. Remove 2015-12-16 and 2014-06-11.
2. Following the above steps make a swipe story map for the Aral Sea (South Aral Sea), Karakalpakstan.
   a. Save Wayback image 2014-02-20 as Aral February and Wayback image 2014-06-11 as Aral June.
   b. Remove 2015-12-16.
3. Following the above steps make a swipe story map for Lake Assal, Djibouti.
   a. Save the **Imagery with Labels** basemap as Assal 2018 and the Wayback imagery 2015-12-16 and Assal 2015.
   b. Remove 1018-03-28, 2018-01-16, and 2018-01-18.

Now all four swipe story maps need to be combined into one tabbed story map.

1. Click the back arrow and go back to **Content**.
2. Click **Poyang Lake 2014-2016 web application**.
3. Open the web application and copy the URL.

4. Return to your Content page and click the **Poyang 2016 web map**.
5. Click **Poyang 2016**.
6. Click **Create Web App** >> **Using a Template**.
7. Click **Build a Story Map** >> **Story Map Series**.
8. Click **CREATE WEB APP**.
9. Add a title: *Fluctuating Lakes*
10. Add a summary: *Fluctuating Lakes of the World*.
11. Click **DONE** >> **Tabbed** >> **START**.
12. Click Blue Arrow.
13. Add a Title: *Poyang Lake 2014-2016*.
14. Select **Web Page** and paste the URL in the Web Page Link.
15. Click **Configure** and **Add**.
16. Click **Save**.
17. Repeat steps 16 and 17 for **Lake Fabuibine 2014 and 2015**.
18. Repeat steps 16 and 17 for **Aral Sea June and Aral Sea February**.
19. Repeat steps 16 and 17 for **Lake Assal, Djibouti 2015 – 2018**.
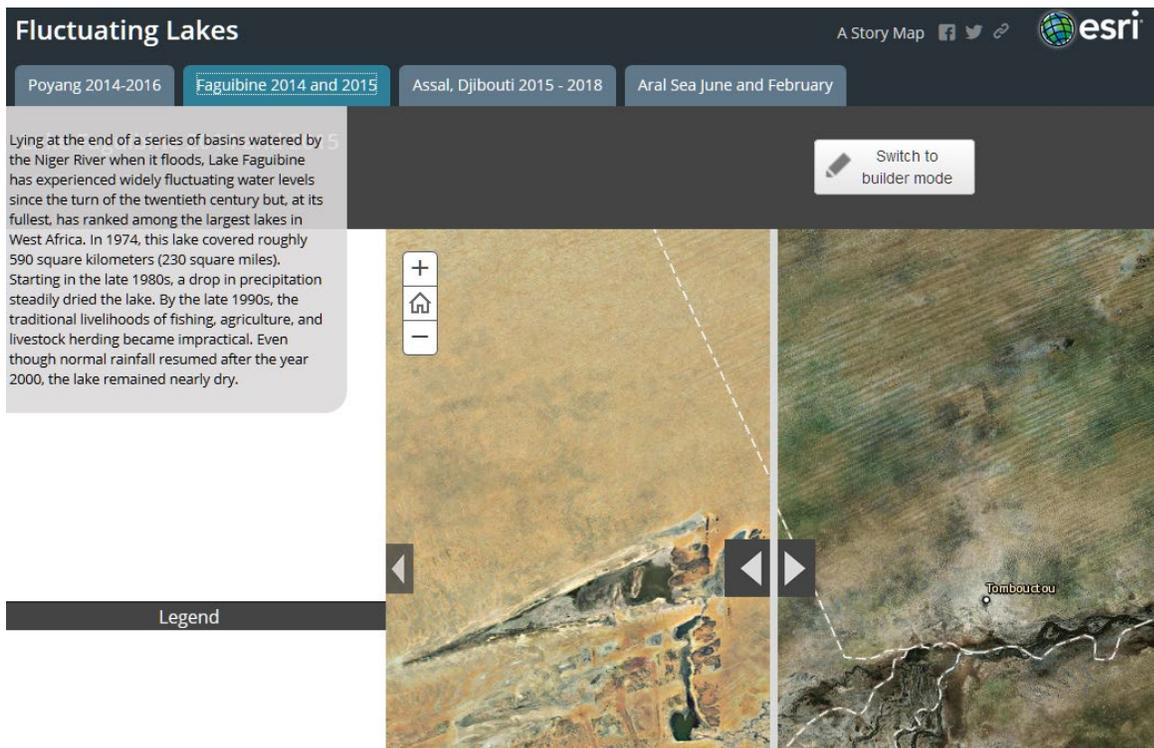
Learn more

Compare different places of change within your county or state using Wayback Imagery. Remember, it is for the last five years.

Using World Imagery Wayback by Bern Szukalski

Story Map Swipe and Spyglass Tutorial

Embedding a Story Map within a Story Map by Bern Szukalski

Understanding elevation and derivative layers

ArcGIS makes it easy to work with elevation data by offering a dynamic world elevation service (TopoBathy) and a specific land elevation (Terrain). These services provide online access to elevation data.

You have been asked to provide an online experience introducing users to elevation services. You are to provide instruction in the use of the TopoBathy and USA elevation services. Derivatives produced from the elevation services are to be included in your explanations.

Build skills in these areas

➢ Displaying world elevation and bathymetry
➢ Identifying various elevations of the world
➢ Displaying terrain
➢ Displaying and understanding slope
➢ Comparing slope to contour lines
➢ Displaying and understanding aspect
➢ Displaying and understanding hillshade

What you need

➢ Account required
➢ Estimated time: 30 minutes to 1 hour

1. World Bathymetry Display

The TopoBathy image service combines topography (land elevation) and bathymetry (water depths) around the world. Heights are based on sea level = 0, and bathymetric values are negative downward from sea level. Once again, the unit of height of measurement is meters.

1. Sign into your ArcGIS organizational account.
2. Click Map on the top Ribbon.
3. Click add and select Browse Living Atlas Layers.
4. Search for TopoBathy and Add to map as layer.

TopoBathy
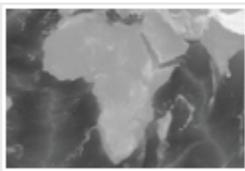
Add layer to map ▾

5. Zoom all the way out to see the land elevation and water depth.
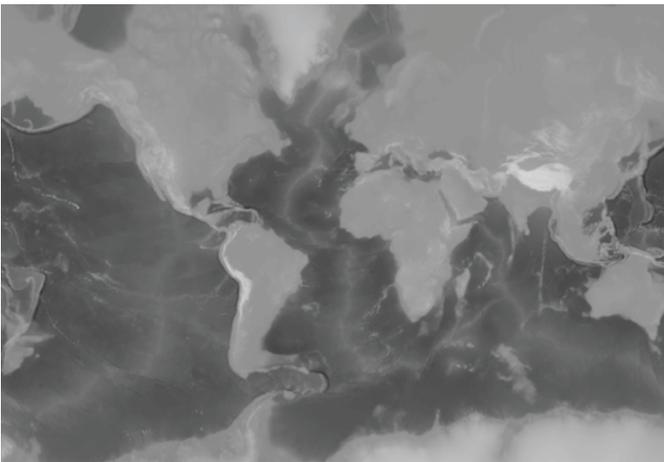
6. Uncollapse the legend in the contents pane.

Q1 What is the lowest and highest elevation shown on the imagery server?

7. Right-click TopoBathy and go to Image Display.
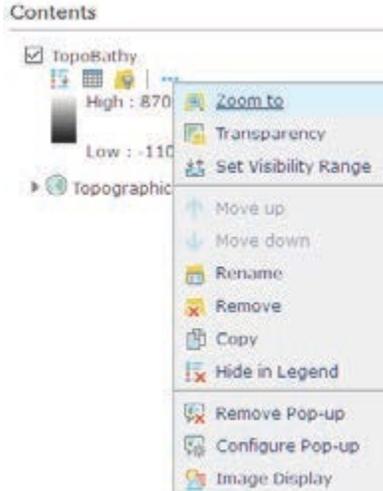
8. Select the following parameters to the Image Display Menu:
   a. Rendered is User Defined Renderer.
   b. Stretch Type is Minimum and Maximum.
   c. Check Dynamic range adjustment.
   d. For Color Ramp choose Purple to Green, Diverging Dark. This color ramp has been chosen so that the deepest place in the ocean is dark purple and the highest places on land are dark green.

9. Click APPLY.
10. Click CLOSE.

2. World Bathymetry: Structures

Using the TopoBathy image service you will now identify and mark various elevation structures on the map. All the following structures will be identified by searching and adding a map note marker. To learn how to add a map note, start by adding to the location where you live.

1. In the upper right corner, type your address and press Enter to go to a map of the designated location.
2. On the upper ribbon click Add and Add Map Note.
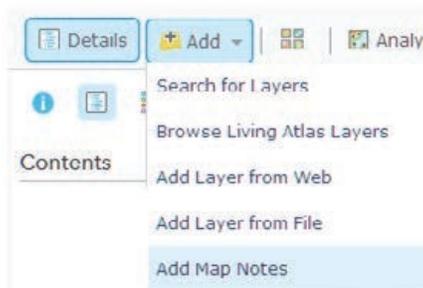
3. Click Add Map Notes:
   - Name is Home Address.
   - Template is Map Notes

4. Click CREATE
5. Pick the Pushpin and click the location. Use the following parameters:
   - Title is Home Location.
   - Description is Where I live.
6. Click CLOSE.
7. Repeat the process for the Highest Structure in the Ocean using a different type of map note.
8. Repeat the process for the Lowest Structures in the Ocean using a different type of map note.

9. Repeat the process for the Structures Below Sea Level on Land using a different type of map note.
   - Highest Structures
     - Mount Everest, Nepal
     - Aconcagua, Mendoza, Argentina
     - Denali, Alaska
   - Lowest Structures in the Ocean
     - Mariana Trench, Northern Mariana Islands
   - Structures Below sea level on land
     - Dead Sea, Jordan
     - Lake Baikal, Russia
     - Lake Eyre, Australia
10. Click Save on the upper ribbon.
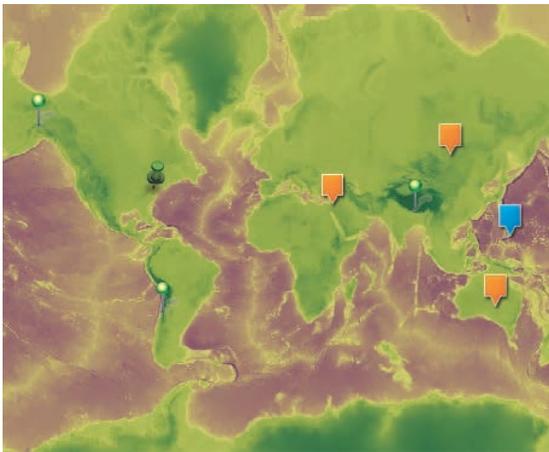
11. Complete the documentation for your map. Use the following parameters:
   - Title: Elevations Around the World
   - Tags: Add individualized tags
   - Summary: Location of High and Low Elevations Around the World

Save Map

Title:	Elevations Around the World
Tags:	elevation ✕ bathymetry ✕ kk ✕
	Add tag(s)
Summary:	Locations of High and Low Elevations Around the World
Save in folder:	

SAVE MAP   CANCEL

12. Click SAVE MAP.

3. Derivative of elevation: Slope, aspect, and hillshade from terrain

Using the dynamic surface Terrain, you can access elevation values for use in analysis with slope, aspect, and hillshade.

1. Click Create New Map in the upper right corner.
2. Click Yes Open the Map.
3. Go to Browse Living Atlas and search for and add the following layers:
   - Terrain
   - Terrain: Slope Map
   - Terrain: Elevation Tinted Hillshade
   - Terrain: Aspect Map
   - USA Topo Maps

Examine each layer separately.

4. Terrain gives you land elevation.
   - Right click terrain and to the Image Display
   - Stretch type is minimum and maximum
   - Pick a color ramp

5. Slope….The slope map provides a colorized representation of degree of slope. Flat surfaces are represented as gray, shallow slopes as light yellow, moderate slopes as light orange, and steep slopes as red-brown.

Q2 Where on the map is the greatest slope represented? Why?

6. Zoom into Washington State in the United States.

Q3 What are the cone-like features?

7. On the top ribbon, change basemaps to National Geographic.

Q4 What are the names of the cone-like features?

8. Turn on USA Topo Maps.

Q5 How do the contour lines represent the slope?

9. Turn off all maps but Terrain: Aspect.

The terrain layer provides a colorized representation
of aspect, generated dynamically using the server-side aspect function of the
terrain layer. The orientation of the downward sloping terrain is indicated by
different colors, rotating from green (North) to blue (East), to
Magenta (South) to orange (West). The numeric aspect values are represented
by values from 0 to 359 degrees and the values are shown in the image below.
Aspect is used in northern climates to show areas that would not receive as
much sun and would, therefore, stay cold and icy longer. Aspect is also used in
vineyard selection since a region's climate makes the aspect of the land
important.

10. Zoom into any part of the land and identify by color which direction the land is
    facing.

Many places on the map will give you a numerical value for the aspect if you click
on the map.

11. Zoom into Greenland since it is a good example of a landscape that shows
    distinct aspect.
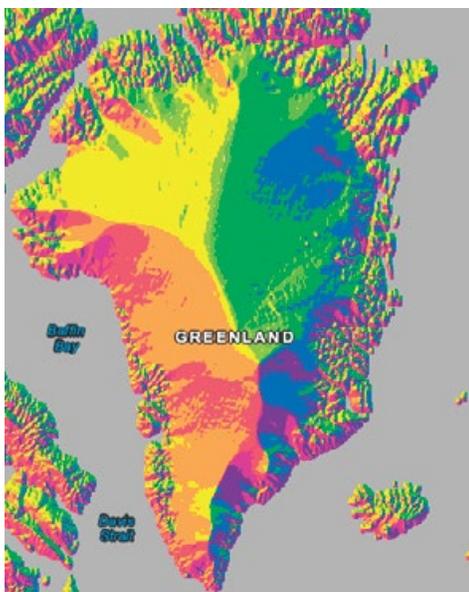
12. Turn on Terrain: Hillshade. Hillshade is a grayscale 3D representation of a surface based on a solar altitude angle of 45 degrees and solar aspect angle of 315 degrees. The map provides a quick indication of the shape of the terrain at a range of map scales.
13. Zoom to the West Coast of the United States.
14. Click and drag Terrain above Terrain: Hillshade.
15. Right-click Terrain and select Transparency.
16. Set the Transparency to 60 to give the Terrain layer a 3D look.
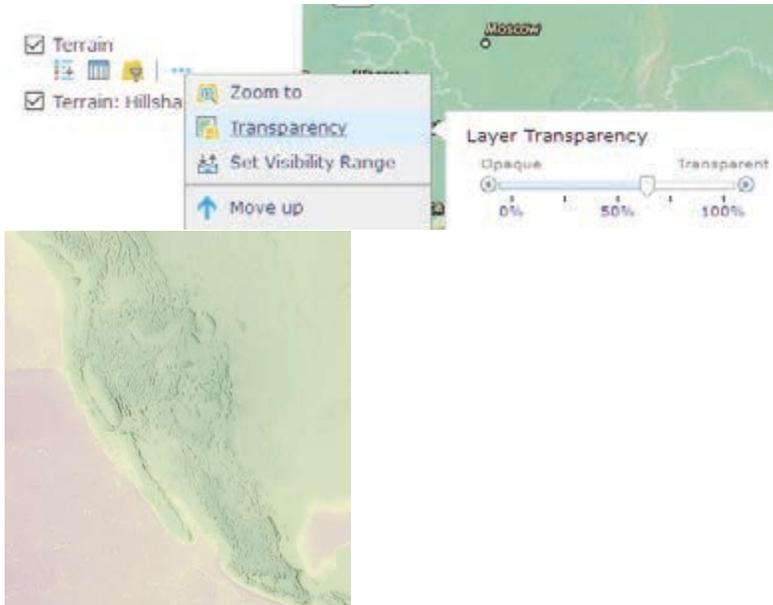
Q6 Write a paragraph description of Terrain, Slope, Aspect, and Hillshade.

The Power of Where

How spatial analysis leads to insight

Once data is mapped, a unique set of tools available in ArcGIS Online can be used to perform an analysis. These extensive spatial tools are the cornerstone of GIS and enable you to delve deeper into any project or inquiry before you. There are tools to summarize and aggregate data based on a geographic entity, network and locational tools, surface analysis tools, visibility analysis tools, tools that combine layers of data, and statistical tools, to list a few. They may sound out of reach to you now, but they are not. They are simple to engage, extend your reach, and enable you to answer questions and solve problems, faster and more accurately than almost anyone could do without them.

This chapter offers the opportunity to do the following:

- Create custom pop-ups.

- Use Arcade expressions to calculate values and label map features.

- Apply analytical spatial tools to select a location for a new hospital.

Use the questions at the end of this chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 5 of *The ArcGIS Book*.

Introductory activities

Videos

The opening video from the 2015 Esri International User Conference highlights the relationship of humans to their environment. It is followed by the ArcGIS Overview video which highlights the integration of GIS into a network of GIS users.

EsriUC 2015 opening video

EsriUC 2015 opening video

EsriUC **2015 Opening Video**. Get to know all the latest on **Esri ArcGIS** Platform.

2:57

ArcGIS Overview

ArcGIS Overview

esri

2:49

Activity

Discover your local green infrastructure assets using the Green Infrastructure app.
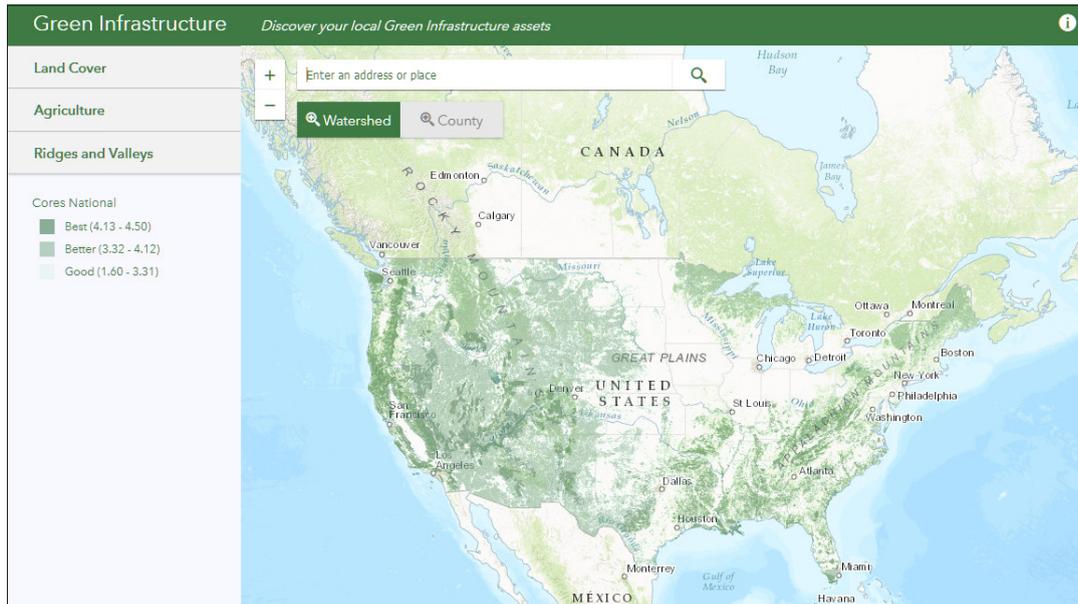
Esri has produced a set of tools and data to help communities protect the places and natural resources that help people, wildlife, and the economy thrive. Developing these tools has resulted in a GIS layer that defines habitat cores. A core is an area or patch of relatively intact habitat that is sufficiently large to support more than one individual of a species. In this activity, you will investigate a political boundary (your state) and derive information about the percentage of intact habitat core within your state boundary. You will then investigate your local county (political boundary). You will also record the ratio of how many more roads they are in relationship to streams within your state.

1. Search for the following places to navigate to designated states.

2. *Complete this table:*

Place/State	% Intact Habitat Core Area	Roads vs Streams (more roads than streams)	National Average (more roads than streams)
Phoenix, AZ			
Richmond, VA			
Albany, NY			
San Diego, CA			

Which of the designated states has the most intact core habitats. The least?
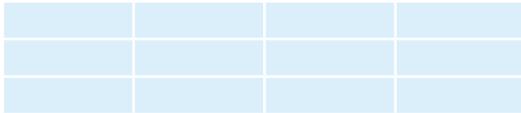
Why do you think Arizona has 8.4 times more roads than streams?

Compare two counties within your state.

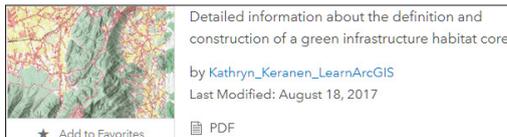|			

3. Zoom out until you can see your entire state.

4. Click the layer Land cover.

Write a description for the distribution of land in your state. What is the dominant land cover: agriculture? Urban? Forest?

Locating and mapping a local habitat core

With a green infrastructure strategy, communities work to preserve and connect open spaces, watersheds, wildlife habitats, parks, and other critical landscapes. Communities are trying to identify local valuable landscapes, prioritize which to protect, and plan connections within and beyond their boundaries. Your task is to look at your county and make recommendations as places where local habitat cores could be identified.

1. Go to Green Infrastructure Core Information.

2. Open and read the document.

Detailed information about the definition and construction of a green infrastructure habitat core.

by Kathryn_Keranen_LearnArcGIS
Last Modified: August 18, 2017

★ Add to Favorites   📄 PDF

What are the dimensions of a core habitat area?

What are other parameters to consider when defining core habitats?

3. Go to ArcGIS Online.

4. Click Map to create a new map.

5. Click Modify Map in the upper right corner.

6. Click Add and search for Intact Core Habitat Areas in ArcGIS Online.

7. Uncheck within map area.
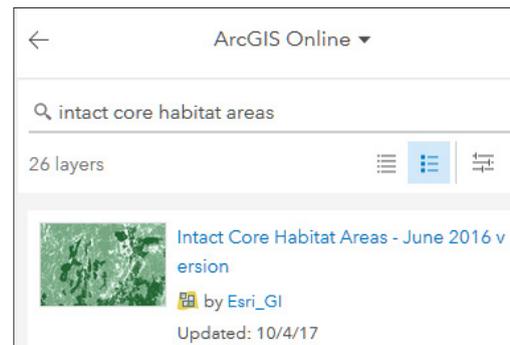
8. Click Add.

9. Click DONE ADDING LAYERS.

10. In the upper right corner in the Find address or place tab, search for your county.
    As an example: Loudoun, VA.

11. On the top menu ribbon click Basemap and change the Basemap to Imagery with Labels.

12. On the top ribbon click Manage Bookmarks (to the left of the search tab) and Select Add Bookmark.

13. Name the Bookmark.

Your assignment now is to zoom in and see if you can identify an area that would be a candidate for an intact habitat core. You must take in all the specifications you have read and then you must see if the area under consideration has a large enough area. After you have selected an area, you need to measure to see if it meets the 200 acres and 200 meters wide specification.

14. Carefully examine the area.

15. Select an area.

16. Click the Measure tool on the top ribbon:

- Click Area.

- Unit of Acres.
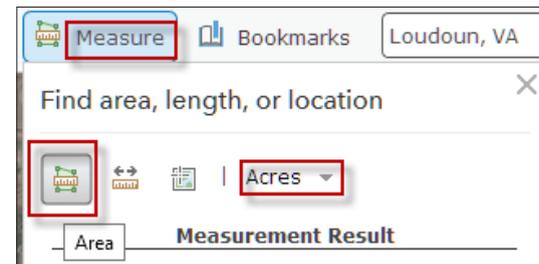
17. Click Area and click the map once for every vertex of the area you want to measure. Double-click to complete the area.

18. See if the area is 200 acres or more.

19. Click the Distance tool and measure to see if the area is 200 meters wide.

Write a paragraph or give an oral report about reasons that the core habitat area that you picked is appropriate.

The ArcGIS Book, chapter 5
Questions for reading comprehension, reflection, and discussion

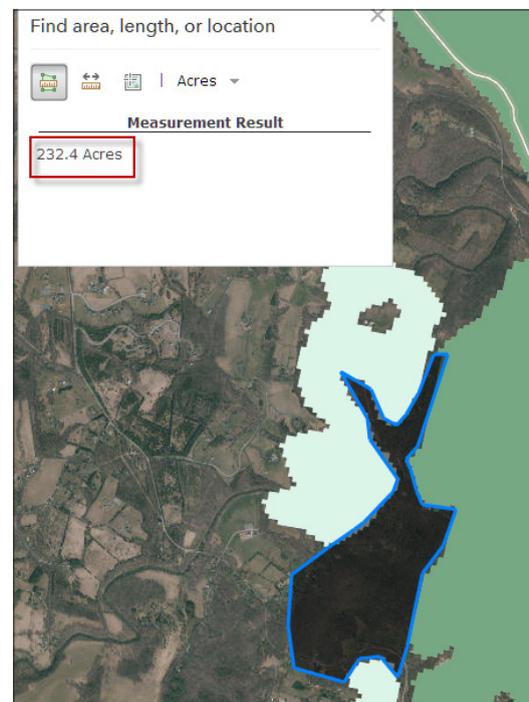Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

Geographic analysis

Write a paragraph explaining this statement: GIS is more than a map.

Give at least three examples where spatial analysis tools have been used to solve problems.

Visualization

What can my map show me?

Insights: Real-time exploration and analysis of maps and data

What is Insights for ArcGIS workflow?

Modeling: Using the language of spatial analysis

What is a typical modeling sequence?

Spatial problem solving: A conceptual framework

What are the steps of spatial problem solving?

Thought leader: Linda Beale—The challenge is making complex data understandable

Explain the specific role GIS plays in health analysis.

Learn ArcGIS: Guided lessons based on real-world problems

Track Crime Patterns to Aid Law Enforcement
Symbolizing data.
Determining proximity.
Summarizing data.
Creating heat maps.

Track Crime
Patterns to Aid
Law Enforcement
Help the Lincoln Police
Department allocate
resources to combat
crime.

Streamline Deliveries with Drive-Time Analysis

Creating drive-time areas.
Finding and modifying driving directions.
Saving routes as map layers.
Analyzing data with Esri's USA Tapestry Segmentation layer.

Streamline Deliveries with Drive-Time Analysis

Create delivery zones so Wok & Roll stays in business.

I Can See for Miles and Miles

Using spatial analysis to create viewsheds.

I Can See for Miles and Miles

Identify areas from which turbines on a proposed wind farm would be visible.

Analyzing a severe windstorm: Spatial analysis and emergency management

This section provides a real-life example of GIS being used for emergency management. You are tasked with creating maps that would be used by first responders or the public during an emergency. You will use symbolizing/classifcation and querying/filtering along with the geospatial tools of proximity and overlay.

To work on this lesson, you do not have to be logged in to an organizational account; however, if you're not, you cannot save your work. Here are some suggestions for how to deal with this:

- Block off a long period of time.
- Assess the work in parts.
- Take screenshots of your work to show completion to your instructor.

A derecho is a widespread, long-lived, straight-line wind storm that is associated with a land-based, fast-moving group of severe thunderstorms. At 10 p.m. on June 29, 2012, a derecho hit Fairfax County, Virginia. Within one hour, the county's Emergency Operations Center was activated and additional agencies from the public schools, facilities management, park authority, Virginia Department of Transportation, Dominion Power, and local phone companies were contacted. The Fairfax County GIS department was called to provide maps of the situation. These maps were to be made available online to first responders and the public. As a GIS analyst, you oversee a map that shows the following:

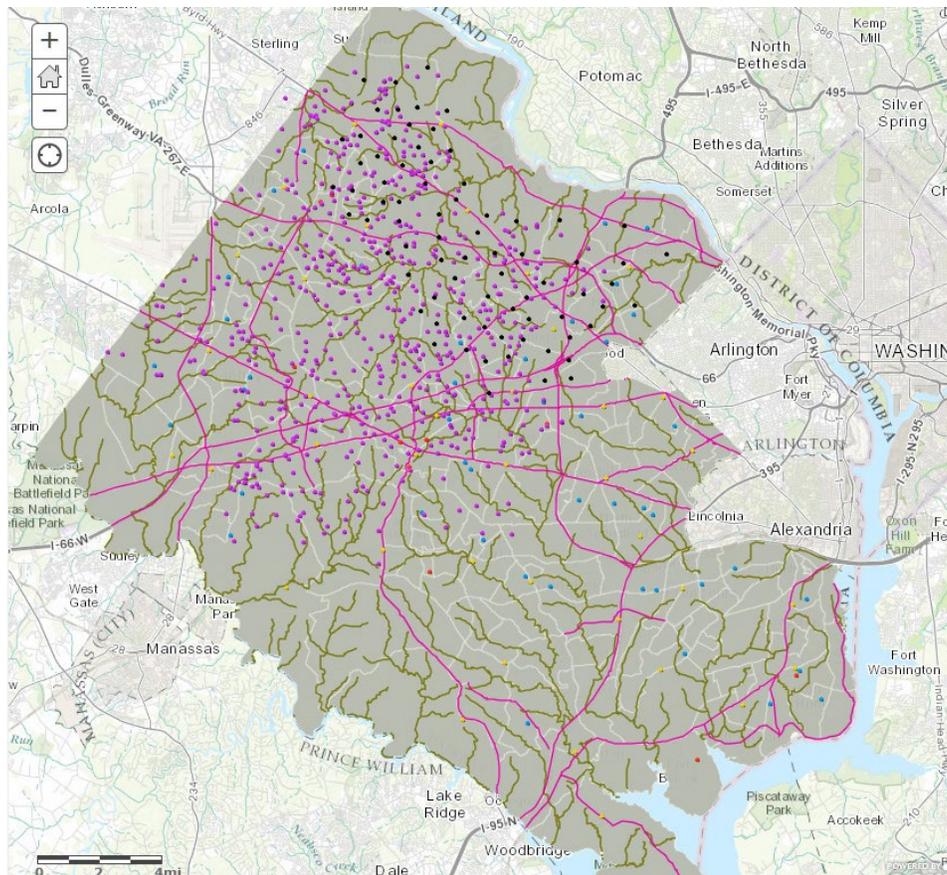- Census tracts displayed by population density
- Hospitals, schools, and fire stations symbolized
- Symbolized rivers and highways

Build skills in these areas

- ➤ Symbolizing
- ➤ Classifying
- ➤ Clearing map notes layers
- ➤ Using advanced filtering
- ➤ Generating a heat map
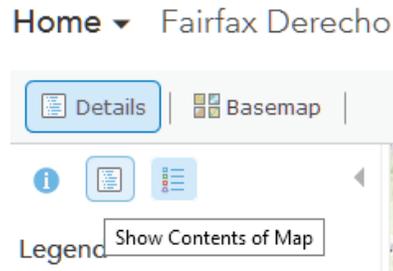
What you need

- ➤ Account not required
- ➤ Estimated time: 30 minutes – 1 hr

Publication date: February 21, 2019

2

1. Opening map and classification/styling

1. Open Fairfax Derecho.
2. Click Contents under Details on the top of the page to reveal the map layers available for your analysis

Home ▾ Fairfax Derecho

[Details] | Basemap |

Legend Show Contents of Map

3. Check Census Tracts to turn the layer on.

   The census tracts are shown as one color or by location only. The request from the Emergency Center was to display the census tracts by population density in 2010. This will show where there is the highest concentration of people. The attribute to choose is POP10_SQMI, which indicates the number of people per square mile in 2000.

4. Click Change Style under Census Tracts.

   ☑ Census Tracts

   Topogra| Change Style
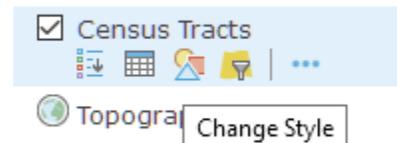
5. Choose POP10_SQMI for the attribute and click Counts and Amounts (Color).
6. DONE.
7. Click Census Tracts in the Contents pane to expand the legend.

Notice the density varies from 3,951 people per square mile to 0 people per square mile. You can see that there are sections of the county that have more people per square mile than others.
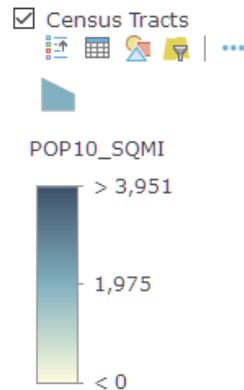
8. Click Census Tracts again to close the legend.

2. Symbolization

The map will be easier to read and interpret if it is symbolized correctly. Rivers, highways, schools, hospitals, and fire stations all need to be symbolized.

1. Uncheck the Census Tracts layer you have symbolized.
2. Check Rivers to turn on the layer.

The rivers first draw onto the map at an appropriate size. It would be better if the rivers were blue to indicate water.

3. Click Rivers and Change Style.
4. Click Options.
5. Click Symbols and choose an appropriate color.
6. OK,
7. DONE.
8. Repeat steps 3-7 for Highways.

You now need to symbolize schools, hospitals, and fire stations appropriately.

9. Turn on Schools and click Change Style.
10. Click OPTIONS.
11. Click Symbols.
12. Click People Places and choose a symbol to represent a school.
13. Change the Symbol Size to 12.
14. OK.
15. DONE.
16. Repeat steps 9-15 for hospitals. Look under the category Health for more symbols.
17. Repeat steps 9-15 for Fire Stations. Look under the category Safety Health for more symbols.
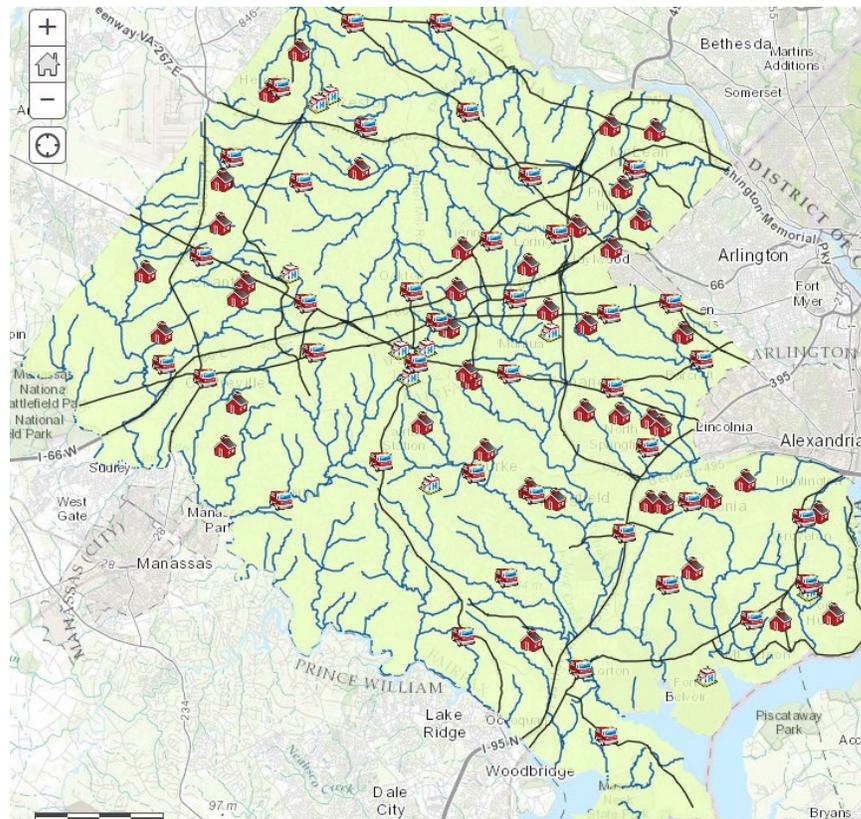
3. Queries to find highway intersections where live wires are down

It has been identified that live wires are down at the following intersections:

- Georgetown/Leesburg
- Leesburg/Dranesville
- Dolley Madison/Capitol Beltway

You need to first find the intersection and mark it with a map note.

1. Turn off by unchecking all layers except Fairfax County and Highways.

   Filter highways to identify the locations of the intersection. The first intersection to be identified is Georgetown and Leesburg.

2. Click Filter on the Highway layer.
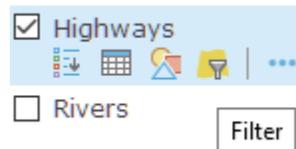
3. You need two expressions.
   - Name is Georgetown. You must click Unique.
   - Add another expression.
   - Name is Leesburg
   - Be sure the selection says: Display features in the layer that match **any** of the following expressions.

4. Click Apply Filter

Mark the location of the intersection with a map note.
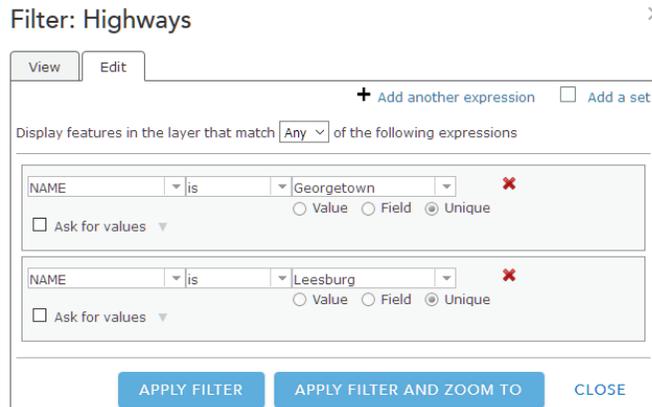
5. On the top of the page, choose Add and Add Map Notes.
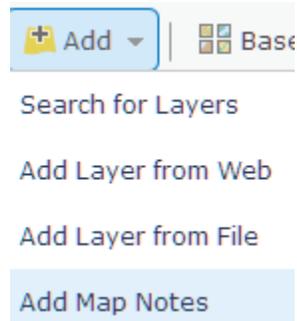
6. Name the Map Note Georgetown and Leesburg.
7. Click Create.
8. Choose the Pushpin and place it on the intersection.
9. Title: Intersection of Georgetown and Leesburg.
10. Description: Powerlines damaged and down.

11. Click Close.
12. Click Details.
13. Click Highways and Filter.
14. Click Remove Filter. The hidden roads appear.
15. Repeat steps 2-14 for the Leesburg/Dranesvile intersection. Remember Any.

16. Repeat steps 2-14 for the Dolley Madison/Capital Beltway. Remember Any.
17. Remove filter from roads before proceeding.

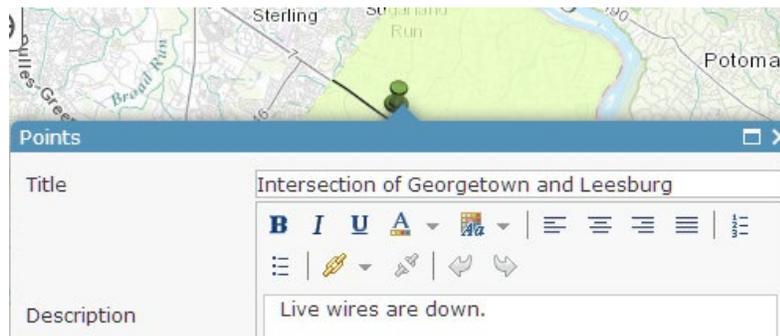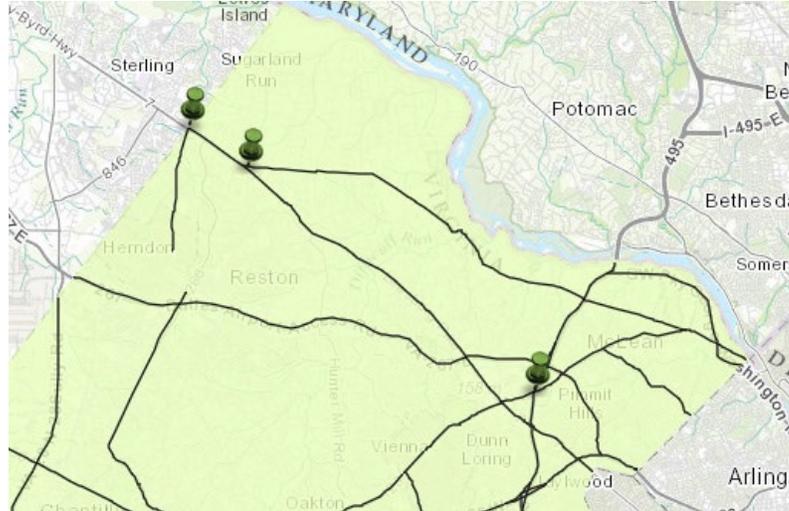# 4. Identification of deployed fire stations with a drive-time around 10 minutes each

1. Check Fire Stations.
2. Filter using the following expressions:

- Stations is Fox Mill.
- Station is Springfield.
- Station is Wolftrap.
- Check Any.

If you are not logged into an organizational account, you cannot perform an advanced analysis on drive-times. The drive-time area has been made, and all you do is check it to turn it on. A drive-time area is the area that can be reached with a specified drive-time. It is a proximity analysis.

3. Check Travel from Fire Stations (10 Minutes).

4. You might want to click Other Options and Move Fire Stations above the Travel from Fire Stations (10 minutes).
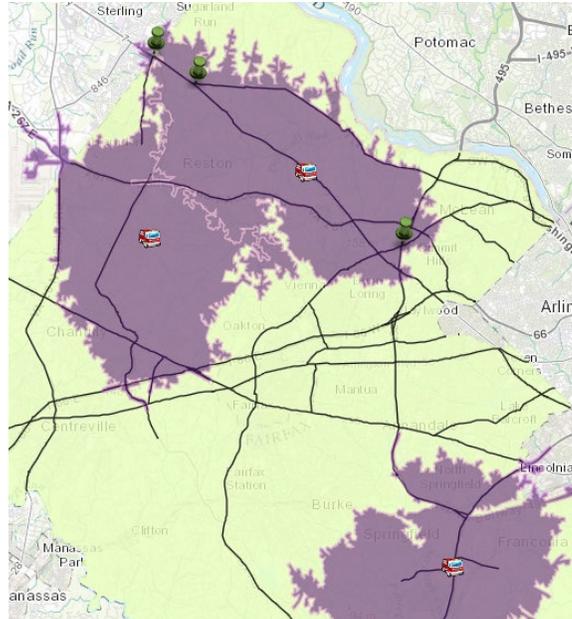
5. Locations of where roads cross rivers

1. Turn off all layers but Fairfax County, Highways, and Rivers.

   Intersect is one of the overlay geospatial analysis functions. Because all the layers are bound together geographically, these analytical functions work.

2. Turn on t... This layer shows where the high... ts will vary.

6. Continuous surface maps from point data

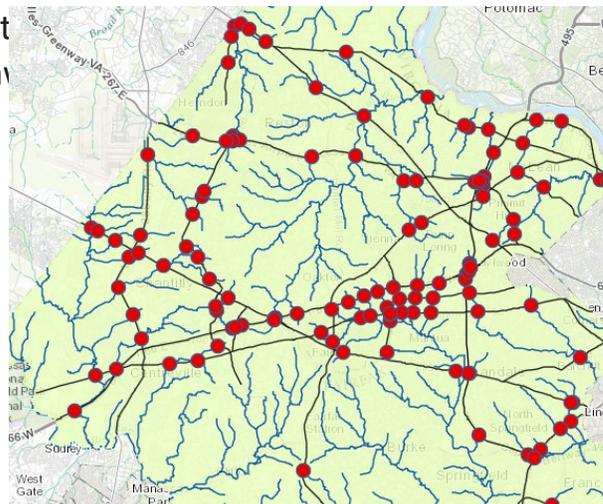The Command Center would like a continuous surface map made from both the phone outages and the power outages. Heat maps show an occurrence of a set of points as a continuous density surface. To produce the density calculation, a filter is applied to blur or smooth the surface representation, and it removes noise and unnecessary detail. A heat map has all the following characteristics:

- It is scalable.
- It has no units.
- No data is formed.
- It is not to be confused with temperature.

1. Uncheck all layers except Highways and No Power. The No Power layer represents areas that are without electrical power. To perform more analysis, you might want to turn other layers, such as hospitals and fire stations, on and off.
2. Click No Power and click Change Style.
3. Select Heat Map.

   A heat map represents the geographic density of features on a map.

4. Done.

You might want to change the Basemap to Imagery and turn on Hospitals, Schools, and Fire Stations. Notice that as you zoom in and out the heat map is scalable, allowing you to investigate the data at all scales.

5. Repeat steps 3 and 4 for Phone Outages.

In this lesson, you have created maps for first responders by using a variety of GIS skills: symbology, classification, filtering, and proximity.
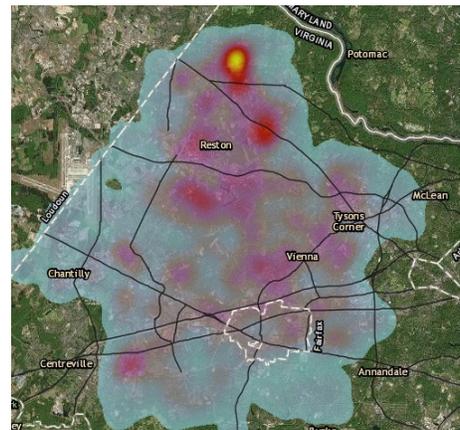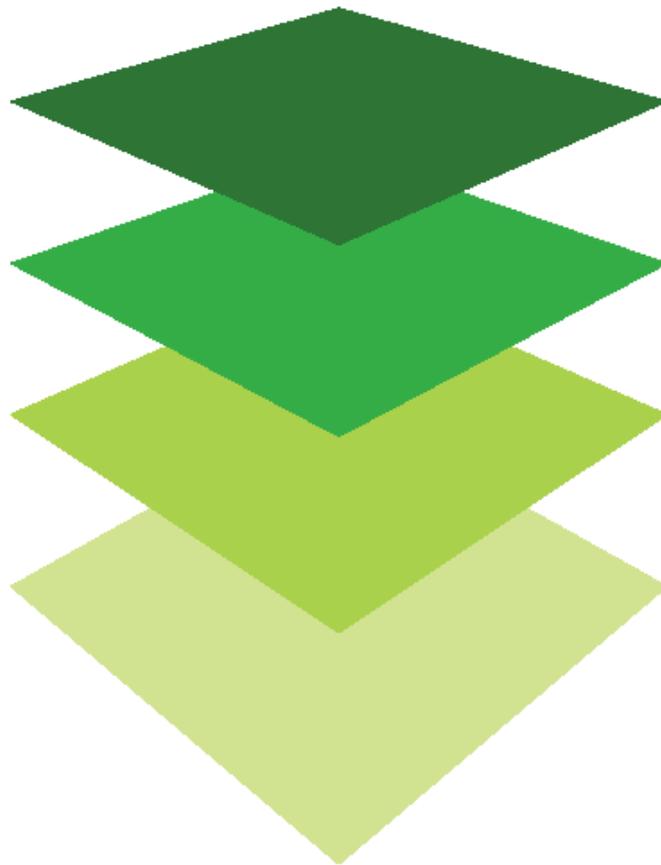
Climbing high
Custom pop-ups

A map can show descriptive information about features configured to display in a pop-up. Pop-ups can bring to life the attributes associated with each feature layer in a map. You can show images and can link to external web pages. As a map owner, you can reconfigure the pop-ups to define the list of visible fields and how to present information. Instead of manually typing in every pop-up, you can use a custom expression to modify a list of field attributes, choose contents from a single field for display, or remove the attributes altogether. In this lesson, you will configure pop-ups from a text file using information, links, and images.

The information for the following lesson has been obtained from the Daily News Dig, which in turn used Wikipedia: List of highest mountains on Earth.

The International Climbing and Mountaineering Federation has hired you as a GIS specialist to create an interactive map of the 10 highest mountains. The federation has asked that you identify the following information about each mountain:

- Name of Mountain
- Range
- Elevation
- Image of Mountain

Build skills in these areas

➢ Adding a text file
➢ Configuring pop-ups using a custom attribute display
➢ Configuring pop-ups with images
➢ Researching and adding information to a text file

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

esri | THE SCIENCE OF WHERE™

1. Open and save a map

1. Sign into your ArcGIS organizational account.
2. Click Map on the top ribbon to create a new map.
3. Click Show Contents of Map under Details.
4. Zoom all the way out to a world view.
5. Change the Basemap to Terrain with Labels.
6. On the top ribbon go to Save As.
7. Save your map with the following information:
   a. Title: Climbing High_yourinitials.
   b. Tags: Remove tags and add individualized tags
   c. Summary: Information about the 10 highest mountains in the world to climb
8. Click SAVE MAP.

2. Add a new CSV file

You can add layers to a map by importing data that has been saved in a delimited text file (.csv or .txt). The delimited text file with location must have either latitude-longitude or address information. For this lesson, latitude-longitude will be used.

A table has been prepared that has the following fields:
Lat   latitude
Lon   longitude
Name   name of the mountain
Range   parent range of mountain
Elev_ft   elevation in feet
Thumb_url   URL of a thumbnail of an image of the mountain
Photo_credit   URL to the location of the source of the photo

Notice that the latitude and longitude are expressed in decimal degrees and that there are no spaces after each comma.

1. Copy the information below that has been researched and prepared.

lat,lon,name,range,elev_ft,thumb_url,photo_credit
27.9879,86.9250,Mt.Everest,Himalayas,29029,http://dailynewsdig.com/wp-content/uploads/2014/08/Mount-Everest-Highest-Mountains-In-The-World.jpg,http://dailynewsdig.com/highest-mountains/
35.8825,76.513333, K2Qogir,Karakoram,28251,http://dailynewsdig.com/wp-content/uploads/2014/08/K2-Highest-Mountains-In-The-World.jpg,http://dailynewsdig.com/highest-mountains/
27.7025,88.1475,Kangchenjunga,Himalayas,28169,http://dailynewsdig.com/wp-content/uploads/2014/08/Kangchenjunga-Highest-Mountains-In-The-World.jpg,http://dailynewsdig.com/highest-mountains/
27.9626,86.9336,Lhotse,Himalayas, 27940, http://dailynewsdig.com/wp-content/uploads/2014/08/Lhotse-Highest-Mountains-In-The-World.jpg,http://dailynewsdig.com/highest-mountains/
27.8860,87.0912,Makala,Himalayas,27766,http://dailynewsdig.com/wp-content/uploads/2014/08/Makalu-Highest-Mountains-In-The-World.jpg,http://dailynewsdig.com/highest-mountains/

2. Past it into any application where it can be saved as a text or a CSV file (Notepad++ or Microsoft Office is the most commonly used software).
3. Save the file and name it mountains.
4. Click Add from the top menu and go to Add from File.
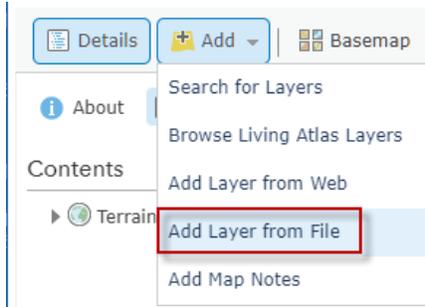
5. Choose File. Navigate our computer and find the mountain.txt file that you saved above.
6. Click IMPORT LAYER.

7. Click Types (unique symbols)>>OPTIONS.
8. Click the three bars by COUNT.
9. Change the Symbol Size to 30.
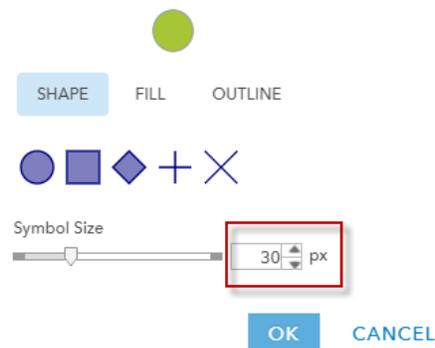
10. Click OK.
11. Click OK.
12. Click DONE.
13. Click Save.

You can see four of the five mountains distinctly. Zoom into see the mountains that are close together.
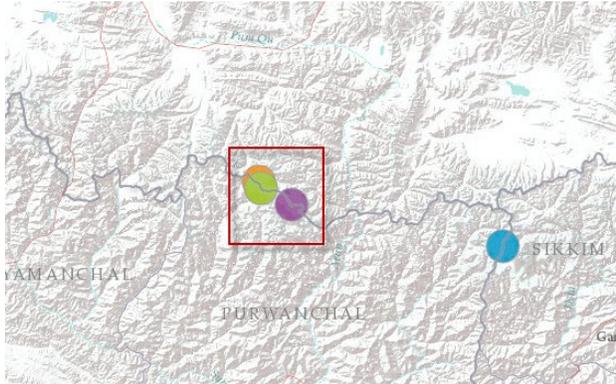
3. Configure custom expression attributes

In this section, you will use the Custom Attribute Display to enter a combination of free text and fields chosen from the drop-down list. The pop- up will be customized to show the name of the mountain, the range, and elevation of the mountain.

    1. Click More Options at the end of mountains layer.
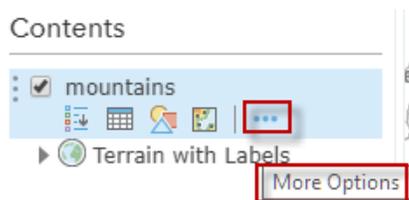
2. Select Configure Pop-up.
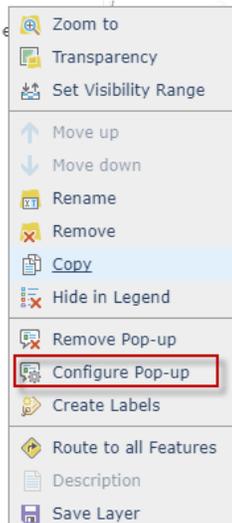
3. Choose A custom attribute display.
4. Choose CONFIGURE.
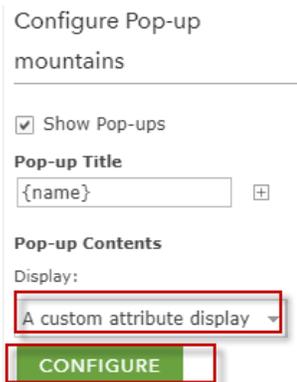
5. In the Custom Attribute Display window you can add a combination of free text and fields chosen from the drop-down list.

This is the expression that you are constructing.

{name} is located in the {range} range and has an elevation of {elev_ft} feet.

Custom Attribute Display

Use the area below to define, format, and lay out the information you want to display.

B *I* U A ▾ ▤ ▾ | ≡ ≡ ≡ ≡ | ≣ ≣ ⇥ ⇤ | ✎ ▾ ✦ ▣ ▾ ✎ | ↩ ↪ |

Font [＿＿＿＿＿ ▾] Size [x-small ▾] ⊞

{name} is located in the {range} range and has an elevation of {elev_ft}.
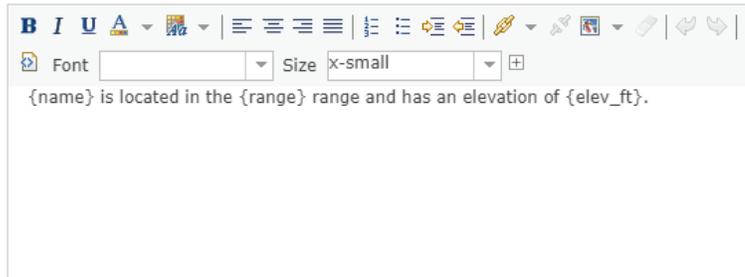
OK   CANCEL

6. Click OK.

This is how the pop-up appears when opened.

□ ✕

Kangchenjunga

Kangchenjunga is located in the Himalayas range and has an elevation of 28,169 feet.

Zoom to   Get Directions   Edit

7. Save the map.

4. Configure media: images with photo credit

Finally, you want to construct your pop-up to display an image and a photo credit for the image.

1. Go to Configure Pop-up on the mountain layer.
2. Under Pop-up Media click Add.
3. Scroll down toward the bottom of the pop-up configuration.

4. Add Image.
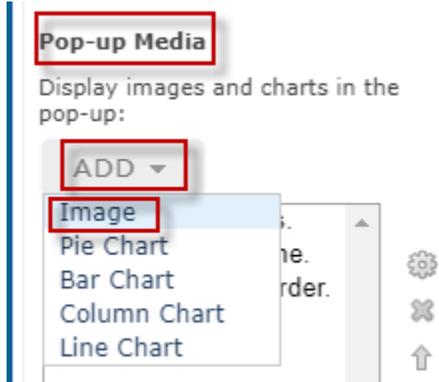
5. Click Image and open the Image menu.
6. Delete the Title.
7. Add the (thumb_url) to both the URL and the Link.
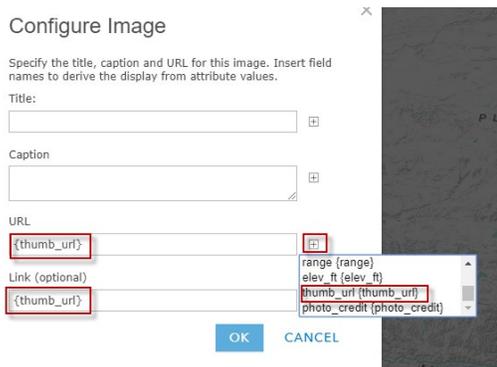
8. Click OK.
9. Click CONFIGURE.
10. Add Photo Credit from the drop down.
11. Copy (photo_credit). (Refer to image below for visual directions.)
12. Click the Link button to create a link and set its properties.
13. Paste (photo_credit) field name in the URL tab.
14. Type Photo Credit in the Link Text.
15. Click Set.
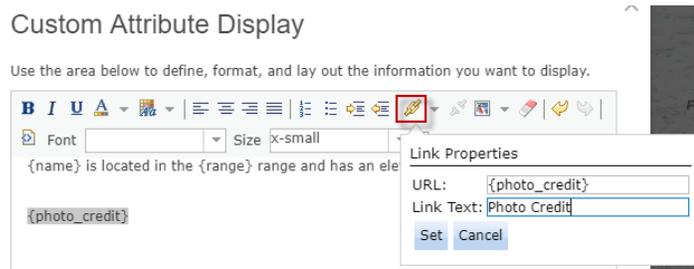
16. Click OK.
17. Test the Photo Credit link.
18. Click Save.

When the pop-up is opened, a thumbnail of the image is available that can be tapped to reveal the larger image, and the link to the photo credit is available.

K2Qogir

K2Qogir is located in the Karakoram range and has an elevation of 28,251 feet.

Photo Credit

Zoom to   Get Directions   Edit

5. Assessment: Research and add information to the preexisting mountain text file

For the last part of the exercise, you need to research and add the required information about the 5 remaining of the 10 highest climbing
mountains. You can use the
but do not feel limited to this one resource. You need to find the information about the last five mountains:
Cho Oyu
Dhaulagiri
Manaslu
Nanga Parbat
Annapurna

Creating thematic maps with hexagons
Analyze Toxic Release Inventory

The most common shape type in GIS analysis and thematic mapping is the grid. Over the past few years, the hexagon has become increasingly popular. There are several advantages to using hexagons. Read more about the increasing use of hexagons and their advantage at Why hexagons? Esri has provided a series of hexagons called hexbins that can be accessed for aggregating and summarizing spatial data in the Living Atlas of the World. Individual published layers of hexagons can also be generated. Hexagons are useful in displaying data that has many overlapping points.

Build skills in these areas

➢ Aggregating point data
➢ Using hexbins from the Living Atlas of the World
➢ Enriching data
➢ Using an individual published hexagon layer
➢ Filtering data

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

Scenario #1: Analysis of Toxic Release Inventory

The Toxic Release Inventory (TRI) is a listing of US facilities that have certain toxic chemicals that may pose a threat to human health and the environment. The Environmental Protection Agency has asked for a visualization of the TRI sites that produce or have produced carcinogens. You have the point data, but many of the points are overlapping, which makes it hard to visualize patterns and clusters in the data. You have decided to use hexbins to visualize the data and have decided on a 10 km resolution hexbin.

1. Open and save the map

1. Sign into your ArcGIS organizational account.
2. Open USA TRI Carcinogens.
3. Click Content.
4. On the top ribbon click Save As.
5. Save the map with the following parameters:
   a. Title: USA TRI Carcinogens
   b. Tags: Use individualized tags
   c. Summary: Toxic release sites within the USA

Save Map

Title:	USA TRI Carcinogens
Tags:	IGARC2_TRI_yourinitials ✕ Add tag(s)
Summary:	Toxic release sites within the USA
Save in folder:	▾

SAVE MAP   CANCEL

2. Aggregate TRI points within 20 km hexbin

1. Click perform analysis under the feature TRI USA carcinogen.
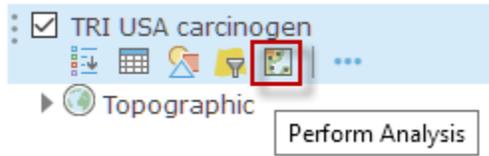
2. Click Summarize Data>>Aggregate Points.

Using a layer of point features (TRI USA carcinogens) and a layer feature (hexbin), this tool determines which points fall within each area and calculates statistics about all the points with each area. The layer hexbin will be obtained from the Living Atlas of the World.

Aggregate Points

Using a layer of point features and a layer of area features, this tool determines which points fall within each area and calculates statistics about all the points within each area. For example:
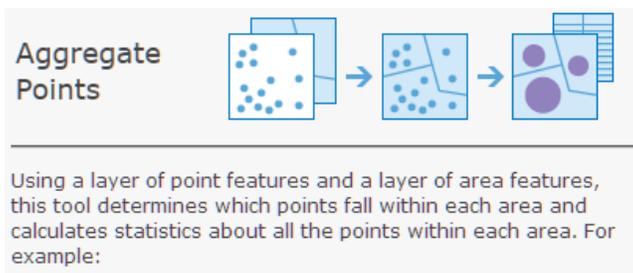
3. Click Aggregate Points.
   a. TRI_USA carcinogen is the layer containing points to aggregate into areas.
   b. Choose Living Atlas Analysis Layer in the Choose layer containing aggregation areas. You will find this on the drop-down menu under Choose the polygon layer.
      o Click Hexbins
      o Choose North America Hexbins 25 km.
   4. Uncheck Use current map extent.

3
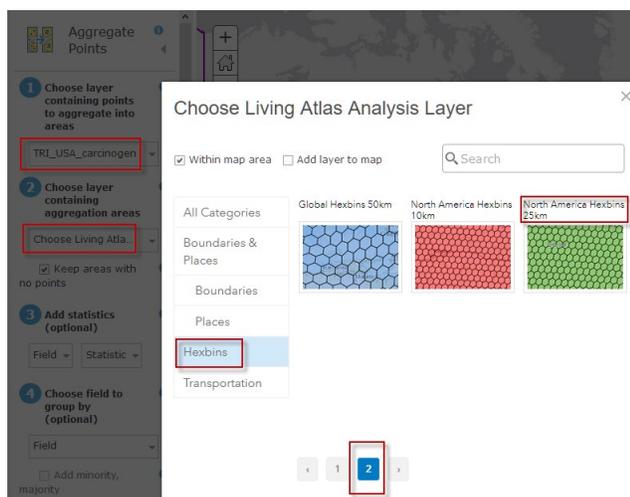
5. Uncheck Keep areas with no points.
6. Uncheck Use current map extent.
7. Before running analysis, check number of credits used and validate that you have enough credits to do this analysis.
8. Click RUN ANALYSIS.
9. Check off the TRI USA Carcinogen layer.
10. Click Change Style under Aggregation of TRI USA carcinogen to North Ameirca Hexbins 25 km.
11. Choose an attribute: Count of Points.
12. Select Counts and Amounts (Color).
13. Click OPTIONS.
14. Select Symbols.
15. Choose a dark red to light red ramp.
16. Change the basemap to Dark Gray Canvas to make the symbols pop.
17. Click OK.
18. Click DONE.
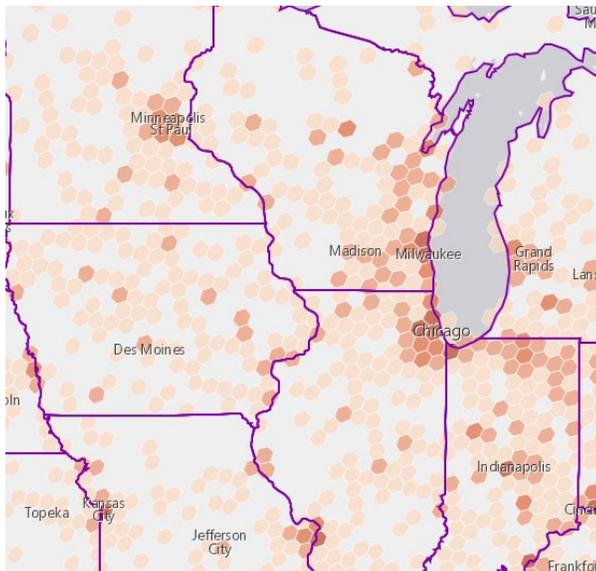
3. Interpret the data

1. Move USA States (Generalized) above the aggregation of TRI USA.
2. Zoom in and around the US.

Q1 Which states seem to have the highest concentrations of TRI sites?

Q2 What layers could you add to enhance your observations?

Scenario #2: Enrich hexagons with health insurance data

Kaiser Permanente Health Care Organization is proposing to bring its quality care affordable health plan to the state of South Carolina. Kaiser has asked you to construct a map showing the population that has health care within South Carolina.

4. Open and save a map

1. Open Hexagon Health.
2. Sign into your ArcGIS organizational account.
3. On the top ribbon, click Save As.
4. Save the map with the following parameters:
    a) Title: Hexagons Healths_yourinitials
    b) Tags: Use individualized tags.
    c) Summary: Representative hexagons for the USA.

Save Map

Title:	Hexagons Healths_ youriniatials
Tags:	IGARC2_health_yourinitials ✕
	Add tag(s)
Summary:	Representative hexagons for the USA.
Save in folder:	▼

SAVE MAP   CANCEL

5. Filter South Carolina

1. Click Content.
2. Click Filter under Hexagons.

Contents
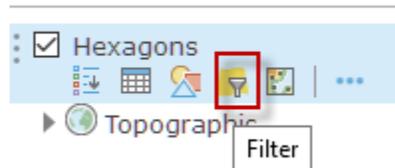
3. Construct the expression: STATE_ABBR is SC

Filter: Hexagons
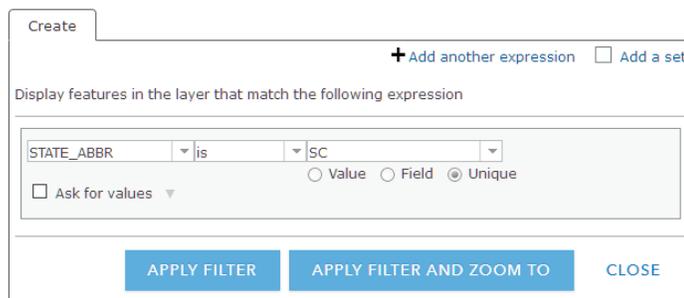
4. Click APPLY FILTER. The hexagons for only South Carolina are selected.

5. Click Analysis on the top ribbon.
6. Click Data Enrichment.
7. Click Enrich Layer. Be sure that United States is selected in the upper corner box.
8. Click SELECT VARIABLES.
9. Click Population.
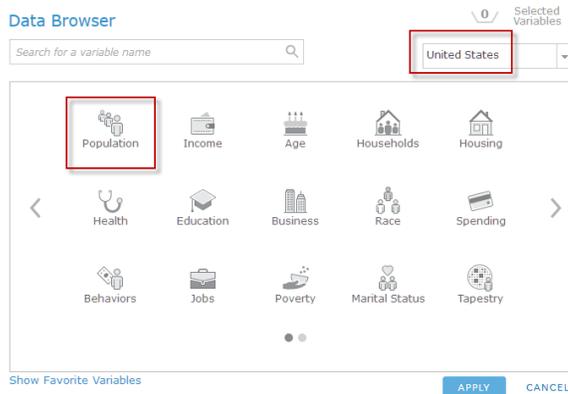
10. Select 2017 Total Population (Esri).
11. Click Back.
12. Choose Health.
13. Select 2017 Health Insurance.

14. Click APPLY.
15. Uncheck use current map extent.
16. Add your initials to the Result layer name.
17. Check credit usage.
18. Click RUN ANALYSIS.

6. Normalize and symbolize the data

1. Select Change Style under Enriched Hexagons.
2. Choose an attribute to show select Health Insurance.
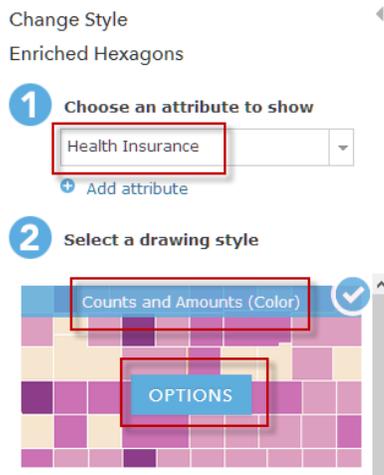
3. Select Counts and Amounts (Color).
4. Choose OPTIONS.

The colors that you see on the map in South Carolina represent the number of people insured. To obtain the percentage of residents that are insured, you must divide the number of people by the total population. That will give you a more realistic interpretation of the data.

5. The default is Divided by NONE. Use the drop-down menu to select Divided by 2017 Total Population.

6. Click Symbols and choose a dark red color ramp.
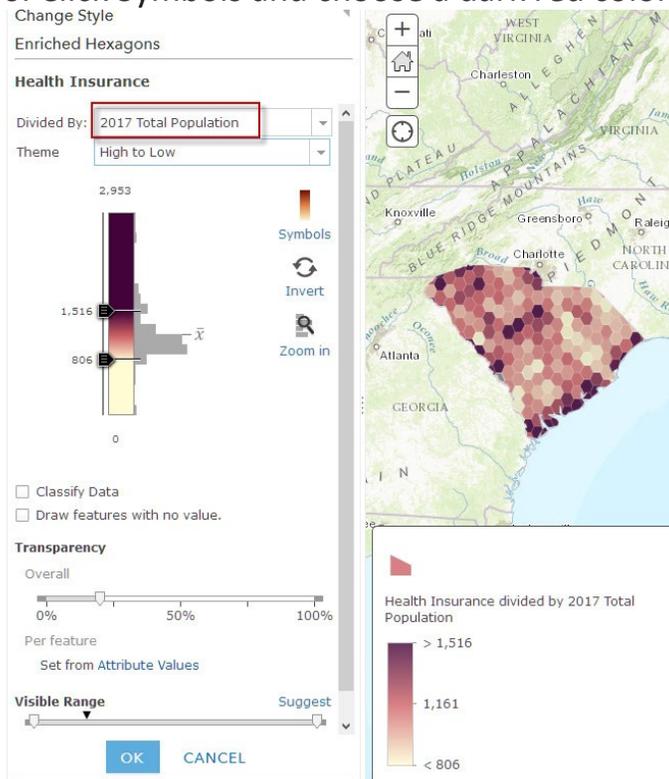
7. Click OK.
8. Click Done.

7. Interpret the data

Q3 What parts of South Carolina have the largest percentage of people with insurance?

8. Assessment

Repeat the above process using your state or, if you live in South Carolina, another state that interests you.

Introducing ArcGIS Arcade expressions

Calculate percentage unemployment Show population increase and decrease 2010-2017

The December 2016 release of ArcGIS Online introduced the ability to use Arcade expressions. You now can perform calculations and map data without creating a field in the source data.

In preparation for the 2020 election, both Democrats and Republicans have asked for maps of county unemployment and maps of where counties have lost population. They want to use these maps to strategize their campaign stops.

Build skills in these areas

➢ Creating an Arcade expression for calculation
➢ Creating an Arcade expression for labeling

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

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1. Open and save a map

1. Sign into your ArcGIS organizational account.
2. Open USA Unemployment and Population Change.
3. On the top ribbon click Save As.
4. Save the map with the following parameters:
   a. Title: USA Unemployment and Population Change_youninitials.
   b. Tags: delete tags and add individualized tags.
   c. Summary: Using arcade expressions to explore % unemployment and rate of population change.

Save Map

Title:	USA Unemployment and Population Change-Copy
Tags:	IGARC2_arcade_yourinitials ✕
	Add tag(s)
Summary:	Use of arcade expressions to show percent unemployment
Save in folder:	▾

SAVE MAP   CANCEL

2. Create percentage unemployment arcade Expression

You are trying to calculate the percentage of unemployment in each county of the United States.

1. Open the table of Unemployment and Population in the USA.
2. Click Contents.

Unemployment and Population in the USA (Features: 3142, Selected: 0)   ☰ ✕

E	STATE_NAME	FIPS	Total Population in 2017	Unemployed in 2017	Total Population in 2010
om	North Dakota	38073	5,642	81	5,465
bon	Iowa	19009	5,996	11	6,180
a Lakota	South Dakota	46102	14,137	1046	13,596
e	Idaho	16015	7,155	206	7,028

Q1 What attributes are available to use?

3. Close the table by clicking the X on the right corner.
4. Open the Change Style icon under the Unemployment and Population in the USA feature and for the attribute to show choose New Expression.
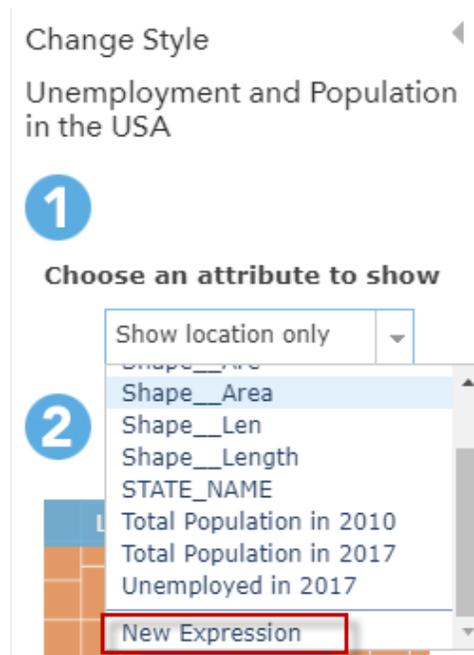
When you click New Expression, a scripting window appears alongside a list of the layers' attributes and their aliases. The scripting window is where you will write your expression. Your manager has requested a map that shows percentage of unemployed. The formula for fnding percentage unemployed would be: (unemployed/total population)*100

Using an Arcade expression, the syntax changes as follows:

($feature["UNEMPLY_2017"]/$feature.TOTPOP2017)*100

5. Using the list of formatted fields, build your Arcade expression to match the one above.
6. Click on Test.

The result is correct but there are 16 unnecessary decimal places when you examine the legend. You need to round the expression to 2 decimal places. Try adding the Round function.

7. Type:

   Round(($feature.UNEMPLY_2017/$feature.TOTPOP2017)*100,2)

   When you examine the legend, the decimal places area less.

8. Change the name Custom at the top of the New Expression window by clicking Edit and typing %Unemployed 2017.

% Unemployed 2017	Save

9. Save.
10. OK.
11. Click Change Style.
12. Choose an attribute to show: %Unemployed.
13. Click Counts and Amounts (Color).
14. SELECT.
15. DONE.
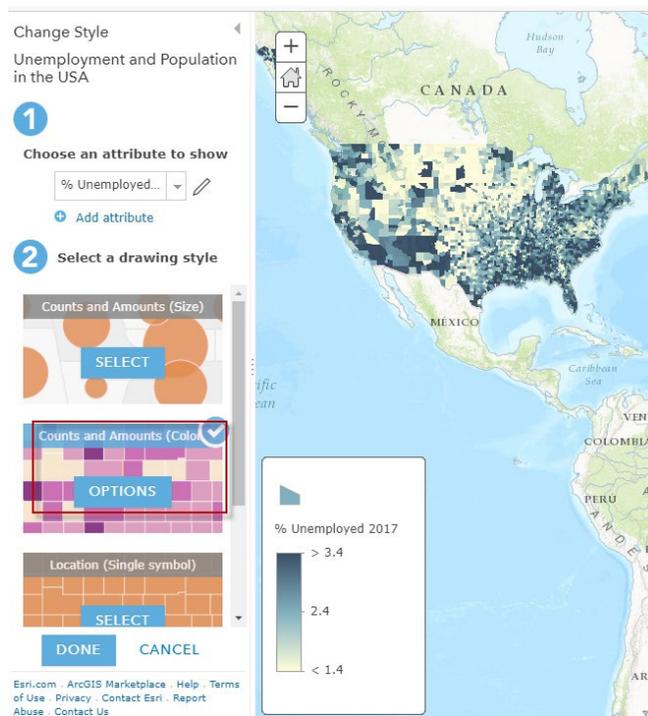
Q2 Is there a spatial pattern of unemployment?

3. Show counties that have increased or decreased in population from 2010 to 2017

The formula to show increase or decrease in population would be population 2017 – population 2010. An arcade expression can be used to show the relationship to 0. Any value below 0 will be a decrease and any value above 0 will be an increase.

1. Click Add attribute.
2. Click New Expression.
3. Edit the name to Change in Population
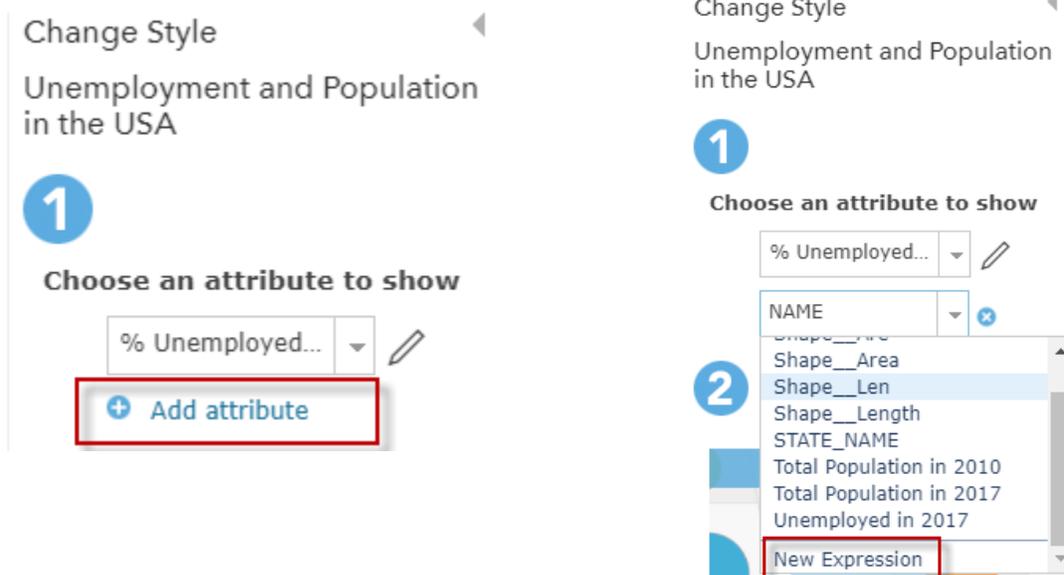
The following Arcade expression shows that anything below 0 or negative will show a decrease and anything else will show an increase.

```
var dif=($feature.TOTPOP2017-$feature.Population2010);if(dif<0)
{return'Decreased';}else
{return'Increased';}
```

4. Type of copy the expression in the script box.
5. Save.

The expression creates a variable named dif that represents the value of population in 2010 subtracted from the population in 2017. It then tests if the difference is greater or less than 0. If less than 0, it returns that the population decreased, and if not, it returns that the population increased.

6. OK.
7. Change the style to Counts and Amounts (Color).
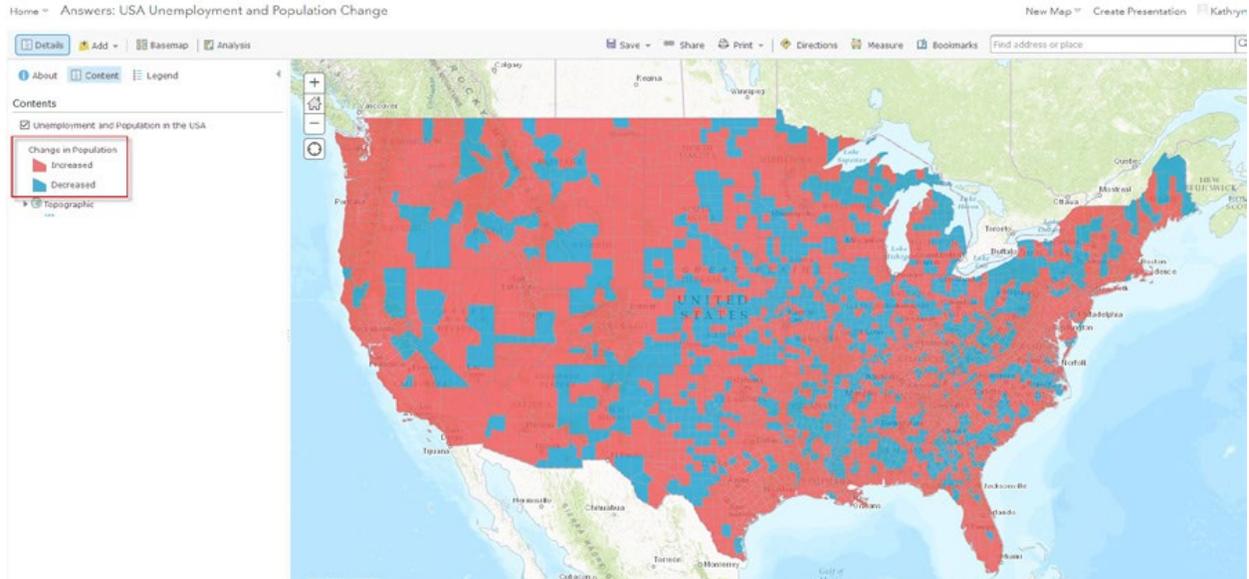
4. Label counties % change

Arcade expressions can also be used to create custom labels. The map would provide more information if the % of change was shown on each county.

1. Click the three small dots under Unemployment and Population in the USA.
2. Select Create Labels.
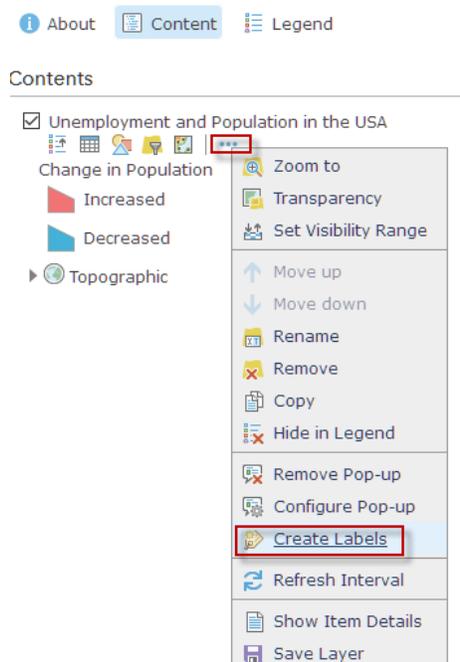
3. Under Name choose New Expression.
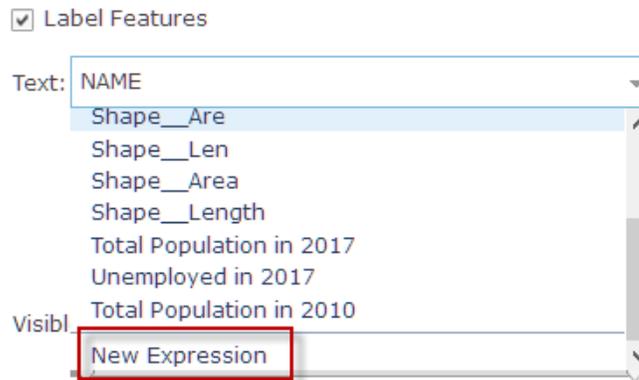
4. Type or copy the following expression:

Round((($feature.TOTPOP2017-$feature.Population2010)/$feature.Population2010)*100,2)

5. Click Edit and change Custom to % Change.
6. OK and OK.

Now the counties are labeled with percentages.
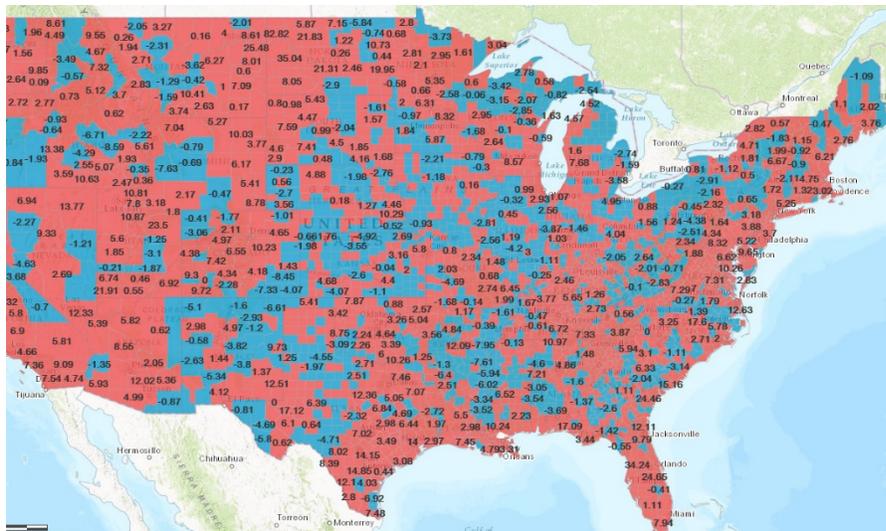
Q3 Do you see any correlation between the counties that have the highest percentage of unemployment and the counties that have lost population?

Learn more

ArcGIS Arcade

Using Arcade Expressions to Map Your Ideas

Siting a new hospital in Loudoun County, VA

Use GIS to create new knowledge

Two analytical functions in ArcGIS Online are proximity tools and tools that manage layers. In this exercise, you will use the proximity tools of buffer and drive-time and the managing layers tool of intersect.

The Loudoun County Board of Supervisors has requested that the GIS Department analyze the county for a potential new hospital. The potential site must meet the following parameters:

- One mile away from the existing main roads
- Two miles from the most populated places
- Twenty minutes away from the existing hospital
-

Build skills in these areas

➢ Using analytical functions to solve a problem
➢ Using proximity tools of buffer and drive-times
➢ Using overlay skill of intersect
➢ Enriching layers

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

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1. Open and save a map

1. Sign into your ArcGIS organizational account.
2. Open Loudoun Hospital.
3. On the top ribbon click Save As.
4. Save the map with the following parameters:
   a. Title: Loudoun Hospital_your initials
   b. Tags: Delete existing tags and use individualized tags
   c. Summary: Site selections for a new hospital in Loudoun County, VA

Save Map

Title:	Loudoun Hospital
Tags:	IGARC2_hospital_yourinitials ✕
	Add tag(s)
Summary:	Site selections for a new hospital in Loudoun County, VA
Save in folder:	▼

SAVE MAP   CANCEL

5. Become familiar with the layers by turning them on and off.

2. Use proximity tools of buffer and drive_time

In this section of the lesson, you will use two proximity tools to create additional layers to solve the problem. You will use the create buffer and the create drive-time areas proximity tools.

Create Buffers – create areas a given distance away.

Create Drive-Time Areas – the area that can be reached within a specified drive time.

1. Click Perform Analysis under Places.
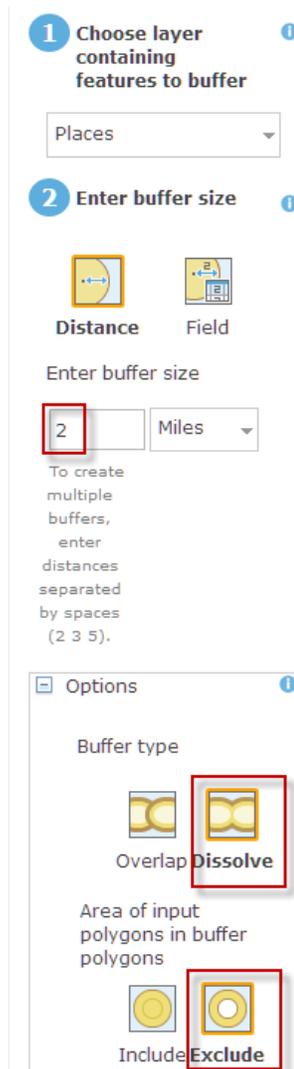
2. Choose Use Proximity.
3. Select Create Buffers and use the following parameters:
    a. Buffer size = 2 miles
    b. Expand Options
        Dissolve
        Exclude
    c. Result layer name = bufplaces2mi_yourinitials
    d. Uncheck Use current map extent
4. Click RUN ANALYSIS.

5. Uncheck Places.
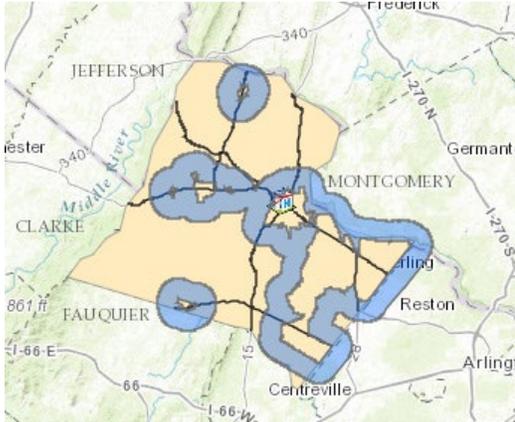
6. Click Perform Analysis under Loudoun Hospital.
7. Choose Use Proximity.
8. Select Create Drive-Time Areas and use the following parameters:
    a. Measure = 20 minutes
    b. Areas from different points = Dissolve
    c. Result layer name = drive20min_hospital_yourinitials
    d. Uncheck Use current map extent
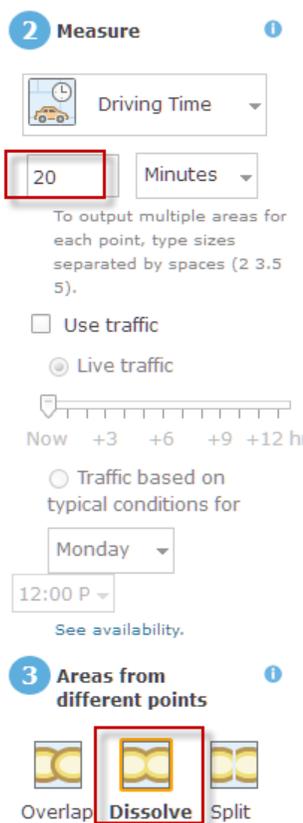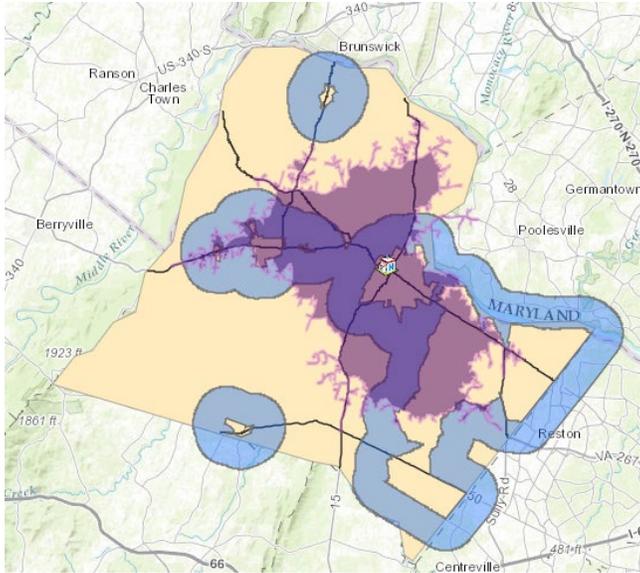
9. Click RUN ANALYSIS.

3. Erase 2-mile buffered places within 20-minute drive-time from hospital

The hospital should not be located anywhere within the 20-minute drive time. Use the analytical overlay tool to erase those areas.

Erase – The result will contain features or portions of features in the overlay layer that do not overlap with the areas in the analysis layer.

Erase

1. Click Perform Analysis under bufplaces2mi.
2. Choose Manage Date.

3. Choose Overlay layers and use the following parameters:
   a. Overlay layer = drive20min_hospital
   b. Overlay method = Erase
   c. Result layer name = suitable1_yourinitials
   d. Uncheck Use current map extent
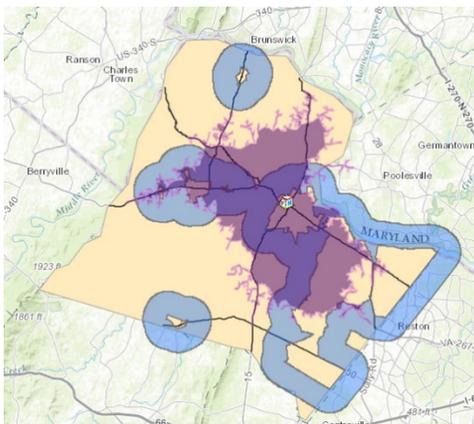
4. Click RUN ANALYSIS.
5. Turn off drive20minhospital.

4. Buffer 1 mile from Loudoun roads

1. Click Perform Analysis under roads.
2. Choose Use Proximity.
3. Select Create Buffers and use the following parameters:
   a. Buffer size = 1 mile
     -Expand options
        --Buffer type = Dissolve
   b. Result layer name = bufrds1mile-yourinitials
   c. Uncheck Use current map extent
4. Click RUN ANALYSIS.
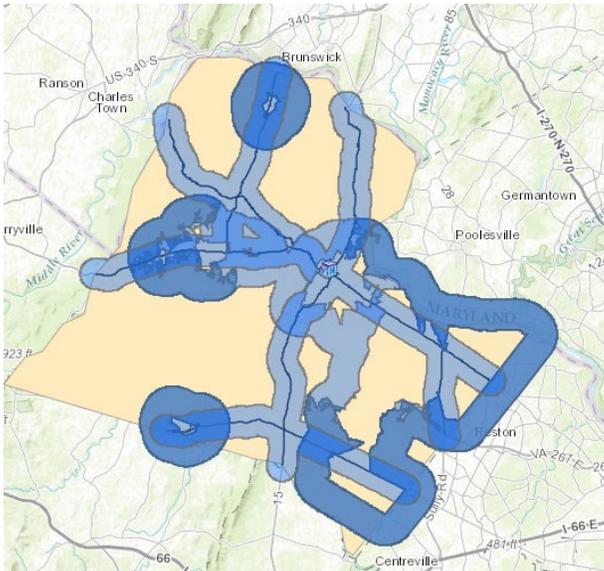
5. Use manage layers tool intersect

Now you want only the areas that are within the 1-mile buffer of the road and the buffered area of the places. For this you will use the intersect tool.

1. Click Perform Analysis under the bufrds1mile layer.
2. Click Manage Data.
3. Select Overlay layers and use the following parameters:
   a. Overlay layer = suitable1
   b. Overlay method = intersect
   c. Result layer name = potentialhospitalareas_yourinitials
   d. Uncheck Use current map extent
4. Click RUN ANALYSIS.
5. Uncheck suitable1.
6. Uncheck bufrds1mil.

The area shown are the areas that meet all the criteria of the problem:
- One mile away from the existing roads.
- Two miles from the most populated places.
- Twenty minutes away from the existing hospital.
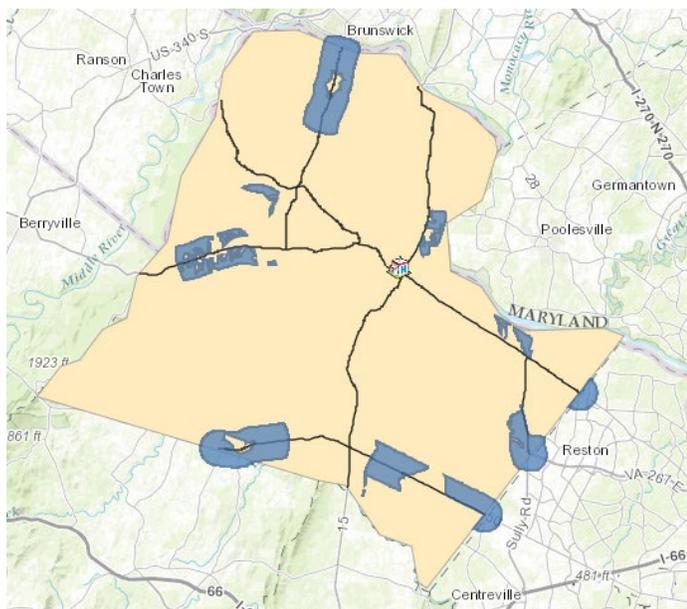
6. Make a decision

Your last task is to rank the areas. You can change the basemap. You can use the measuring tool to calculate acreage or you can add additional layers from ArcGIS Online.

Write a paragraph defending your site selection.

Mapping the Third Dimension
A change in perspective

To be a perfect graphic representation of the world, a map would have to be a sphere. Viewing it in 3D makes it so. The expectation for data to be viewable in 3D is generational. Introducing Esri's ArcGIS Scene to a mixed-age group, you find the older generation becoming a bit awed that they can manipulate, turn, and tilt data in a 3D setting. Anyone under 10 is not impressed. Young learners live in a world of 3D and expect data to be displayed in 3D; after all, they have been playing sophisticated 3D games for years.

What does 3D data bring to the table? It introduces vertical and volumetric information. Data in 3D is a tool for city planners and urban designers, and volumetric analysis serves those investigating things like groundwater contamination. In Esri's ArcGIS Scene, you not only can see your data in 3D but also navigate around and through the data at both a local and a global level.

This chapter gives you the opportunity to do the following:

- Reflect current events combined with 3D geospatial technology.
- Make a 3D presentation.
- Visualize time zones.

Use the questions at the end of this chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 6 of *The ArcGIS Book*.

Introductory activities

These map videos represent Esri's 3D ArcGIS Online software:

Author Web Scenes Using ArcGIS Online

Esri's Prototype Lab

Vocabulary match game

Mapping in 3D has its own unique terminology. Explore this terminology by matching the term with the online map illustrating the concept.

___1. 2D map   Map A

___2. 3D crime visualization   Map B

___3. local scene   Map C

___4. photorealistic   Map D

___5. fixed symbols   Map E

___6. global scene   Map F

The ArcGIS Book, chapter 6
Questions for reading comprehension, reflection, and discussion

Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

The evolution of 3D mapping: Advantages of 3D

What advantage does vertical information give?

What is human-style navigation?

Important 3D terminology: Getting the z-terminology straight

Explain these terms (including the difference between them where appropriate):
maps and scenes
local and global
surfaces
real size and screen size

Representing the world in 3D

Define photorealistic.

What makes 3D cartography powerful?

What two factors are involved to create a feeling of virtual reality?

What makes a great scene?

What is meant by implying a 3D scene is designed to be immersive?

What are the three choices of styling 3D content?

List two ways to illustrate thematic views.

Thought leader: Nathan Shephard—The rise of the 3D cartographic scene

What does Nathan discuss?

Who uses 3D cartography? Go to ArcGIS Web Scenes Gallery and investigate three of the maps.

Learn ArcGIS: Guided lessons based on real-world problems

Get Started with Scene Viewer

Create a 3D scene showing Florida's beaches and inlets.

Get Started with Scene Viewer
Navigating a scene.
Adding layers to a scene.
Making layer groups to organize data.
Capturing slides.
Creating a 3D web app.

Fly Through South America in a 3D Animation

Animate a 3D tour of a famous geographer's epic journey.

Fly Through South America in a 3D Animation
Creating a scene with imagery layers.
Adding and labeling map notes.
Creating an animation.
Exporting an animation to video format.

Understanding current events in 3D

Use a virtual globe to broadcast the news

You have been asked to pick one of the scenarios below and prepare a newscast using the virtual globe as your visualization tool.

Build skills in these areas

- ➢ Manipulating a globe within a 3D environment
- ➢ Searching for geographic locations
- ➢ Connecting news with a world sphere
- ➢ Presenting material using geospatial technology

What you need

- ➢ Account not required
- ➢ Estimated time: under 30 minutes

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The world is three dimensional, and many GIS applications require that 3D experience. Esri's Scene Viewer allows you to visualize data on a world sphere. The Scene Viewer provides a variety of tools for orientation, navigation, search, and toggling basemaps and layers.

The virtual globe of Scene Viewer is also a way to combine current events with geospatial technology. It provides a geospatial focus for a wide range of subjects and can connect many curriculum areas. It provides the opportunity for learners to look at geospatial news at all levels: global, regional, and local.

1. Scenario (world)

Since 2011, Syria has been in a civil war. More than 4 million people have fled to neighboring countries. Some countries are more welcoming than others. Research your topic and use the globe as your visualization.

1. Go to ArcGIS Online.
2. Click on Scene on the top ribbon.
3. Click the X to close the 3D Scene Viewer information tab.
4. Take time to learn the navigational buttons:
   - Click the Home button to return to the initial position.
   - Click + to zoom in. You can also use your mouse and scroll wheel to zoom in and zoom out or press and hold the middle mouse button and move down or up to zoom in or out.
   - Click the Pan button to pan. Click and hold the left mouse button and drag the map in the direction you want to move it. You may also pan by using the arrow keys on the keyboard.
   - Click the Rotate button to rotate. Click and hold the left mouse button and drag the map in the direction you want to rotate it.
   - Click the Compass button to reorient your scene North. You may also press on your keyboard.
5. Search for Syria using the search button in the upper right corner.
6. Zoom in to the designated location.
7. Change the basemap to different maps for different information.

8. Below are some focus questions:

   Why is it dangerous to go through Greece without going through Turkey?

   What routes either by land or water would the refugees have to take to get to Germany? Name the countries and water bodies.

   Hungary and Austria have shown signs of resistance to the refugees and are closing or threatening to close their borders. How would this affect the routes the refugees would have to take?

2. Scenario (regional)

Hurricane Irma was a powerful hurricane that made landfall at Cudjoe Key, FL. The storm caused catastrophic damage to the Florida Keys and particularly Cudjoe Key and the surrounding area. Research the topic and then use the globe to explain. Below are some focus questions:

When Hurricane Irma made landfall at Cudjoe Key, what was the hurricane strength? Category and sustained winds?

What towns are close to Cudjoe Key?

Why is Cudjoe Key Particularly vulnerable?

1. Repeat steps 1-7 above. Search for Cudjoe Key, FL.

3. Scenario (local)

Pacifca, CA, has declared a state of emergency because citizens must leave their homes because of erosion. Research the topic and then use the globe to explain. Below are some focus questions:

Is this emergency weather related? How?

Will the residents get any financial relief?

1. Repeat processes 1-7 above. Search for Pacifica, CA. The specific address where the apartments are falling into the sea is 310 Esplanade Ave., Pacifica, CA.
2. Right-click and change from 2D to 3D to see a vantage point like the one in the graphic below.

6

Visualizing water landforms
Present the planets's geometric masterpieces

A water landform is a feature of the planet's surface that is associated with water. Water landforms are caused by geologic processes, and some of them are geometric masterpieces.

As an instructor of geography, you have decided to give your students an exam on the identification of water landforms by imagery. You are putting together a visualization of five different water landforms to be identified. The landforms are found by either longitude and latitude or by address. The water landforms that are to be identified are listed here:

- Gulf of Mexico Continental Shelf -88.278,27,889
- Maldives
- Kenai Fjords
- Isthmus of Panama
- Mississippi Delta -89.844,29.418
-

Build skills in these areas

➢ Open Scene
➢ Searching for a location by longitude, latitude, or address
➢ Creating slides and saving a presentation

What you need

➢ Account required
➢ Estimated time: under 30 minutes
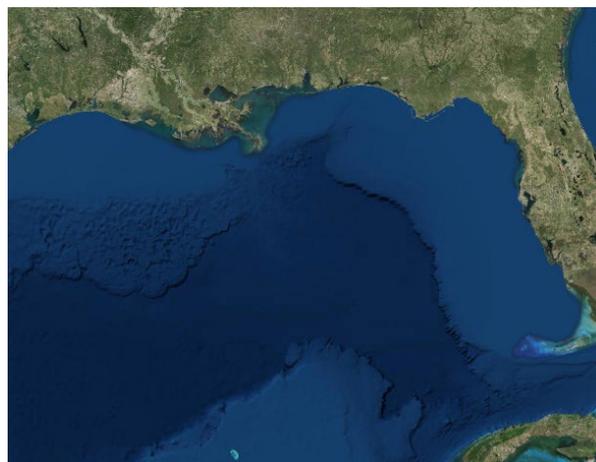
Open Scene

1. Sign into your ArcGIS organizational account.
2. Click Scene on the top Ribbon.
3. Click the Scene Viewer by clicking the X in the right corner.
4. Take the time to learn the navigational buttons in the left corner:
   a. Click the Home button to return to the initial position.
   b. Click + to zoom in. You can also use your mouse and scroll wheel to zoom in and zoom out or press and hold the middle mouse button and move down or up to zoom in or out.
   c. Click the Pan button to pan. Click and hold the left mouse button and drag the map in the direction you want to move it. You may also pan by using the arrow keys on the keyboard.
   d. Click Rotate button to rotate. Click and hold the left mouse button and drag the map in the direction you want to rotate it.
   e. Click the Compass button to reorient your scene North. You may also press N on your keyboard.
5. Search for −88.278,27.889 using the search button in the upper right corner. A pointer appears at the location. That longitude and latitude show the continental shelf in the Gulf of Mexico.
6. Zoom to the location.
7. Pick an appropriate basemap by clicking the Basemap icon. Imagery is a good choice.
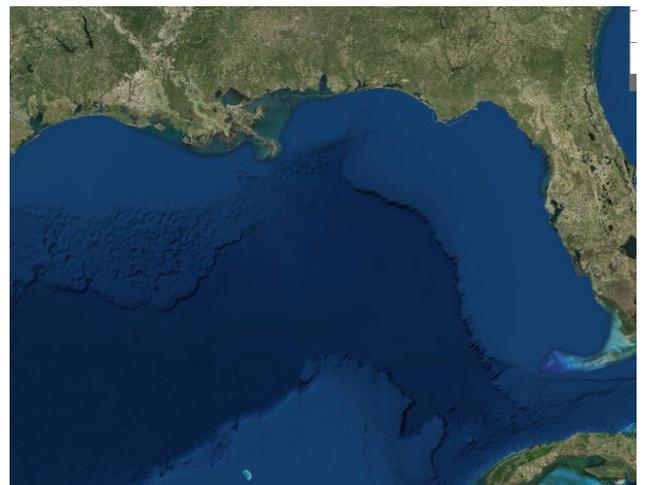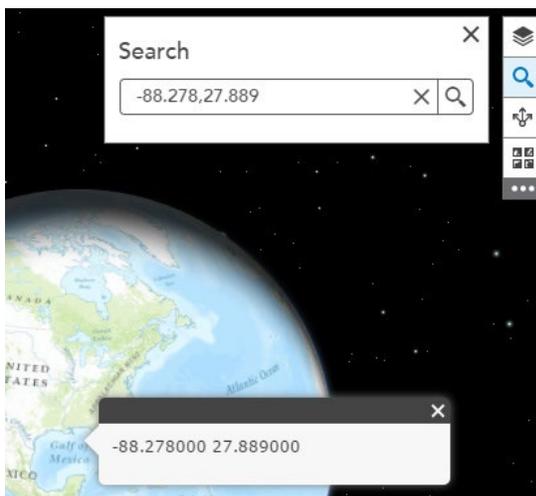
8. Click the Modify scene button (Pencil) in the upper left of your screen to open the Scene designer.
9. Click the Slides arrow.

10. Click CAPTURE SLIDE.
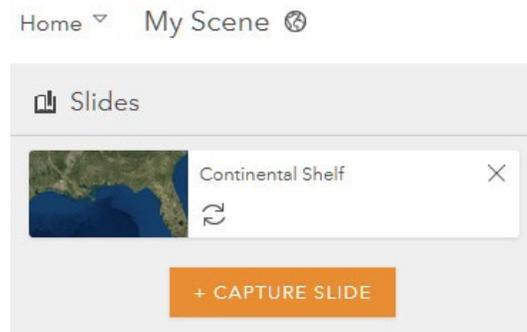
11. Add a title.
12. Click Done.
13. Repeat processes 5-11 searching for the Maldives.
14. Repeat processes 5-11 searching for Kenai Fjords.
15. Repeat process 5-11 searching for the Isthmus of Panama.
16. Repeat process 5-11 searching for -89.844,29.413. This longitude and latitude show the Mississippi Delta.
17. Click SAVE SCENE.
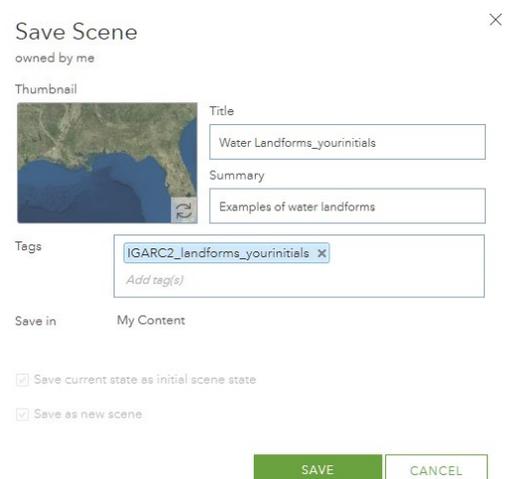
18. Complete the metadata:
    a. Title: Water Landforms_yourinitials.
    b. Summary: Examples of water landforms.
    c. Click SAVE.

Responding to an earthquake off the western coast of Mexico

View depth of earthquake and aftershocks in 3D

On September 8, 2017, an 8.1 magnitude earthquake hit off the southwestern coast of Pijijiapan, Mexico, toppling hotels and houses. It hit about 73 miles from Tres Picos, Mexico. Its epicenter was 102 miles west of the southern Chiapas state, and it had a depth of about 21 miles. The quake was so powerful, it was felt by people in Mexico City, 650 miles away. You have been asked to build a story map to document the event. The story map used as a presentation will be the introduction to start the discussion asking for humanitarian aid.

Before preparing the story map, you must create the maps and scenes to populate the story map. The maps and scene required are as follows:

- Video for introduction
- 3D scene showing location of the earthquake
- Map showing live earthquake fee
- 3D map of earthquake depth

Build skills in these areas

➢ Build a story map that includes video, maps, and scenes
➢ Add live earthquake feed data from an URL
➢ Minimizing the Scene Viewer

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

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1. Scene 1—A scene displaying a 3D view of the location of the earthquake

1. Sign into your ArcGIS organization.
2. Click Scene.
3. Close the Scene Viewer.
4. Click Modify Scene.
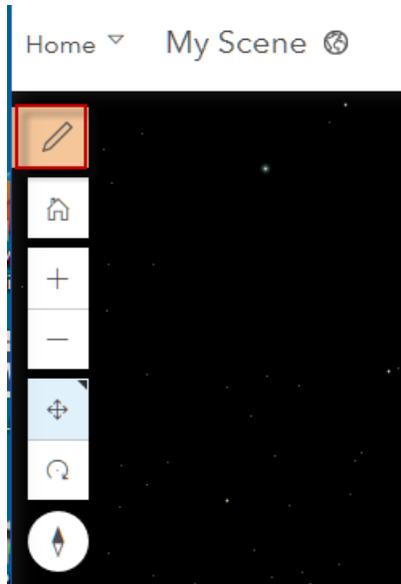
5. Click ADD LAYERS.
6. Search for IGARC2_mexico_cities in ArcGIS Online. Click DONE.
7. Click the plus button to Add.
8. Search again for Recent Earthquakes and Add.
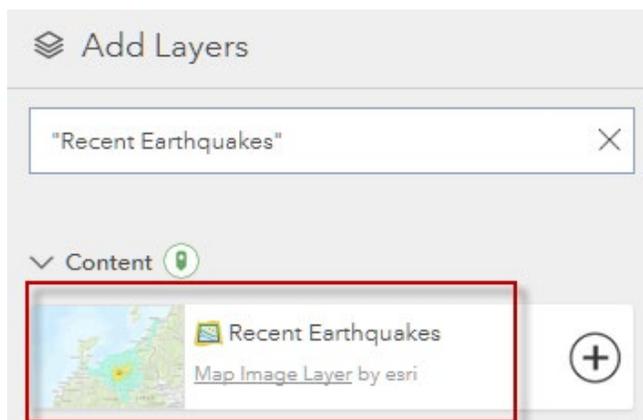
9. Click DONE.

10. On the right tab change the basemap to imagery.
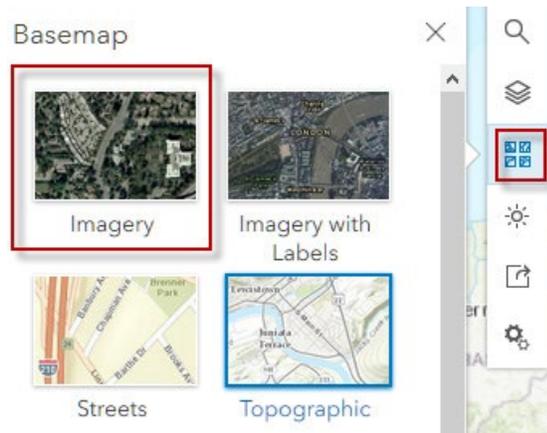
11. Click Done.
12. SAVE SCENE using the following parameters:
    a. Title: Scene 1: Mexico Earthquake
    b. Use individualized tags.
    c. Summary: Mexico Earthquake September 8, 2017.
13. Click Save.
14. On the top line of the browser, copy the URL to be used in your story map. Paste the URL in a text document that you can access later.
15. Make some notes about what you are visualizing.

2. A map showing live earthquakes

The US Geological Survey provides live feed earthquake data in a CSV ASCII text file. This live feed can be added to an ArcGIS Online map by referencing the URL file. Your map will then be updated from the source every time you refresh or open your map.

1. Go to Home.
2. Click Map.
3. The CSV ASCii file can be accessed at USGS Earthquake Data.
4. Scroll to Past 30 Days>>M2.5+Earthquake.
5. Right-click and Copy the link location.
6. Go back to the new map.
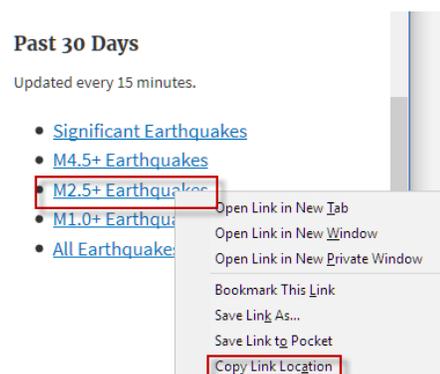
7. To add the layer to your map click Add>>Add layer from Web>>CSV file.
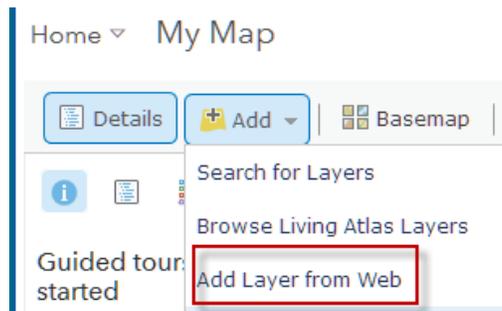
8. Use the drop-down menu to select the CSV file.

9. For type of data choose CSV file.
10. Paste the location from USGS.
11. Click ADD LAYER.

12. Click DONE.
13. Change Choose an attribute to show to mag (magnitude).
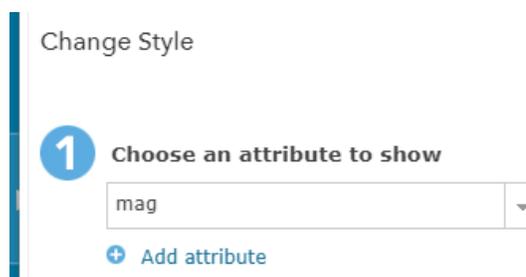
14. Click Counts and Amounts (Color)…….SELECT.
15. Click OPTIONS.
16. Click Classify Data.
  a. Using: Natural Breaks
  b. 4 Classes
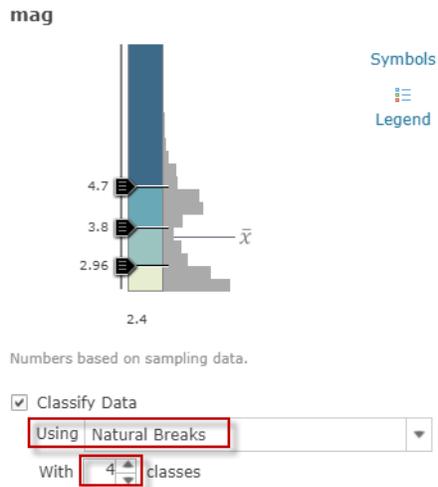
17. Click OK.
18. DONE.
19. Right-click and rename the layer Earthquakes.
20. Change the Basemap to Oceans.
21. On the top ribbon click Save As.
22. Use the following parameters in the Save menu:
  a. Title: USGS Live Earthquakes_yourinitials.
  b. Tags: Use individualized tags.
  c. Summary: Live earthquake feed from USGS.
23. Click SAVE MAP.

3. Scene 2: A scene showing earthquake depth

1. Go to Home and select Scene.
2. Close the Scene Viewer.
3. Click Modify Scene.
4. Select ADD LAYERS. Click +.
5. Search for **Quake 9/8/2017** in <u>ArcGIS Online</u>.
6. Add **Scene 2: Quake 9/8/2017**.
7. Click DONE.
8. Save Scene using the following parameters:
   a. Title Scene 2: 3D Quake Depth_your initials.
   b. Tags: Use individualized tags.
   c. Summary: Visualization of earthquake depth in 3D.
9. Click SAVE.
10. Click Layer Style on the tab at the end of the layer file.
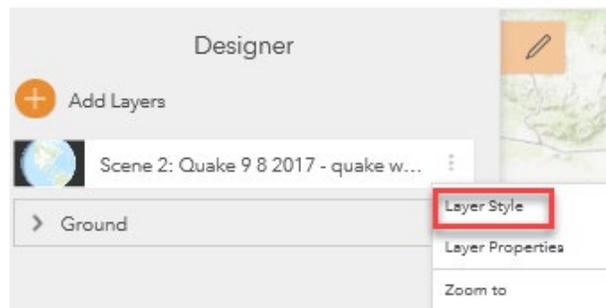
11. Choose depth2 as the main attribute to visualize.
12. Click 3D Counts & Amounts>>SELECT.
13. Click OPTIONS and select a circle as the symbol.
14. Click DONE.
15. On the upper right ribbon, change the basemap to imagery. On the Basemap Ground Transparency, move to 25 transparency.
16. Click DONE.
17. Save SCENE.

18. Click SAVE.
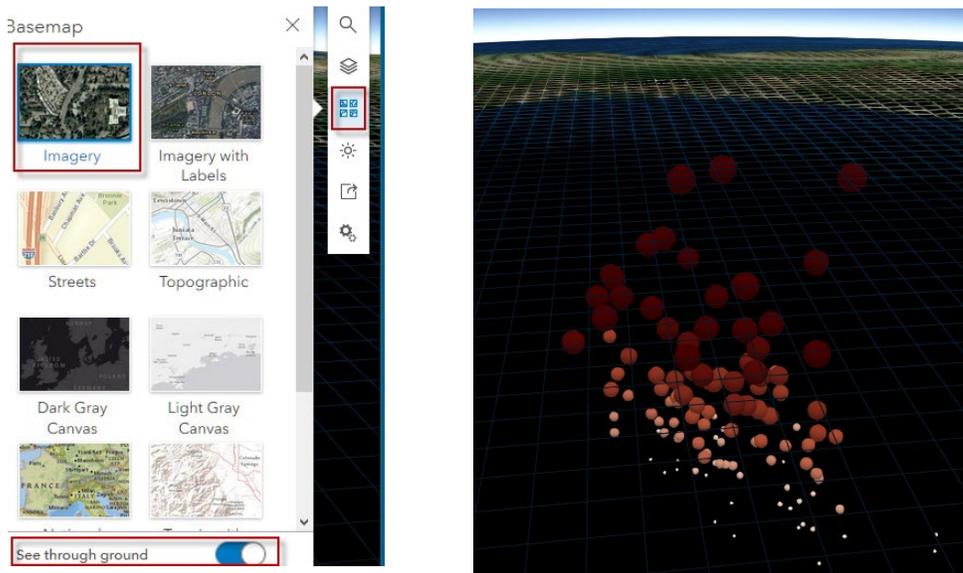
19. DONE.
20. Save SCENE.
21. Click SAVE.

You have been asked to document the Mexico September 8 earthquake in a story map. Story maps let you combine maps, scenes, multimedia, and text.

3. Build a story map using the scenes and map prepared above

1. Go to your table of contents of click USGS Earthquakes_yourinitials.
2. Click Create Web App>>Using a Template.
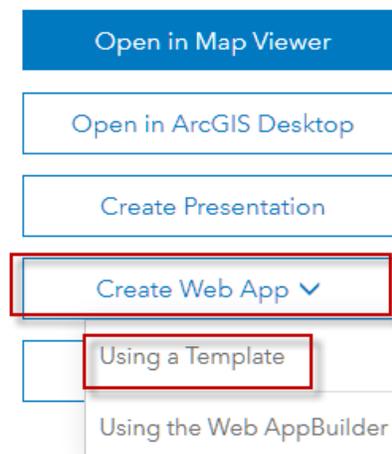
3. Click Build a Story Map.
4. Click Story Map Journal.

Story Map Journal

5. Click CREATE WEB APP.
6. For Summary enter: "Presentation of earthquake that hit off the coast of Mexico on September 8, 2017."
7. Click Done.
8. Choose the default Side Panel and click START.
9. Call your map journal: "Mexico Earthquake September 8, 2017".
10. Click the Blue arrow to proceed.

 You have four options for CONTENT: Map, Image, Video, and Web page. To make your story map powerful, start with a video. The link to the video below has a standard YouTube license so it can be used in your story map.

4. Story map: Section 1—A live video

1. Click Video.
2. Click YouTube.
3. Copy and paste this link into the web page.
   Link: https://www.youtube.com/watch?v=8OrC0k44X0c
4. Check.
5. Click Select this video.
6. Enter a Section title: "Video of Earthquake".
7. Click Next.
8. Add some text about the earthquake. You can also add a hyperlink.
9. Click ADD.

5. Story Map: Section 2—A map displaying a 3D view of the location of the earthquake

Before starting this section, go to Content and open Scene 1: Mexico Earthquakes, open the scene, and copy the URL.

1. Click ADD SECTION.
2. Section Title: "Location of the Earthquake".
3. Click Web Page.
4. Paste the URL in the URL tab. If you want to use the Scene Viewer in a story map but you want to eliminate unneeded tools and menus, add **&ui=min** to the scene viewer URL. This will hide all but the map and slide navigation tools.
5. Click Configure.
6. Click NEXT.
7. Add some text.

This map shows the location of the three identified cities that were affected by the earthquake. It also shows a ShakeMap. A ShakeMap is a product of the USGS Earthquake Hazards Program in conjunction with regional seismic networks. ShakeMaps provide visualization of shaking intensity following significant earthquakes. ShakeMaps help federal, state, and local organizations prepare for post-earthquake recovery.

8. Click ADD.

6. Story map: Section 3—A map showing live earthquakes

Before starting this section, go to Content and open Quakes live, open the map, and copy the URL.

1. Click ADD SECTION.
2. Section Title: "Live USGS Earthquake Feed".
3. Click Map.
4. Select the map: Quakes Live.
5. Click NEXT.
6. Add some text.
   USGS live earthquake feed for the last 30 days of earthquake with a magnitude of 2.5 or above.
7. Click ADD.

7. Story Map: Section 4—A scene showing earthquake depth

1. Click ADD SECTION.
2. Title: "Quake Dept 9/8/2017 Mexico".
3. Click Web Page.
4. Paste the following URL:

http://learngis.maps.arcgis.com/home/webscene/viewer.html?webscene=f4ca9a902abe4266b428266047edddb8&ui=min

5. Click Style.
6. Click NEXT.
7. Add text: **This scene shows depth of earthquakes in 3D below ground.**
8. Add
9. Click SAVE.
10. Click VIEW STORY.

In this section you have used videos, maps, and scenes to create a presentation about the September 8, 2017, earthquake off the coast of Mexico.

Styling LAS point cloud layers in Scene Viewer

Baltimore City, MD, LAS lidar

Scene Viewer now has the capability of styling published LAS data into three distinct categories: elevation, class, and intensity.

The City of Baltimore has access to a published LAS dataset. City officials would like an explanation of what the different classifications of lidar points are. They have asked you to use the published dataset to explain.

Build skills in these areas

- ➢ Opening Scene Viewer
- ➢ Navigating a published LAS dataset
- ➢ Using Smart Mapping Styling for elevation, class, and intensity

What you need

- ➢ Account required
- ➢ Estimated time: under 30 minutes

1. Open Scene Viewer and Identify Structures

1. Sign into your Organizational Account.
2. Open Baltimore Lidar. Noe: Does not work in Internet Explorer. Works best in Google Chrome
3. Change the basemap to Imagery with labels.
4. Use the middle mouse button to switch to perspective view and look at structures from the side, particularly the baseball stadium.
5. Zoom around on the map and identify.
   a. Baseball Stadium – Camden Yards
   b. Cranes
   c. B & O Railroad museum

2. Classify Points

1. Click the Modify Scene icon in the upper left corner.
2. Click Layer Style at the end of the Lidar Point Cloud Data feature. This gives you three different styles:
   a. Class
   b. Elevation
   c. Intensity
3. Investigate all three different styles.

Class: Every lidar point can have a classification assigned to it that defines the type of object that has been reflected. Lidar points can be classified into various categories, including bare earth or ground, top of canopy, and water.

Elevation: Symbolizes points based on point elevation.

Intensity: A measure, collected for every point, of the return strength of the laser pulses that generated the point, It is based, in part, on the reflectivity of the object struck by the laser pulse.

In this lesson, you have visualized a lidar dataset and explored three types of

classification.

Teaching world time zones: Chart the hour

For centuries, humans have marked time by the position of the sun. The sun rose in the east, moved across the sky, and set in the west. Solar noon occurred when the sun was directly overhead. However, solar noon in one location could occur in the middle of the night in another. What could we do to solve this problem? The answer came through establishing worldwide standard time zones. There are 24 time zones, each 15 degrees of longitude wide. The starting point for the standard time zones is the Prime Meridian. Travelers moving westward from the Prime Meridian move their clock back to earlier times (minus 1 hour for each time zone), while those moving eastward change to later times (plus 1 hour for each time zone). A traveler going around the world would have to change not only the time but also the date. Establishing the International Date Line solved this problem. Travelers moving westward advance their calendars one day as they cross the International Date Line (Saturday to Sunday), and travelers moving eastward move their calendars back one day (Saturday to Friday).

A large university that has a major department in International Relations and Diplomacy has asked you as a GIS educator to provide them with a lesson that will explain worldwide standard time zones. The university has asked that the course be online and that it be a hands-on experience. ArcGIS Online is the software that is available at the university.

Build skills in these areas

➢ Opening Scene Viewer
➢ Searching and adding layers
➢ Configuring layers
➢ Saving a Scene
➢ Using a Scene to answer questions

What you need

➢ Account required
➢ Estimated time: under 30 minutes
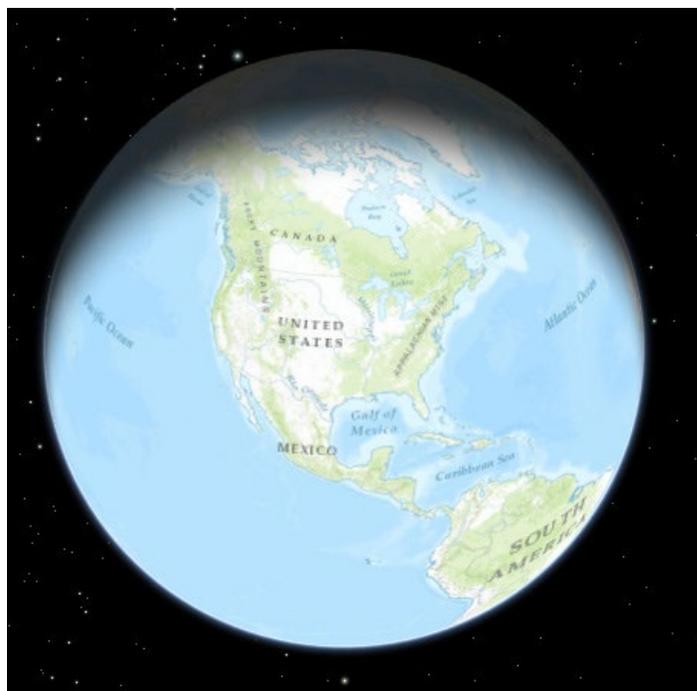
Open Scene Viewer, search for and add layers, configure, and save.

1. Sign into your ArcGIS organizational account.
2. Click Scene on the top Ribbon.
3. Take time to learn the navigational buttons:
    a. Click the Home button to return to the initial position.
    b. Click + to zoom in. You can also use your mouse and scroll wheel to zoom in and zoom out or press and hold the middle mouse button and move down or up to zoom in or out.
    c. Click the Pan button to pan. Click and hold the left mouse button and drag the map in the direction you want to move it. You may also pan by using the arrow keys on the keyboard.
    d. Click Rotate button to rotate. Click and hold the left mouse button and drag the map in the direction you want to rotate it.
    e. Click the Compass button to reorient your scene North. You may also press N on your keyboard.

You need to add the following layers to construct the lesson:
- Prominent World Longitude and Latitude
- World Time Zones
- Cities_tzones

4. Close the Scene Viewer Intro.
5. Click Modify Scene.
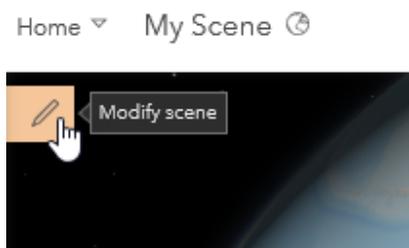
5. Click + ADD LAYERS.
6. Change Search Area from My Content to ArcGIS Online.
7. Where it says Search for layer….type **Prominent World Longitude and Latitude** by Maps.com_carto.

8. Click the + button.

Add Layers «

Prominent World Longitude and Latitudes   ✕

⌄ Content ⊙

Prominent World Longitude...
Feature Layer by Maps.com_carto   ⊖
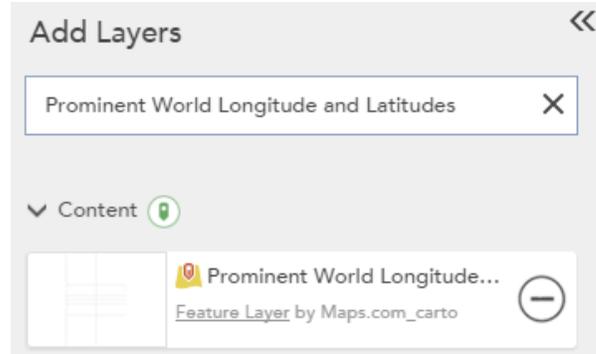
9. DONE.
10. Click the pull-down arrow at the end of the layer name.
11. Layer Symbology
12. Change Original Symbols to Change Symbols.
13. Change Size to 10.
14. DONE.
15. Click + ADD LAYERS.
16. Search for **World Times Zones**. Click + World Time Zone Feature layer by esri.
17. DONE.

You now have two layers on your map. You can turn these layers on and off by clicking the top icon on the top right corner.

Layers   Legend   ✕

✓ World Time Zones - World Ti...

☐ LongitudesAndLatitudes - Maj...
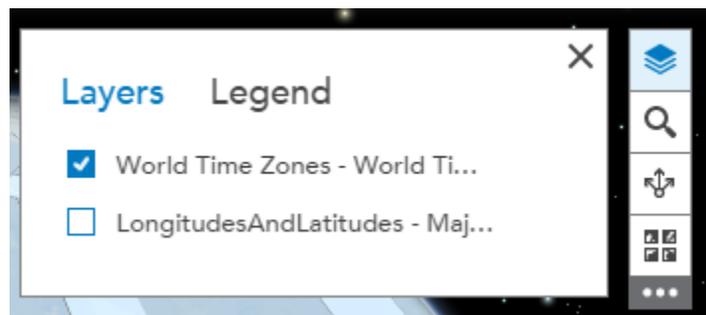
Q1 Describe the standard time zones.

Q2 Why do some of the standard time zones have irregular boundaries on land?

Q3 Explain the need for an International Date Line.

Q4 How many time zones are in the continental US?

18. Click + ADD LAYERS and search for **city_tzones** and add to your scene.
19. DONE.

Q5 What cities are represented?

20. DONE.
21. Click SAVE SCENE.
22. Add appropriate metadata:
      a. Scene title: World Time Zones
      b. Tags: individualized tags
      c. Summary: Spatial display of World Time Zones

Save Scene
owned by me

Thumbnail

Title

World Time Zones

Summary

Spatial display of World Time Zones

Tags
  learnarcgis ✕ time_zones ✕ scene ✕
  Add tag(s)

23. Click SAVE SCENE again.
24. Go to My Content to open the World Time Zones Scene.

🌐 World Time Zones

Q6 Use the constructed Scene to compete the following chart.

Start City	Day/Time	Travel Direction	End City	Day/Time	# Time Zones Crossed
London	Mon 11 AM	West	Denver	Mon 4 AM	
London	Mon 11 AM	East	Denver	Mon 4 PM	
Paris	Wed 1 AM	West	Minneapolis	Tues 6 PM	
Paris	Wed 1 AM	East	Minneapolis	Tues 6 PM	
Rio de Janeiro	Friday 10 PM	West	Tokyo	Sat 10 AM	
Rio de Janeiro	Friday 10 PM	East	Tokyo	Sat 10 AM	

5

Three-dimensional scenes

Where and what?

ArcGIS OnlineSM 3D Scene Viewer allows users to explore the world in 3D. The scene viewer is an app built into the ArcGIS Online website for creating and interacting with 3D scenes. The scene viewer works with most modern browsers. Users can choose global or local views, switch basemaps, add layers, configure layers, capture slides, and save scenes. In this introductory activity, you will match a verbal description with a 3D scene.

Build skills in these areas

- ➢ Navigate a 3D scene
- ➢ Search
- ➢ View layers
- ➢ Choose a basemap

What you need

- ➢ Account not required
- ➢ Estimated time: under 30 minutes

Published June 2018

Find and Describe Locations

1. Open the Three Dimensional Map Scene and investigate the maps at the bottom of the viewer.
2. Click the Map. At the bottom, the app shows various locations on Earth. When you click on any of the locations, it opens within the scene view.
3. Navigate a scene using all the tools.

4. Practice opening different views by clicking scenes at the bottom.

Navigate your scene

In the upper left of your screen are the navigation controls.

- Click **Initial view** 🏠 to return to the initial camera position.
- Click **+** to zoom in.
- Click **-** to zoom out.
- You can also use your mouse and scroll wheel to zoom in and zoom out or press and hold the middle mouse button and move down or up to zoom in or out.
- Click **Pan** ✛ to pan. Click and hold the left mouse button and drag the scene in the direction you want to move it. You may also pan by using the arrow keys on the keyboard.
- Click **Rotate** ↻ to rotate. Click and hold the left mouse button and drag the scene in the direction you want to rotate and tilt it.

  > 💡 **Tip:** The black triangle in the upper right of the tool indicates which tool is selected.

- If you have a two-button mouse, you can use the left mouse button for the primary navigation and the right mouse button for the secondary navigation. For example, if you click **Rotate** ✛, you can use the left mouse button to rotate and the right mouse button to pan.
- **Compass** ◊ gives you the orientation of the scene. Click **Compass** ◊ to set your scene to North orientation.

5. Learn to use the scene tools, paying attention to changing the basemaps.

Toolbar functionality from top to bottom:

Search and type a location into the search box

View layers

Choose a basemap

Adjust daylight

Share the scene

Change settings

Complete the chart

- Add the region

- Select a description from the choices given.

Location	Region	Description
Mount St. Helens		
Mount Whitney		
Grand Canyon		
Bell Rock		
Horseshoe Bend		
Meteor Crater		
Bowknot Bend		
Devil's Tower		
Venice Lagoon		
Mount Blanc		
Mount Vesuvius		
Ayres Rock		
Diamond Head		
The Badlands		
Guitar Shaped		
World's Largest		
Star Fort		
Potash Ponds		

Descriptions:

A. Farm shaped like a guitar, tribute to wife who died

B. Only active volcano in mainland Europe

C. Butte composed of sedimentary rock

D. Evaporation ponds near Moab

E. Meteorite

F. Fort during the age of cannon battlefields

G. Enclosed bay of the Adriatic Sea

H. Landscape inhabited by bison, and bighorn sheep

I.   Massive sandstone monolith

J.   Green River canyon that doubles back on itself

K.   Caused by 277-mile river eroding

L.   Highest mountain in the Alps

M. A hairpin turn on the Colorado River

N.   Highest summit in contiguous USA

O.   Flat-topped volcanic formation

P.   Butte composed of sedimentary rock

Q.   Volcanic cone on Island of Oahu

R.   Highest mountain in the Alps

In this lesson you have learned how to navigate in a 3D scene environment.

Learn more

View scenes in Scene Viewer

3D Across All Scales

The ArcGIS Online 3D scene viewer is an app built into the ArcGIS Online website for creating and interacting with 3D scenes. The scene app is spherical, which makes it ideal to view global data. The app gives users the option of looking at data in the global or local scene. A global scene is good to use when you want to understand or provide context for phenomena that wrap around the spherical surface of the earth. A local scene can display data that has a spatial reference in a local projected coordinate system. Local scenes are best used for displaying or analyzing data at the local or city scale that has a fixed extent in which you work. The following activity allows you to explore both global and local scenes.

Build skills in these areas

➢ Use a 3D Viewer
➢ Understand scale

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

Explore 3D

1. Open 3D Across All Scales.

2. Hover your mouse below the scene, and then click the 2Global – Precip slide.

    Q1 What do the colors mean? (Additional information can be obtained from the side panel.)

    Q2 Describe the precipitation pattern of South America.

    Q3 Describe the precipitation pattern of Africa.

2
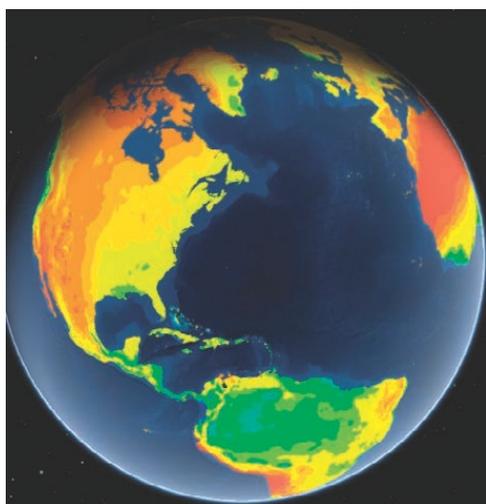
3. Click the 3 Global Sediment Thickness slide.
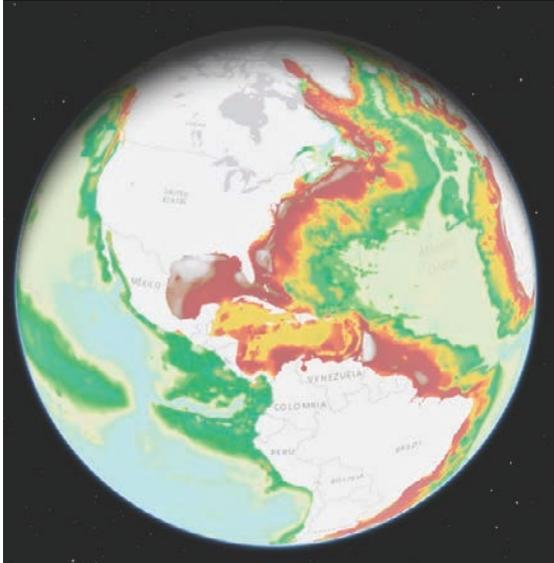
Q4 *Explain what the global thickness is measuring.*

4. Click the 4 Regional Scale slide, which includes county – to country-sized areas.

Q5 *Describe the regional view.*

Q6 *Explain what ecological land units are. (Additional material can be obtained from the side panel).*

For the next part of the exercise, activate the Full Screen display at the lower right. The Full Screen Icon Is on the right side of the bottom of the screen.
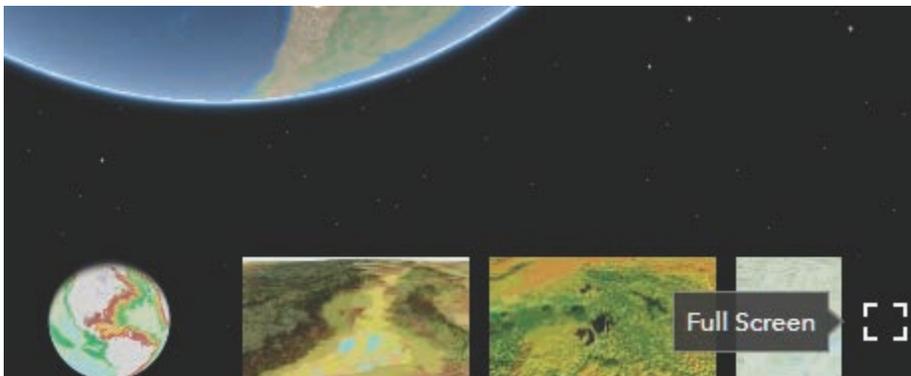
When the app is viewed in full screen, more layers are displayed to investigate. Notice that the initial view tool is always available to allow you to zoom to the full extent.
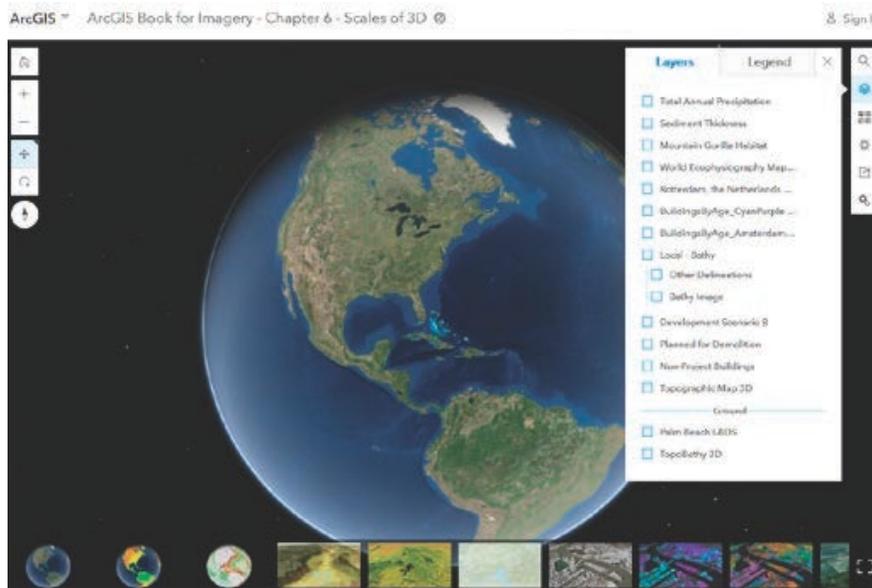
Q7 Pick one world and one regional or local layer and write a description of the scene. Explain what layers are displayed.
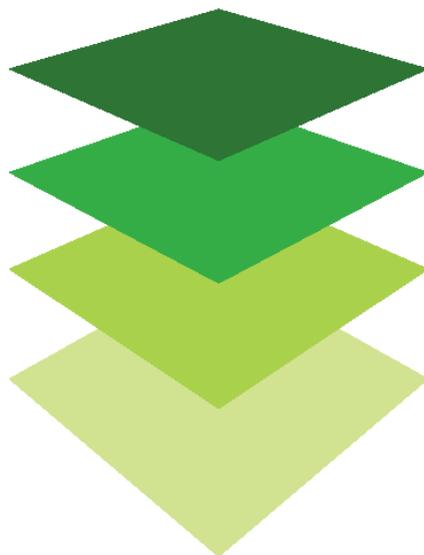
The Power of Apps
Focused tools that get the work done

"With billions of users worldwide, apps are a technology trend that has captured the world's attention. Online maps provide the information that powers the use of GIS. And every map has an interface—a user experience for putting that map to use. These experiences are apps, and they bring GIS to life for users." (*The ArcGIS Book*, p. 92)

Have you ever been out to dinner and noticed that no one is talking to you? They are on their smartphones, their iPads, or their Androids. It is the invasion of the apps. You can find a place to eat, a hotel, a ball game; sitting down, standing, or walking, you can look up almost any information. Wherever you are, you can check the weather forecast or know when a plane is landing.

Apps are lightweight computer programs designed to run on the web with smartphones, tablets, and other mobile devices. While all such applications serve a purpose, GIS apps are even more useful because they are map centric and spatially aware. GIS apps can collect data, alert you to geographic events, and answer questions through analysis.

This chapter gives you the opportunity to do the following:

- Visit ArcGIS Marketplace and pick out two apps of interest to you, then download and investigate them.

- Participate in a collaborative data experience showing participant skill and location of everyone using *Instructional Guide for The ArcGIS Book*.

- Explore a flood modeling app and a historic map app.

- Learn different ways to collect field data.

The lessons in this chapter offer practice (and entertainment) in downloading and experiencing apps. Use the questions at the end of this chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 7 of *The ArcGIS Book*.

Introductory activities

These videos below represent the new trend using ArcGIS mobile apps:

ArcGIS Apps for the Field

ArcGIS Apps for the field

esri • 4K views • 1 year ago

See how to improve **field** operating efficiency with **ArcGIS apps**. Eliminate your reliance on paper-based workflows to coordinate and

2:21

Survey123 for ArcGIS: Leveraging Your Survey Data in Other Apps

Survey123 for ArcGIS: Leveraging your Survey Data in Other Apps

ArcGIS • 2.6K views • 1 year ago

This video shows you how to **leverage your survey data** into **other applications** such as Story Maps and Web AppBuilder.

2:07

Esri Solutions for Business

Esri Solutions for Business

esri • 4.4K views • 1 year ago

1:52

1. Go to ArcGIS Marketplace.

What is marketplace?

Who can use the apps?

Select two apps and explain why you would want to use them. Download them to your mobile device and enjoy.

The ArcGIS Book, chapter 7
Questions for reading comprehension, reflection, and discussion

Teachers can use the items in this section as an assignment, an introduction, or an assessment tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

The rise of spatially intelligent apps

What is an app?

How is a GIS app unique?

Where do apps come from?

List some ways to solve a problem with an app.

Thought leader: Jeff Shaner

On the scene at the Deepwater Horizon oil spill

How did the use of mobile GIS influence the Deepwater Horizon emergency response?

Case study: US Geological Survey

In 2009, the US Geological Survey began the release of a new generation of topographic maps in electronic form and in 2001 complemented them with the release of high-resolution scans of historical topographic maps of the US dating back to 1882. View these using the USGS Historical Topographic Map Explorer. Use the app to do the following:

Find the area you want to explore.

Use the timeline to select the maps.

Compare the maps.

List three of Esri's ArcGIS ready-made apps.

Learn ArcGIS: Guided lessons based on real-world problems

Manage a Mobile Workforce
Publishing a web layer.
Creating a web map.
Sharing maps with workers in the field.
Using Collector for ArcGIS.

Get Started with Survey123 for ArcGIS

Creating a survey with the Survey123 for ArcGIS website.

Submitting a survey with a URL link in a web browser and the Survey 123 field app.

Analyzing survey results in the Survey123 website.

Sharing survey results with other ArcGIS platform client apps.

Get Started with Survey123 for ArcGIS

Survey safety prevention measures and create an inventory of emergency assets.

Collecting data collaboratively

Apps provide the interface for the efficient collection of spatial data so you can leverage your handheld device as a data collection tool. As a user of Instructional Guide for The ArcGIS Book, you are being asked to enter your location and learning environment into the cloud using an editable feature service (a shared tool) and working on the map collaboratively. Record your location by clicking on the map and recording the following information:

- Higher education
- K-12 education
- Online program

Build skills in these areas

➢ Opening a map with an editable feature service
➢ Contributing information to a collaborative map

What you need

➢ Account not required
➢ Estimated time: 5 minutes

The Learn Team wants to collect data about the learners using the Teach with GIS Site.

1. Go to the Instructional Guide User Map.
2. Click Edit on the top of the page.
3. Click Learners in the table of contents.
4. Click to add a point on your location on the map.
5. Fill out the information requested.
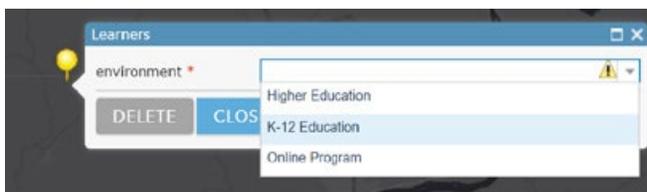
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Warming Alaska with Map Notes

In Chapter 9 of The ArcGIS Imagery Book, there is a focused story map that offers convincing evidence about the warming of Alaska. The story map is an example of shared imagery by the greater GIS community.

After being inspired by observing the story map, Alaska Ice: Documenting Glaciers on the Move, you have decided to try your hand at adding Map Notes with links images and videos.

Build skills in these areas

- ➢ Locating sites
- ➢ Adding Map Notes with description
- ➢ Adding links to Map Notes
    - ○ Information links
    - ○ Video links
    - ○ Image links

What you need

- ➢ Account not required
- ➢ Estimated time: under 30 minutes

1. Locate the glacier

1. Open Alaska Ice: Documenting Glaciers on the Move.

2. Investigate the story map and choose three glaciers that are particularly interesting to you. The three examples included here are:
   a. Muir Glacier
   b. Pedersen Glacier
   c. Holgate Glacier
3. Open ArcGIS Online.
4. On the top ribbon, click Map.
5. Click Modify Map.

6. In the Search box, search for Muir Glacier, Alaska, United States.

7. Click Add to Map Notes. When you click Add to Map Notes, it adds a Map Note's graphic and adds a Map Notes layer to the Contents pane.
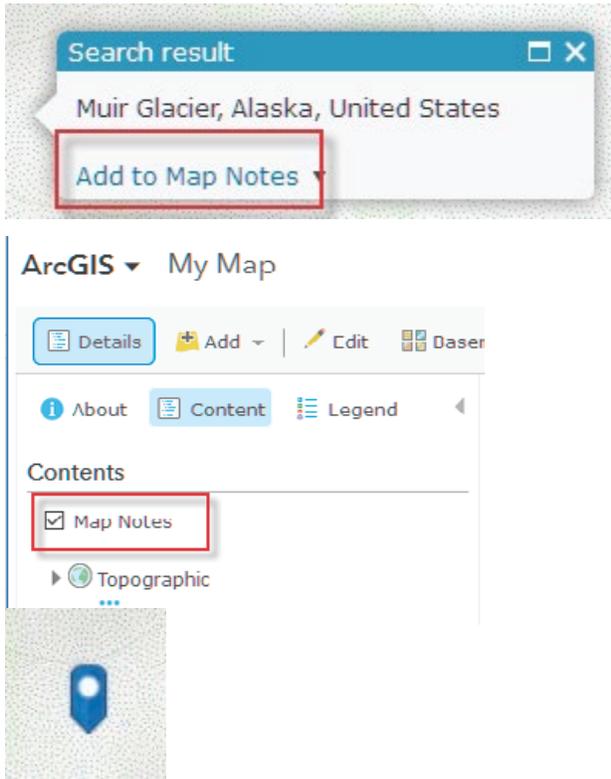
8. In the upper-left ribbon, change the basemap to imagery with labels.
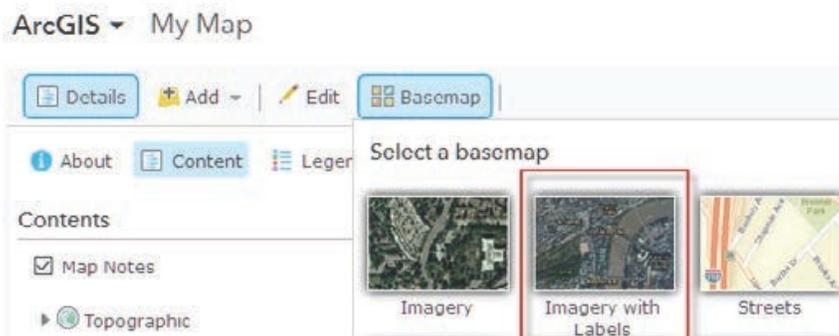
2. Add information to the Map Notes

1. Click the blue Map Notes icon.
2. Click Edit.
3. Write the following description:

Muir Glacier is a tidewater glacier with calved icebergs. It was name after naturalist John Muir.
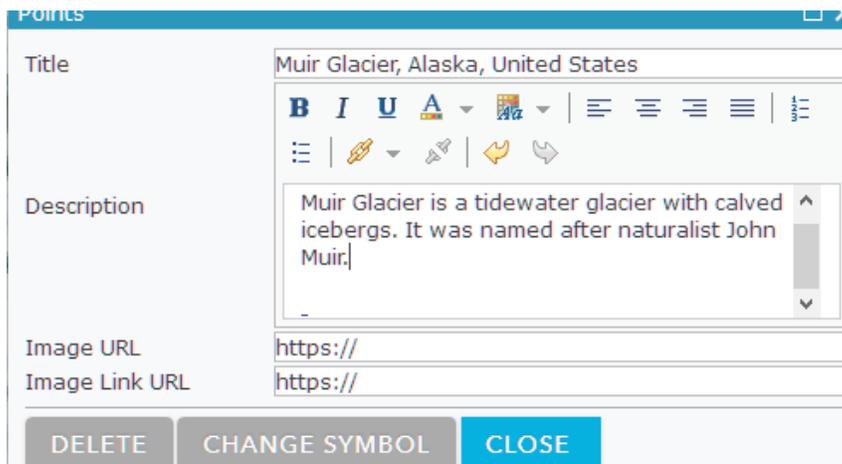
4. Click the link icon and insert the following URL and title.

- https://www.youtube.com/watch?v=42kVM2t0eq4
- Title: Diminishing Muir Glacier
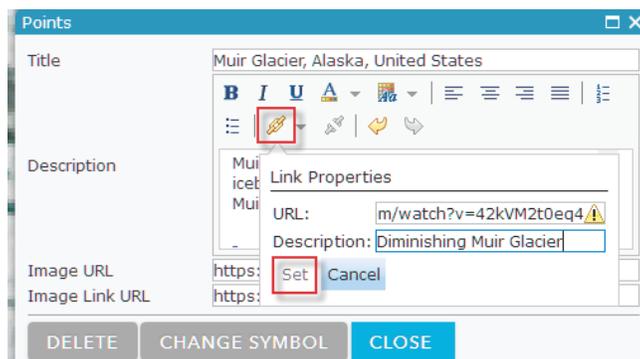
5. Click Set.
6. Click CLOSE.

3. Add information for additional glaciers

Doing your own research and following the instructions above, make Map Notes for Pedersen and Holgate Glaciers.

Visualize Crops using Predominant Mapping

What you need

- ➢ Account not required

- ➢ Estimated time: 30 minutes

1. Open, style, and save map

2. Open US County Crops.

   This map opens without any symbolization. Your job is to use different types of symbolization (color and size).

3. Click Content.

   First you need to display the data by four unique attributes.

4. Click Change Style below US county crops 2007.

5. Under Choose an attribute to show, select Corn for grain, harvested acres.
6. Add Attribute.
7. Select All wheat for grain, harvested acres.
8. Add Attribute.
9. Select Soybeans for bean, harvested acres.
10. Add Attribute.
11. Select Upland cotton, harvested acres.
12. Add attribute.
13. Select Vegetables, acres harvested for sale.

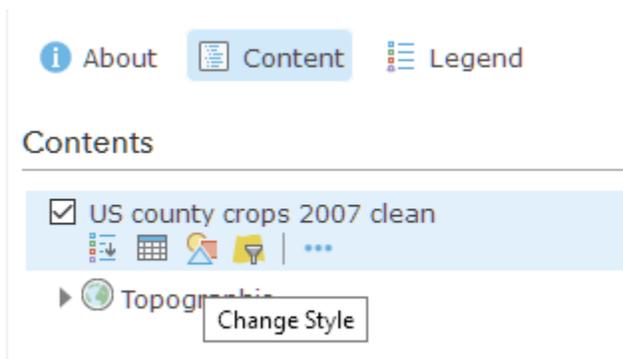Change Style

US county crops 2007 - US county crops 2007 clean

① Choose an attribute to show

Corn for grain, harvested acres.

All wheat for grain, harvested acres.

Soybeans for beans, harvested acres.

Upland cotton, harvested acres.

Vegetables, acres harvested for sale.
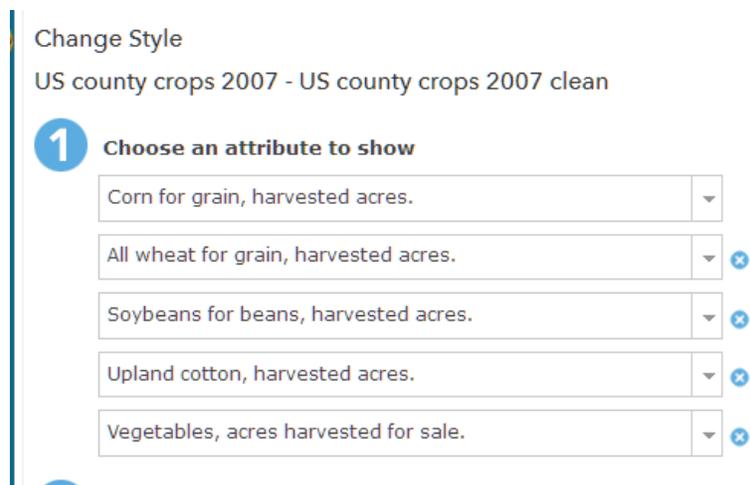
2. Display by Predominant Category

The next part of this activity will introduce you to predominant mapping. A predominance map allows you to analyze multiple fields of related data and show the field that is predominant (has the most units). The multiple fields of data must share a common subject and unit of measurement. The predominant map can either be displayed by Predominant Category or Predominant Category.

1. Select Predominant Category.
2. OPTIONS.

   Change the colors to represent the crop types.

3. Click the square for corn and select yellow. Click OK.

4. Click the square for wheat and select dark tan. Click OK.
5. Click the square for soybeans and select dark brown. Click OK.
6. Click the square for cotton and select white. Click OK.
7. Click the square for vegetables and select green. Click OK.

You can apply transparency to each feature based on the strength of the predominant attribute (percentage of total).

8. Click Set from Predominant Percentage.
9. Click OK to dismiss Predominant category.

Q1. What is dominant in the Midwest and why?

Q2. Why does the West Coast have a majority of vegetable production?
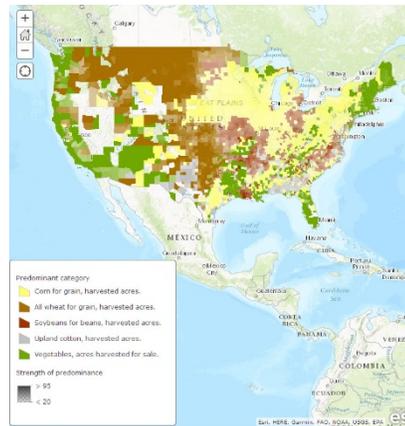
2. Display by Predominant Category

You will now display your data by Predominant Category & Size with color showing the predominant category, size showing the sum of the categories and transparency showing the relative strength of the predominance.

1. In Change style dialog, click SELECT under Predominant Category & Size.
2. Zoom into the county level.
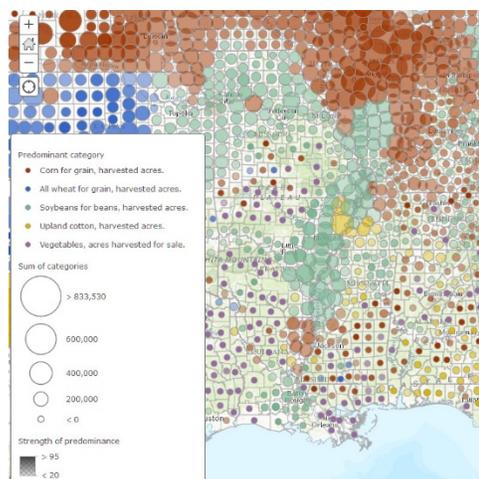
Q3. List the advantages and disadvantages of the two predominant categories styles.

Q4 List the three variables displayed in predominant category and size maps.

The big three: Spatial, spectral, temporal

What you need

➤ Account not required
➤ Estimated time: under 30 minutes

Remotely sensed images all have three things in common: a spatial, spectral, and temporal component. The spatial resolution of an image refers to the size of the smallest object that can be resolved on the ground and in digital imagery is limited by its pixel size. The spectral resolution of an image describes the frequency of the electromagnetic spectrum collected by the satellite. This spectral characteristic allows different features to be seen as separate entities. The temporal resolution of an image is defned as the amount of time needed to revisit and acquire data for the exact same location. In this activity, you will look at three different types of remotely sensed images, describe their spatial, spectral, and temporal components, and record your fndings in the chart below:

Satellite	Spatial Resolution	Spectral Resolution	Temporal Resolution
Landsat 8			
MODIS True Color			
NAIP Preview			

1. Go to ArcGIS.com.
2. Click Map on the top ribbon.

ArcGIS Features   Plans   Gallery   Map   Scene   Help

3. Click Modify Map.

Details | Basemap

About t   Show Contents of Map
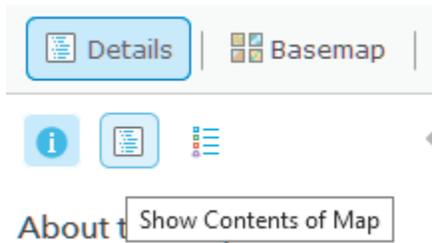
4. Click Details and select Contents.
5. Click Add then select Search for layers and ArcGIS Online.
6. Search for Landsat 8 views.
7. Click Landsat 8 View and Add.

Details   Add

Search for Layers

Find: Landsat 8 views   GO
In: ArcGIS Online
☑   Within map area
19 Results Found
Landsat 8 Views
by esri   Add
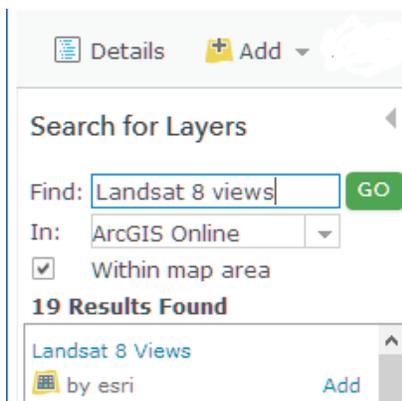
8. Click DONE ADDING LAYERS.

9. Click Show Item Details.
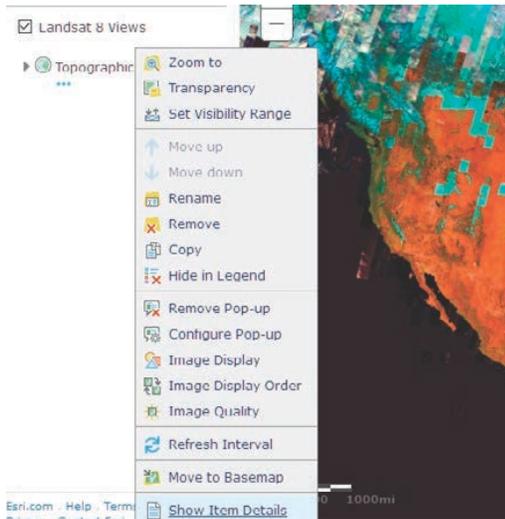
10. Read the item details and record the spatial, spectral, and temporal resolution in the chart.
11. Repeat steps 6-10 searching for MODIS True Color.
12. Add MODIS True Color – Terra Surface by Esri and record information.
13. Repeat steps 6-12 searching for NAIP Annual Coverage
14. Add NAIP Annual Coverage and record information.

Q1 Which of the three images shows the most detail?

Q2 Which of the three images has the most spectral reflectance information?

Q3 Which of the three images has the shortest and the longest temporal interval?

Farming alfalfa and corn in Nebraska

Geospatial technologies provide farmers with tools to help them decide which crops to plant and how to get the most from every acre. Agriculture data taken at specific points can be used to understand how different quantities change across a field.

Precision agriculture is sometimes called "site-specific" farming. A farmer using precision farming will identify the variability of different quantities within a single field. This allows the farm to get the best results. Soil samples are used to determine fertilizer rates and production yields. In this exercise, you will use soil sample data to determine which fields are best to plant corn and which are the best for alfalfa. The table below lists the soil parameters that are best for corn and alfalfa.

	Corn	Alfalfa
pH	6-7	7-8
P	25-80%	26-1%
K	1.8-2.9%	2.5-4.5%

Build skills in these areas

- ➢ Opening an existing online map
- ➢ Symbolizing layers
- ➢ Performing multiple variable filters
- ➢ Adding a field to an attribute table.
- ➢ Changing square meters to acres
- ➢ Understanding continuous surface maps from point data
- ➢ Interpolating point data
- ➢ Using continuous surface maps to answer questions
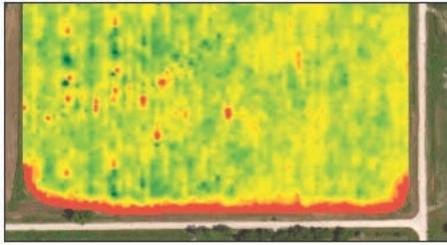- ➢ Saving and documenting an online map

What you need

- ➢ Account required
- ➢ Estimated time: 30 minutes – 1 hour

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Read about Precision Agriculture.

Precision agriculture

1. Find, open, and save the map

1. Sign into your online ArcGIS organizational account.
2. In the search box, type esripress_ig_imagery and Search for Groups

   The default search returns results found only within your organization. To show all public results, you'll remove that filter.

3. Uncheck the box that says to only search in your organization.

   ☐ Show ArcGIS Desktop Content

   ☐ Only search in Participants and Resources

4. Click esripress_ig_imagery to view group content.
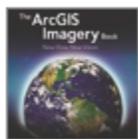
   esripress_ig_imagery
   Instructional Guide to the ArcGIS Imagery book.
   owned by esripress_ig_imagery on February 8, 2017

   Details

5. Click the thumbnail for Precision Agriculture to the map.

   Precision Agriculture
   Precision agriculture analysis.
   Web Map by Kathryn_Keranen_LearnArcGIS
   Last Modified: September 22, 2016
   ★★★★★ (0 ratings, 0 comments, 17 views)

   Open ▼   Details

   High-resolution aerial imagery has been used to construct field polygons. The field polygons provide the basic information needed to complete the precision farming exercise

6. The map opens showing the Topographic basemap, Farm Study Area, Fields, Soil Samples, and Buildings.
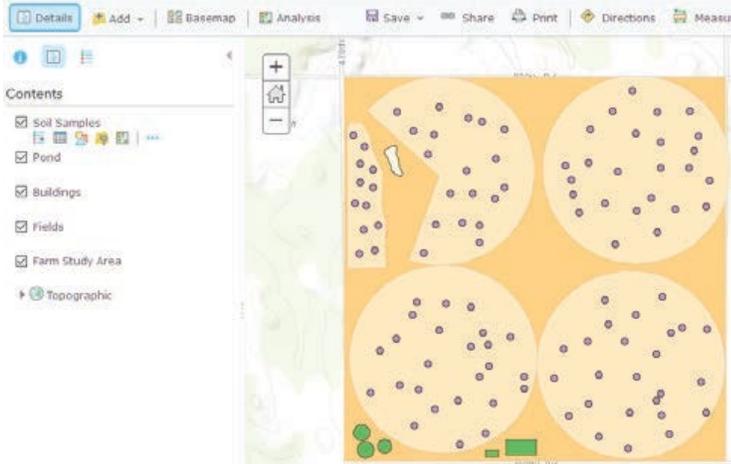
7. To save the map on the top ribbon click Save and choose Save As.
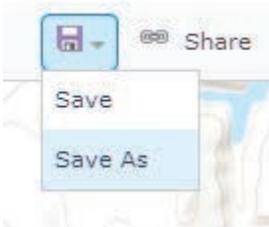
8. In the same Map window, type Answers: Precision Agriculture
9. Type individualized tags and a brief description of the map's content.

10. Click SAVE MAP.

2. Change the basemap, symbolize, and label

1. On the upper bar change the Basemap to imagery if it is set to Topographic.
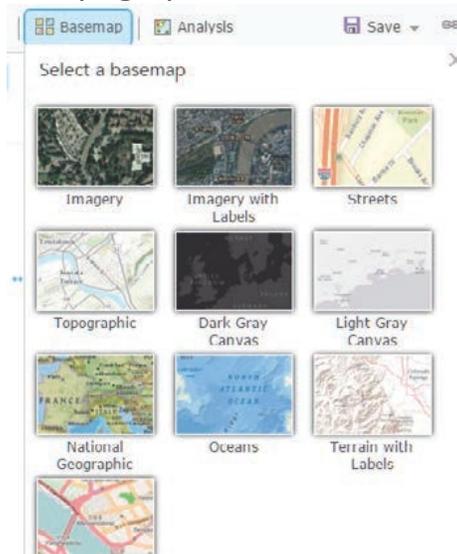
2. Under Details, click Show Contents of Map, and then click Farm Study Area and choose Change Style.

3. Click OPTIONS.
4. Click Symbols.
5. Click FILL and choose No Color.
6. Click OUTLINE and choose Red with a Line Width of 5px.
7. Click OK and OK.
8. Click Done.
9. Click Fields>>Change Style>>OPTIONS>>Symbols.
10. Change the color to light tan.
11. Click OK and OK.
12. Click DONE.
13. Click Fields>>More Options>>Create Labels.
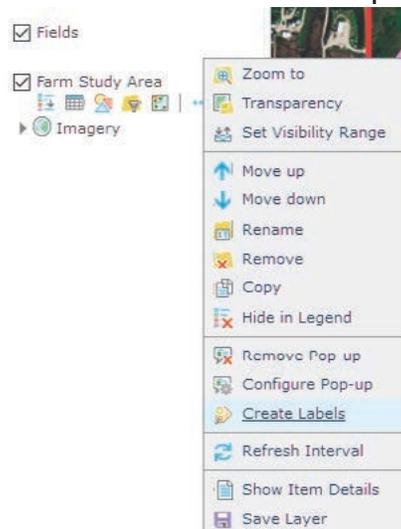
14. Be sure the size is 32.
15. Click OK.
16. Click Buildings>>Change Style>>OPTIONS>>Symbols.
17. Select Red.
18. Click OK and OK.
19. Click Done.
20. Click Pond>>Change Style>>OPTIONS>>Symbols.
21. Select Blue.
22. Click OK and OK.

23. Click Done.
24. On the upper ribbon click Save.
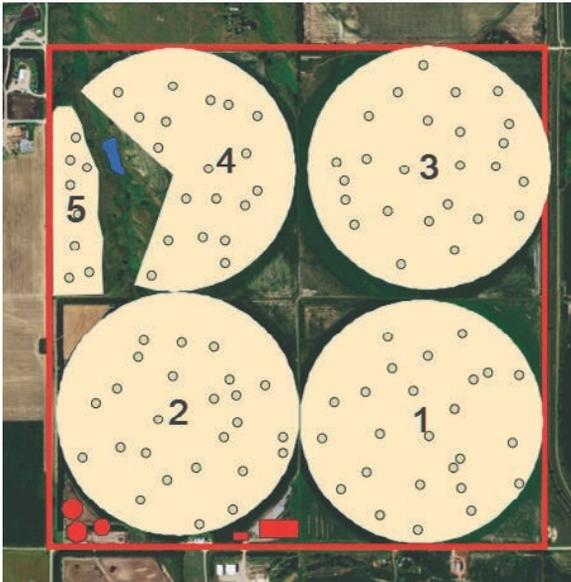
3. Filter double variables for crop growth

Remember your task in this exercise was to use the soil sample data to determine which fields are best to plant corn and which were best for alfalfa. You were given the table below to list the soil parameters best for the two crops.

	Com	Alfalfa
pH	6-7	7-8
P	25-80%	26-1%
K	1.8-2.9%	2.5-4.5%

ArcGIS Online allows users to ask questions of data by using filters. A filter presents a focused view of a feature layer in a map. In this instance, you would like to see the soils samples that represent soil conditions good for corn and soil conditions good for alfalfa. You can create filters by using definition expressions. Definition expressions use three things:
- Field name
- Operator
- Value

Soil best for corn has:
- A pH is between 6 and 7
- Phosphorous is between .25 and .80
- Potassium is between 2.5 and 4.5

1. Click Soil Samples>>Filter.
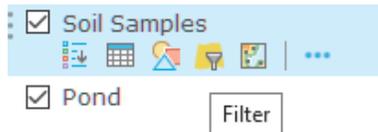
The filter menu opens ready to build the first expression.

2. The expression should be pH is between 6 and 7.
3. Click the + and Add another expression.
4. The expressions should be P is between .25 and .80.
5. Click the + and Add another expression.
6. The expressions should be K is between 1.8 and 2.9
7. Click APPLY FILTER
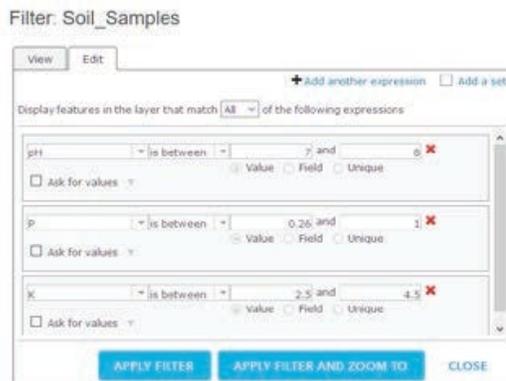
Q1 Which fields are most suited for corn?
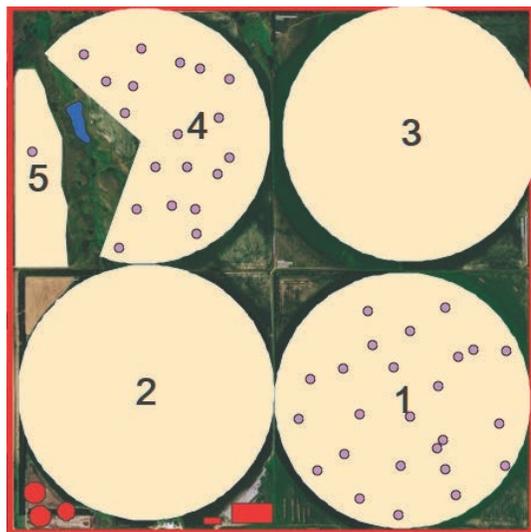
8. Click Soil Samples>>Filter.
9. Click REMOVE FILTER.
10. Build another complex filter expression that identifies fields suited for alfalfa. Refer to the chart at the beginning of the lesson.
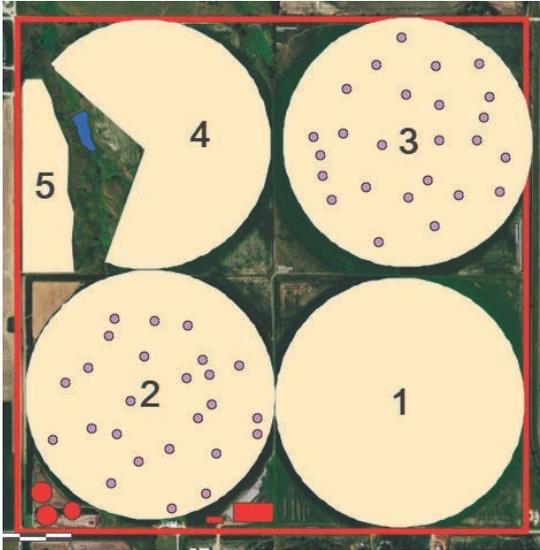
Q2 Which fields are most suited for alfalfa?

4. Create a continuous surface map by interpolation from point data

By using precision agriculture, farmers can use regular soil testing to understand where fertilizer needs to be applied. In this next section, you will establish a base line soil indicator for pH, phosphorous, and potassium. You will use interpolation to create a continuous surface map from point data. (A continuous surface represents phenomena in which each location on the surface is a measure of the concentration level or its relationship from a fixed point in space or from an emitting source.) You will use the Interpolate Points tool to predict values at new locations based on measurement from the soil samples. The tool takes point data with values at each point and returns areas classified by predicted values. The tool uses the Inverse Distance Weighted or IDW algorithm. An algorithm is a set of mathematical rules followed in calculations by a computer. You will make a continuous surface map for pH, phosphorous, and potassium.

1. Click Soil Samples>>Filter>>REMOVE FILTER.
2. Click Soil Samples>>Perform Analysis.
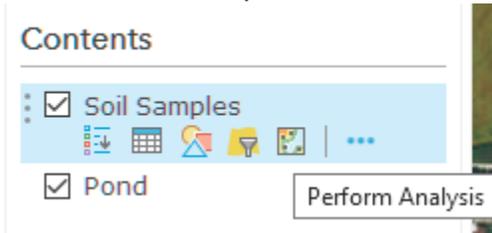
3. Click Soil Samples>>Perform Analysis>>Analyze Patterns>>Interpolate Points.
4. Click Interpolate Points, open the Interpolate Points interface and use the following parameters:
   - Choose point layer containing locations with known values in Soil_Samples.
   - Choose field to interpolate is pH.
   - Click Options
     - Clip output to Fields.
     - Classify by Geometric Intervals.
     - Number of classes is 5.
   - Result layer name is pH.
   - Uncheck Use current map extent.
5. RUN ANALYSIS.
6. Click pH>>Change Style>>Counts and Amounts (Color)>>SELECT>>OPTIONS>>Symbols.
7. If the selected ramp is dark red for high pH and light red for low pH, click OK.
8. Click Done.
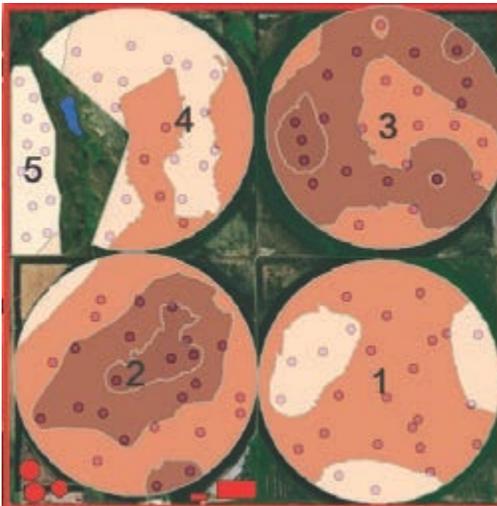
9. Repeat steps 3-8 using P as the variable and selecting a green color. Name the file Phosphorous.
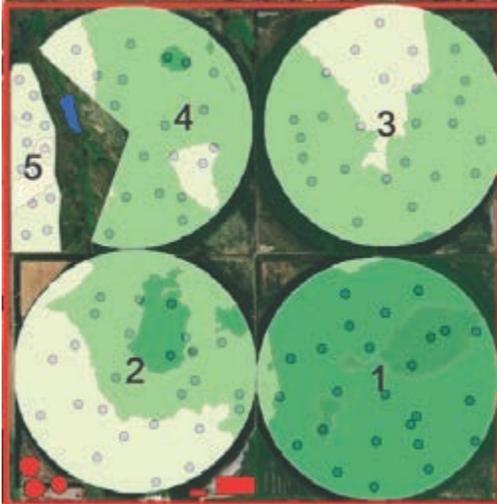
10. Repeat steps 3-8 using K as the variable and selecting a purple color. Name the file Potassium.
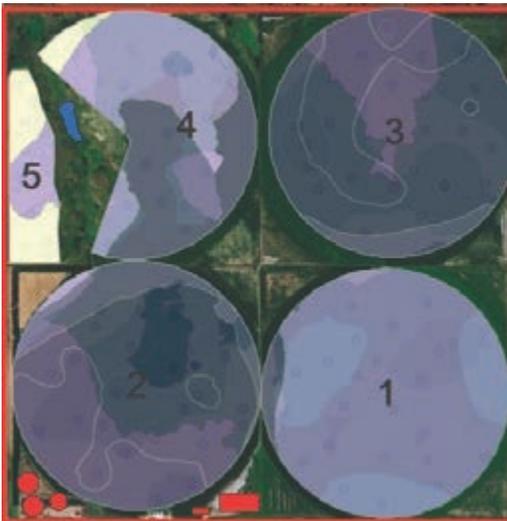
You have now established baseline data for the farm. As previously shown, fields 1-4 are suitable for the designated crops. Soil samples can be taken annually to determine where fertilizer is needed.

5. Analysis of field 5

Field 5 has not been used in several years. Because of the poor quality of its soil, a more extensive individualized analysis should be done.

1. Click Fields>>Filter.
2. Expression should be: Name is 5.
3. APPLY FILTER.
4. Click Soil Samples>>Filter.
5. Expression should be: Name is 5>.
6. Apply FILTER.
7. Repeat steps 3-5 in the previous section.

Ph_ field5

P_field5

K-field5

9. Click Fields>>Filter>>REMOVE FILTER.
10. Click Soil Sample>>Filter>>REMOVE FILTER.

From the above analysis, the farmer can decide how much fertilizer would be needed to make field 5 productive.

6. Data enrichment for fields

Data enrichment produces a layer that retrieves information about the people, places, and businesses in a specific area. It also creates a unique layer for each user, you will now enrich the fields by population. This is going to show the population of the farm, and it will create a layer that allows you to add fields.

1. Click Fields and Perform Analysis
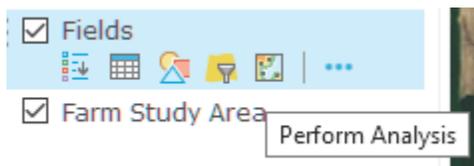
2. Click Data Enrichment and Enrich Layer.

Perform Analysis

> Summarize Data

> Find Locations

▼ Data Enrichment

Enrich Layer

3. Click Enrich Layer to activate the Enrich Layer pane.

   Fields is the chose layer to enrich with new data.

4. Click SELECT VARIABLE to open Data Browser and browse for variables:
   - Be sure that the United States is chose in the upper right-hand corner.
   - Click the arrow to go to the second page.
   - Click Landscape.
   - Click LAND COVER.
   - Uncollapse Landscape Analyst Variables.
   - Check Percent of Pasture/Hay/Cultivated Crops (NLCD).
5. Click APPLY.
6. The result layer name is Enriched Fields_yourinitials.
7. Uncheck Use current map extent.
8. Click RUN ANALYSIS.

7. Add fields and calculate acres and hectares

Open the attribute table. Area is given in square meters. Square meters are not the unit that is used to describe farm fields. Farm fields are described in acres or hectares.

One acre = 4046.8 sq. meters.
One hectare = 2.5 acres.

1. Click Enriched Fields and Open Attribute Table.
2. Click Table Options and Show/Hide Columns.
3. Uncheck all fields except Name and Area.
4. Click Options and Choose Add Field.
   Name is Acres.
   Type is Double.

Fields (5 features, 0 selected)	Table Options ▾
Area	Filter
846,553	Show Selected Records
846,553	Center on Selection
846,553	Clear Selection
846,553	Add Field
589,272	Show/Hide Columns

5. Click ADD NEW FIELD.
6. Right click the gear on the new field Acres and choose Calculate.
7. Enter the following formula: Area/4046.38.
8. Click CALCULATE.

Expression Builder

Acres =

CAST(Area AS FLOAT) / 4046.38

The Acres field now contains acreage.

9. Repeat steps 3-8:
- Name the field Hectares.
- Type is Double.
- Use the formula: Acres/2.5.

You have now provided the farmer with some basic information about the health of his fields and he can make plans for future rotations and fertilizer applications plus decide about the value of Field 5.

Fields (5 features, 0 selected)		Table Options ▼
Area	Acres	Hectares
846,553	209.21	83.68
846,553	209.21	83.68
846,553	209.21	83.68
589,272	145.63	58.25
140,230	34.66	13.86

10. Click Save.

Three-dimensional scenes

Where and what?

ArcGIS OnlineSM 3D Scene Viewer allows users to explore the world in 3D. The scene viewer is an app built into the ArcGIS Online website for creating and interacting with 3D scenes. The scene viewer works with most modern browsers. Users can choose global or local views, switch basemaps, add layers, configure layers, capture slides, and save scenes. In this introductory activity, you will match a verbal description with a 3D scene.

Build skills in these areas

- ➢ Navigate a 3D scene

- ➢ Search

- ➢ View layers

- ➢ Choose a basemap

What you need

- ➢ Account not required

- ➢ Estimated time: under 30 minutes

- ➢ Publication date: March 14, 2019

1. Find and Describe Locations

1. Open the Three Dimensional Map Scene and investigate the maps at the bottom of the viewer.
2. Click the Map. At the bottom, the app shows various locations on Earth. When you click on any of the locations, it opens within the scene view.
3. Navigate a scene using all the tools.

4. Practice opening different views by clicking scenes at the bottom.

5. Learn to use the scene tools, paying attention to changing the basemaps.

    🔍   Search and type a location into the search box

    ▧   View layers

    ▦   Choose a basemap

    ☀   Adjust daylight

    ⤲   Share the scene

    ⚙   Change settings

2.   Complete the chart below

Add the region and select a description from the choices given.

Location	Region	Description
Mount St. Helens		
Mount Whitney		
Grand Canyon		
Bell Rock		
Horseshoe Bend		
Meteor Crater		
Bowknot Bend		
Devil's Tower		
Venice Lagoon		
Mount Blanc		
Mount Vesuvius		
Ayres Rock		
Diamond Head		
The Badlands		
Guitar Shaped		
World's Largest		
Star Fort		
Potash Ponds		

Descriptions:
- Farm shaped like a guitar, tribute to wife who died
- Only active volcano in mainland Europe
- Butte composed of sedimentary rock
- Evaporation ponds near Moab
- Meteorite
- Fort during the age of cannon battlefields
- Enclosed bay of the Adriatic Sea
- Landscape inhabited by bison, and bighorn sheep
- Massive sandstone monolith
- Green River canyon that doubles back on itself
- Caused by 277-mile river eroding
- Highest mountain in the Alps
- A hairpin turn on the Colorado River
- Highest summit in contiguous USA
- Flat-topped volcanic formation
- Butte composed of sedimentary rock
- Volcanic cone on Island of Oahu
- Highest mountain in the Alps

3

In this lesson you have learned how to navigate in a 3D scene environment.

Learn more

View scenes in Scene Viewer
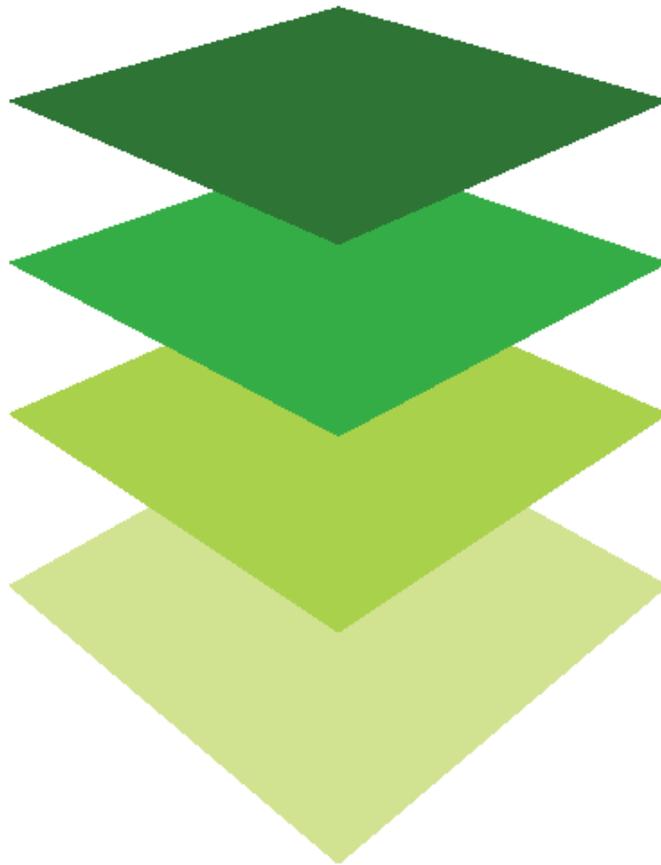
Visualizing change over time with historical topographic maps

The USGS Historical Map Collection includes all scales and all editions of the more than 175,000 topographic maps published by the USGS since its inception in 1882. With the USGS Historical Topographic Map Explorer, not only can you see all 175,000-plus maps, but you can layer them over each other and download them to your own computer.

In January 1961, President John F. Kennedy set the goal to put a man on the moon by the end of the decade. This undertaking would require a large site with extensive test facilities and research laboratories for NASA's Space Task Group. Among other criteria, the site would need to have access to water transport by large barges, a moderate climate, availability of all-weather commercial jet service, and a well-established industrial complex. After consideration of over twenty-five locations, 1,000-acre site twenty-five miles southeast of Houston, adjacent to Clear Lake near Galveston Bay, was selected in September 1961.

You have been asked to identify a set of historic topographic maps to show the transformation of a southeast Texas site from an undeveloped area used for cattle grazing to a world-class 21st-century scientific research and test facility. These maps will be used to create a display in the Johnson Space Center's Visitors Center depicting changes to the site and surrounding area from the 1930s to the present.

Build skills in these areas

➢ Opening the USGS Historical Topographic Map Explorer (HTME) in a browser
➢ Searching for a specific location in the HTME
➢ Identifying available historic topographic maps for a given location

What you need

➢ Account not required
➢ Estimated time: 30 minutes – 1 hour

Publication date: March 14, 2019

Locate the area

1. In a browser, go to USGS Historical Topographic Map Explorer.
2. In the Find a Place search box, type Johnson Space Center and click Enter.
3. Use the zoom out (-) button to get a slightly wider view of the area and pan until your view is approximately the same as one on the right.

4. On the map, click in the cent of the Johnson Space center Area. A red + will appear where you click, and a time line of available maps will be displayed beneath the viewer.
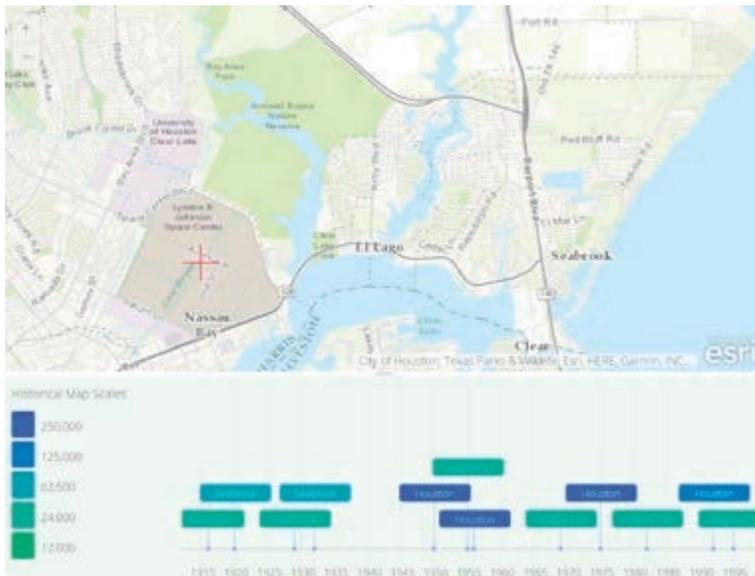
5. Hover your cursor over a map name in the time line to see a thumbnail of the map as well as its scale.
6. In the time line, click the Seabrook 1932 map to add it to the map view.
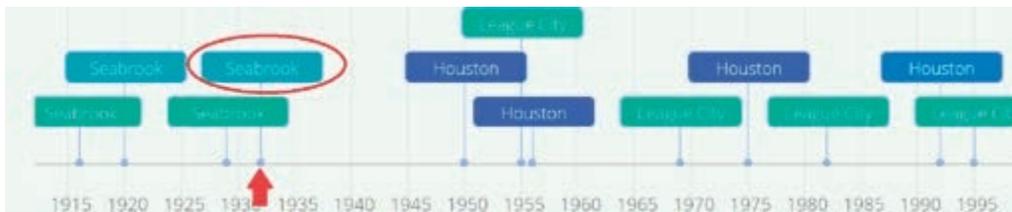
The 1932 map is now shown in the map list on the left side of the view window. Clearly, the space center site was totally undeveloped at that time.

7. Use the transparency slider to hide or show the map. Use the X in the corner if you decide to delete it from the list.
8. Add the League City 1955 topographic map to see changes since 1932.

Q1 Describe changes to the space center site between 1932 and 1955.

Add the first historical topographic map following the selection of the Clear Lake site for the Johnson Space Center.

3

9. League City 1969 is the earliest topographical map after the 1961 site selection. Add it to see the changes to the area since the 1955 map. Use the transparency slider to compare the two maps. The changes since 1955 are shown in purple.

Q2 Besides construction on the site of the space center, what other changes can you see in the area? Add the League City 1983 and League City 1955 map.

10. Turn all the maps off by changing their transparency to 100% (all the way right).
11. Turn them on, one by one, to observe change to this area over time.
12. Turn on the 1932 map and then the 1995 map to see the most dramatic comparison.

Experiment with other maps in the time line beneath the viewer.

Q3 Identify a set of maps to display at the space center to tell the story of the site in the 20th century. For each map, write a sentence summarizing what it shows about the evolution of the space center site during the time span covered.

Your assignment is complete. You used the USGS Historical Topographic Map Explorer to find historical topographic maps of the area surrounding the Johnson Space Center that could illustrate change over time growth from undeveloped waterfront grazing land to a thickly settled residential, boating, research, and commercial area.

Time enabling

Spatial phenomena collected with time information may allow map users to see what happened at a specific time, or what may happen in the future. By animating time-based data, you can visualize it at each step and see patterns or trends emerging over time. Feature layers that include temporal data can be enabled on the item page for the layer. Any CSV (comma-separated values) file that contains a time can be enabled.

You have been given three time-enabled files. You have been asked to time-enable them and analyze the data based on the information being seen throughout a time period. The data you have been given is separate and contains unique datasets involving crime, earthquakes, and terrorist attacks. Visualizing temporal data can help you step through your data in a temporal sequence and see the patterns or trends that emerge in your data over time. For example, does a certain type of crime occur at different times of day, or what periods of time do terrorist attacks occur?

Build skills in these areas

➢ Identifying CSV files of crime, earthquakes, and terrorist attacks
➢ Adding CSV files to ArcGIS Online and converting to a feature layer
➢ Creating time-enabled feature layers

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

esri | THE SCIENCE OF WHERE

1. Time-enabled crime data

Build the map for time-enabled crime data

1. Sign into your ArcGIS organizational account.
2. In the upper search box , type esripress_ig_imagery and click Groups.
   The default search returns results found only within your organization. To show all public results, you'll remove that filter.
3. Clear the check box that says to only search in your organization

   ☐ Show ArcGIS Desktop Content

   ☐ Only search in Participants and Resources
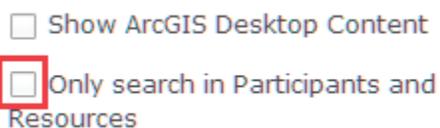
4. Click esripress_ig_imagery to view the group content.

   esripress_ig_imagery
   Instructional Guide to the ArcGIS Imagery book.
   owned by esripress_ig_imagery on February 8, 2017
   Details
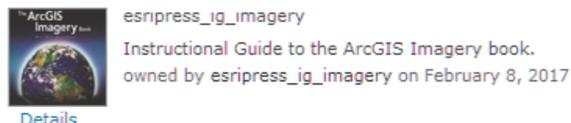
5. Click the Open arrow below the thumbnail for IGIMG_sd_crim.csv and click Download.

   IGIMG_sd_crime
   Crime data from San Diego, CA for 2013.
   📄 CSV by esripress_ig_imagery
   Last Modified: March 10, 2017
   Open ▾   Details   ★★★★★ (0 ratings, 0 comments, 0 downloads)
   Download
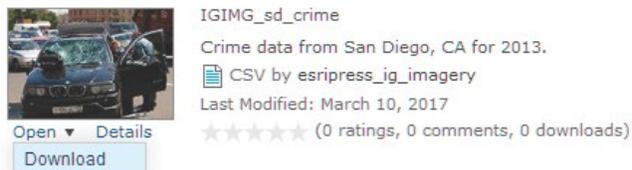
6. Save the file IGIMG_sd_crime.csv to a location of your choice.
7. On the upper ribbon of the software, click My Content.

   Home   Gallery   Map   Scene   Groups   My Content   My Organization

8. Click Add Item>>From my computer and browse to where you stored IGIMG_sd_crime.csv.

   ➕ Add Item ▾   🖼 Create ▾
   From my computer
   From the web
   An application
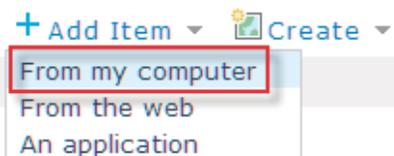
9. Add individualized tags of your choice.
10. Check Publish this file as a hosted layer.
11. Check Latitude/Longitude.
12. Click ADD ITEM. Latitude and longitude are correctly chosen as the defaults.

Creating Service
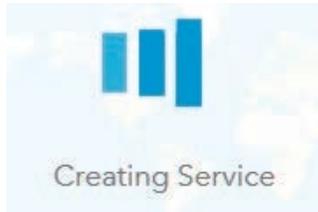
13. Go to the functions for Layers and click Time Settings.

IGIMG_sd_crime

Open In ▼   Export To ▼   Time Settings   Enable Attachments   Service URL
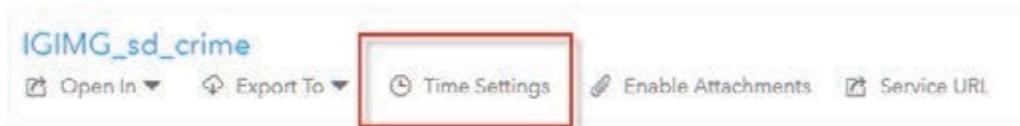
14. Click Enable Settings> Notice that the date field is located.

Time Settings   ✕

Enable time on this layer to visualize how the data
changes over time using the time slider on the map.

☑ Enable time

The time data is recorded as:

● specific events in time
   Time field:
   date ▼

○ time ranges with a start and end time
   Start time field:
   date ▼

End time field:
   time ▼

OK   Cancel
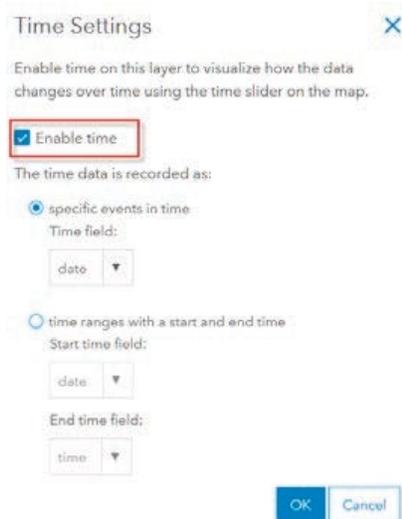
15. Click OK.
16. Click the feature layer box and open in Map Viewer.
17. Under Change Style, choose an attribute to show and select Show location only.

Change Style

IGIMG sd crime

① Choose an attribute to show

Show location only ▼

18. Click DONE.

3
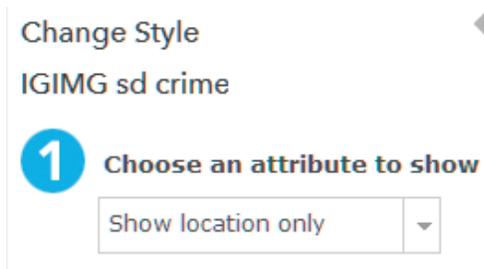
Notice that the time slider now appears at the bottom of the screen.

March 31, 2013 to April 3, 2013

Q1 What is the time period segment, or the time interval selected?

You can configure the time settings by clicking Time Setting to the right of the slider and showing Advanced Options. You can control the following variables:
- Playback Speed: Slower or Faster
- Time Span: shows the designated time period
- Time Display
  o Enter a numeric value for the time interval.
  o Choose units from a drop-down list.
  o As the time passes, choose:
    ▪ Only display the data in the current time interval.
    ▪ Progressively display all the data.

19. Set the Time slider to Slowest.
20. Set the display data to 1 Week. Looking at a time interval of a week allows the user to see if there is a variation in crime per day.
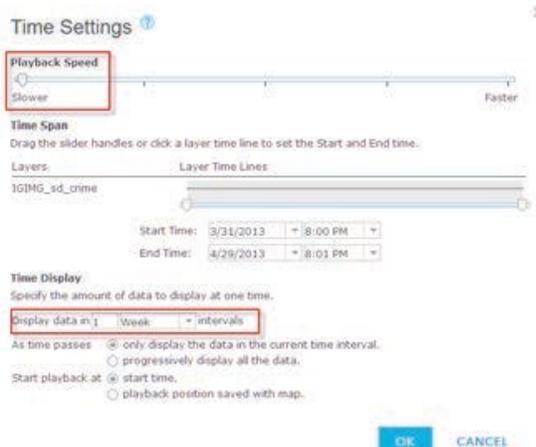
21. Click OK.
22. Click the Play/Pause icon to run the animation.

March 3, 2013 to April 7, 2013

Play/Pause

The animation covers a five-week period showing one week at a time.

Q2 What are your general observations?

Filter expressions

The sd_crime data has many variables. Below are some of the variables:
- Type
  - Arson
  - Assault
  - Burglary
  - Drugs/Alcohol Violations
  - DUI
  - Fraud
  - Homicide
  - Motor Vehicle Theft
  - Robbery
  - Sex Crimes
  - Theft/Larceny
  - Vandalism
  - Vehicle Break-In/Theft
  - Weapons
- Comm_pop: Community Population total
- City
  - SndCHU-Chula Vista
  - SndELC-El Cajon
  - SndLAM-La Mesa
  - SndLEM-Lemon Grove
  - SndNAT-National City
  - SndSAN- San Diego

You can use filters to look at these different variables. A filter presents a focused view of a feature layer in a map. By limiting the visibility of features in a layer, you can reveal what's important. For example, you might create a filter on a crime layer to show only assaults that occurred within a city boundary. By filtering the crime layer based on crime type and city boundary, you can show patterns to help your police department allocate resources. In the next step, you will first filter crime by burglary and run the animation.

1. Click Filter under the IGIMG_sd_crime feature.
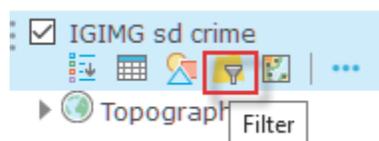
2. Construct the expression:
    Type is MOTOR VEHICLE THEFT
3. Click APPLY FILTER>
4. Go to the top ribbon and select Basemap. Change the basemap to National
    Geographic, Imagery with Labels, or OpenStreetMap to give more information
    about the area.
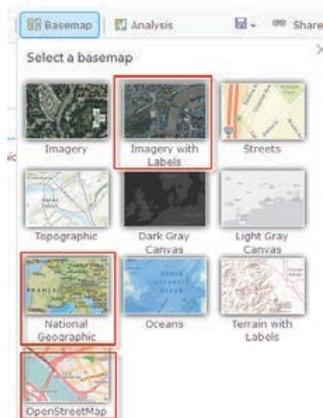
*Q3 What can you observe about the temporal distribution of MOTOR VEHICLE
    THEFT from March 31, 2013, to May 5, 2013?*

*Q4 Are there any features on the map that you can identify as having an impact
    on MOTOR VEHICLE THEFT?*

Expand your filter by looking at MOTOR VEHICLE THEFT within an area with a
population (comm_pop) of 77873. This requires a double expression that isolates
MOTOR VEHICLE THEFT and the area with a population of 77873

5. Click Open Filter.
6. Click Edit.
7. Click the plus sign to add another expression: comm_pop is 77873.
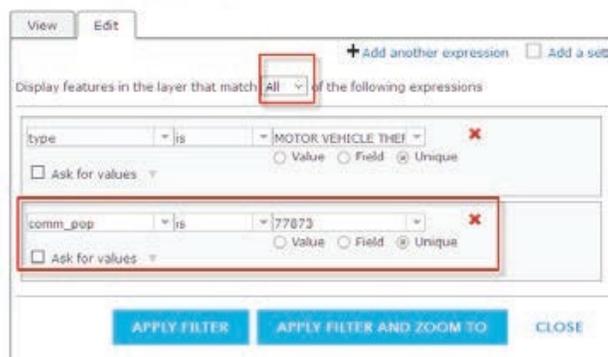
8. Change Any to All so it reads. Display features in the layer that match All of the following expressions.
9. Click APPLY FILTER.
10. Play the animation.

Q5 Can you see any pattern or clusters to the MOTOR VEHICLE THEFT or any relationship to other features on the map?

Make up questions of your own about types, cities, population, or other variables within the database. After defining the question, construct your filters, verify the animations, and analyze the results.

2. Time-enabled earthquakes

1. Repeat steps 3-23, under time-enabled crime data, downloading IGIMG_earthquakes and creating a feature layer.
2. Experiment with time span and tilters. Try the variable of depth and mag (magnitude).
3. Try visualizing on a Dark Gray Canvas Basemap.
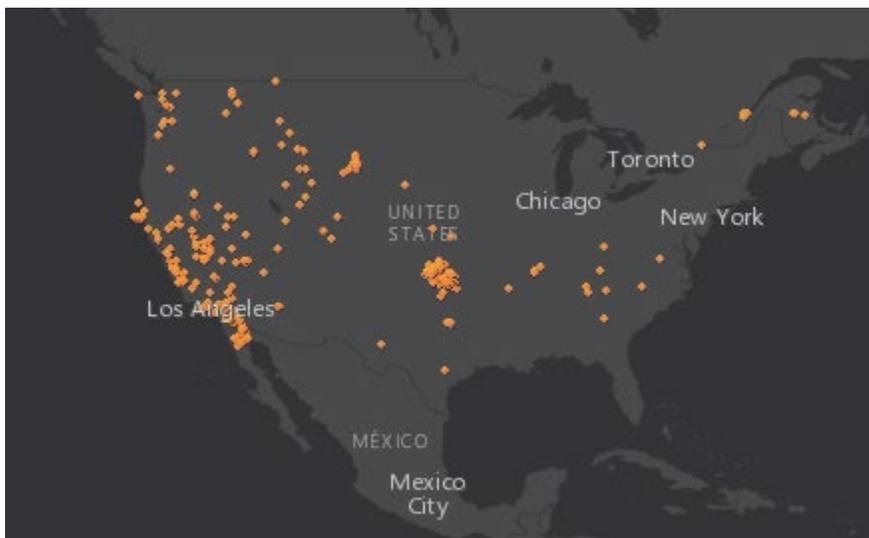
3. Time-enabled terrorist attacks

1. Repeat steps 3-23 under time-enabled crime data, downloading
   IGIMG_terrorist and creating a feature layer.
   - Located features using Address.
   - Select geocoder: Esri World Geocoder.
   - Select country: World.
2. Locate features using Address. When it asks if you want to review
   addresses, say no.
3. Experiment with time span and filters. Try the variables of Target Type
   and Perpetrator.

Another way that you could look at this data is to join the terrorist attacks to world
countries. The Join tool transfers the attributes of one layer or table to another
based on spatial and attribute relationships. Statistics can then be calculated on
the joined features.
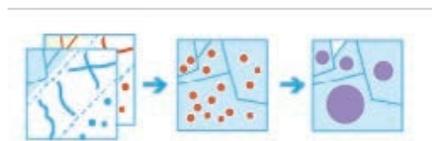
4. Search for World Countries (Generalized) in ArcGIS Online.
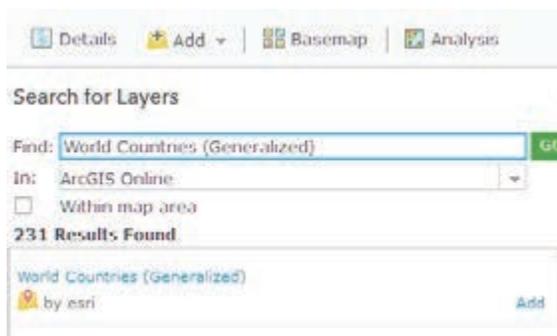
5. Click Add.

6. Click DONE ADDING LAYERS.

7. Move IGIMG_terrorist above World Countries (Generalized).

8. Under IGIMG_terrorist click Perform Analysis.

9. Perform Analysis>>Summarize Data>>Join Features.

10. Click Join Features and use the following parameters:

- Target layer is World Countries (Generalized).
- Layer to join to target layer is IGIMG_terrorist.
- Choose the fields to match : Country = Country.
- Choose join operation: Join one to one.
- Result layer name is Terrorist_by_Country.
- Clear: Use Current Map Extent.

11. Run the analysis.
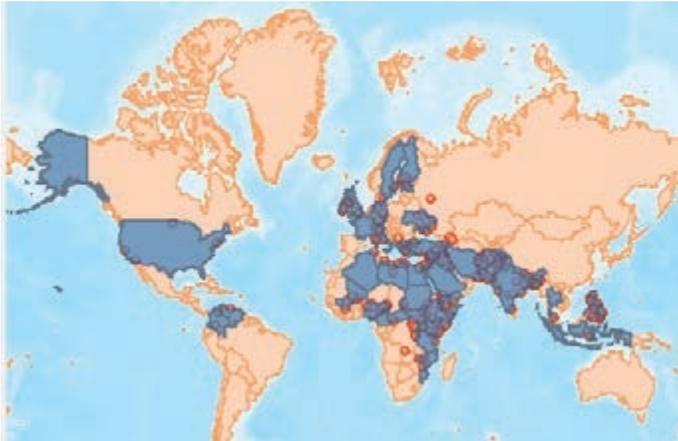
12. Save your map with proper documentation.

13. Go to Show Item Details>>Time settings and enable time.

14. Click Terrorist by Country and go to Show Item Details.
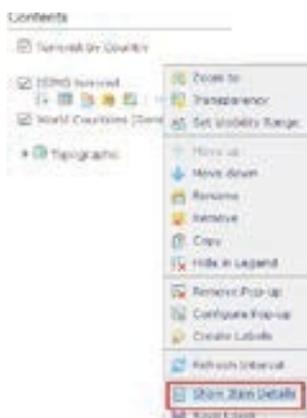
15. Click Time Settings and then Enable Time.

Terrorist by Country

Open In ▾   Export To ▾   Time Settings   Enable Attachments   Service URL

When you open your map again, the Time slider appears.

16. Experiment with time span and filters. Try the variables of Target Type and Perpetrator.

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Using Web AppBuilder for ArcGIS

Web AppBuilder for ArcGIS provides a foundation for building web applications in ArcGIS. It builds intuitive, focused apps that run anywhere, on any device, without writing a single line of code. Community leaders have asked your GIS department to create an app of the county that allows users to do and create the following:

- Scalebar
- Search
- Add data
- Basemaps
- Legends
- Measurement
- Query

Build skills in these areas

➢ Building an app using ready-to-use widgets
➢ Customizing the look of your apps with configurable themes
➢ Publishing the apps

What you need

➢ Account required
➢ Estimated time: over 1 hour

1. Create a map and share as a Web AppBuilder

1. Sign into your ArcGIS Online organizational account.
2. On the top ribbon click Content.
3. Click Create
4. Click Using the Web App Builder.

5. Document the new web app using the following parameters:
   a. Title: Basic Locational and Directional App.
   b. Tags: Remove tags and replace with individualized tags.
   c. Summary: Basic app that allows the user to find locations, measure, and add data
6. Click OK.

2. Add a theme, map, and basic widgets

1. Pick the Billboard Theme.
2. Click Map on the top ribbon.
3. Use current map view.
4. Click Widget on the top ribbon.
5. Add the following standard widgets:
   a. Scalebar
   b. Search
      1. On the icon for search, click pencil for edit.
      2. Click OK to add the Esri World Geocoder.

3. Add custom widgets

1. Click Widget 1.
2. Select Add Data.
3. Click OK and OK.
4. Click Widget 1.
5. Click Basemap gallery.
6. Click OK and OK.
7. Repeat steps 1-4 for Legend.
8. Repeat steps 1-4 for Measurement.
9. Repeat steps 1-4 for Query.
10. Click Save.

4. Preview and launch

1. On the bottom left tab, click Preview.
2. If you are happy with your work, click Launch.

In this lesson, you have created an app with both standard and custom widgets.

The constellation of Earth-orbiting satellites

When deciding how to organize their time around the lessons in this chapter, students and teachers might want to combine the next two lessons (the lesson on basemaps and the one on scale and resolution) as an activity.

In this activity, you will use an app that maps about 14,000 man-made objects orbiting the earth. You will use the app to research various types of satellites and their properties. The satellites and their positions are manned by space-track.org, which is an organization designed to promote space flight safety by sharing space situational awareness services for both US and international satellites.

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

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1. Open the Satellite Map.
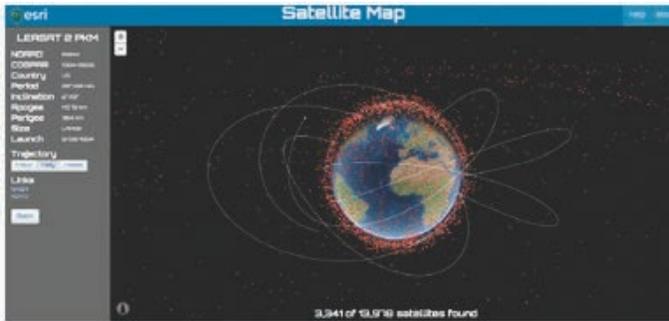
Whoa! 14,000 is a lot of man-made objects. Notice that you can not only zoom in and out, but you can rotate the Earth. The application comes with buttons and slides below preset dropdown menus, which allow you to build your own selections. There are 13,925 satellites loaded in the application. First deal with the preset quick links.

2. Click the Present tab to investigate the Quick Links.

   The first three quick links are self-explanatory country links.

3. Identify by number the country satellites
   a. American Satellites
   b. Chinese Satellites
   c. Russian Satellites

The next set of Quick Links illustrates different satellite orbits.

Before you complete the chart below you should define the following words.
- Elliptical orbit
- Perigee
- Apogee
- Geosynchronous orbit
- Geostationary orbit

Orbit Name	Shape	Distance from Earth	Number of Satellites
Low Earth			
Medium Earth			
Geosynchronous			
Geostationary			
High Earth			

Remember the application also comes with buttons and slides that allow users to build their own selections. Below are some topics that you might want to explore.

Q1 How many man-made objects are junk? Junk consists of spent rocket boosters or debris from satellite collisions. Calculate the percentage of manmade objects that are junk.

Q2 List the countries in order of the number of satellites they have launched.

Q3 How many satellites have been launched by decade that are considered Not Junk?
- *1950-1960*
- *1960-1970*
- *1970-1980*
- *1980-1990*
- *2000-2010*
- *2010-2020*

Q4 Identify the following types of orbits:
- *Geosynchronous*
- *High*
- *Geostationary*
- *Low*
- *Medium*

4. Go to Quick Links and select Landsat.

5. Zoom in and find one of the two Landsat satellites.
6. Click the satellite to see its path projection.

By exploring the satellite map you have learned about the history of satellites, the types of satellites, and their orbits.
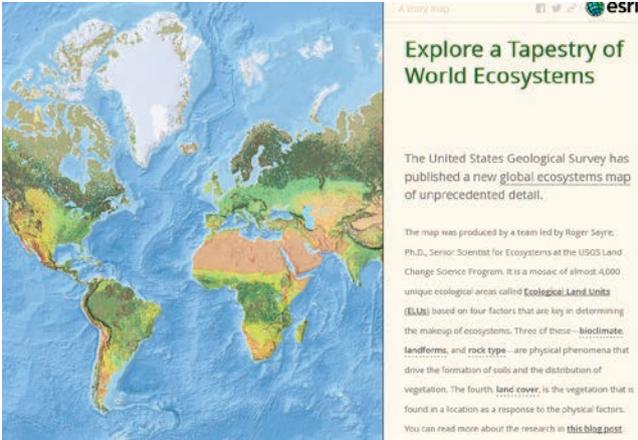
Understanding the Global Ecosystems Map

under 30 minutes

Combining four global units together using GIS

1. Click *Explore a Tapestry of World Ecosystems*.

To understand the ecological land-unit map, you must first understand the four global units.

2. Click bioclimate, which represents climate regions.

Q1 *Write a brief definition of bioclimate.*

3. Click landforms, which has been derived from elevation.

Q2 *Write a brief definition of landforms.*

4. Click rock type based on lithology input.

Q3 *Write a brief definition of lithology.*

5. Click land cover to observe the classes.

Q4 *How was the land cover derived?*

By clicking each layer, you can identify the type of area. Individual places can be accessed by clicking the buttons on the right margin of the app. This story map represents the following places:

- Sweetwater Mountains, California, United States
- Husamlar, Turkey
- Barbreck River, Scotland, United Kingdom
- Praporiste, Czech Republic
- Bishop Creek, California, United States
- Susua and Guanica Forests, Puerto Rico, United States
- Sur, Switzerland
- Gardiner, Montana, United States
- Provo River, Utah, United States
- Waimea River, Hawaii, United States
- Sils, Switzerland
- Dolores Hidalgo, Mexico
- Ixtapan del Oro, Mexico
- Taku, British Columbia, Canada

6. Pick three places that represent different areas of the world. Compare the layers that make up the ecological units in the chart below:

Region	Bioclimate	Landform	Rock Type	Land Cover

The app can be explored without the story map features by clicking *Explore the Ecological Tapestry of the World.*

When you click on a point anywhere on the map, the contributing layers are displayed on the side indicating the values of the layers.

Use the source global ecological land units map of the world to do additional individualized study. The source map allows you to search for areas as well as change basemaps.

7. Search for the administrative boundary where you live and explore your ecological units.
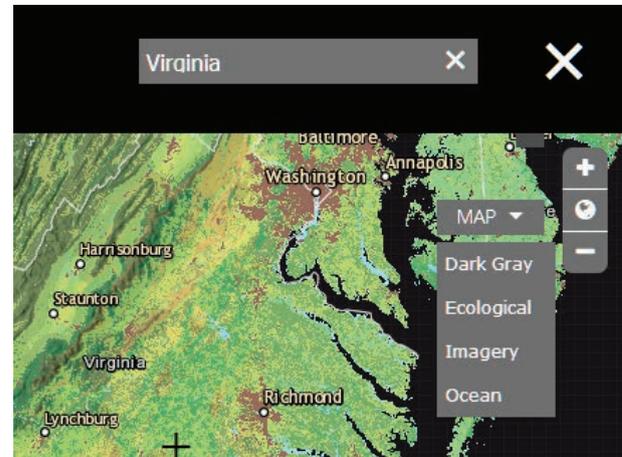
Visualize the Arctic and Antarctic Circle

A map projection is a representation of the 3D earth on a 2D plane. Any way that the earth is represented on a 2D plane results in distortion both by size and shape. Map projections are selected for different studies that present the least amount of distortion of the study area. The map used in ArcGIS Online is in the Web Mercator projection, which is the standard for sharing data on the web. Like any projection, Web Mercator has limitations. As with all Mercator projects, the North and South Poles are distorted.

Build skills in these areas

- ➢ Examine different map projections.
- ➢ Visualize the Arctic and Antarctic Circle
- ➢ Interpret latitude and longitude lines.

What you need

- ➢ Account not required
- ➢ Estimated time: 30 minutes

1. Open map and observe projections, Arctic, and Antarctic Circle

1. Go to your ArcGIS organizational account.
2. On the upper ribbon, click Map.

ArcGIS ~   Features Plans Gallery Map Scene Help   Q Search   ⚊ Sign In   ●esri

3. On the right corner, click Modify Map.

Modify Map   ⚊ Sign In

4. Change the basemap to National Geographic.

🔲 Details   ⬆ Add ~   ▦ Basemap

Select a basemap

Imagery   Imagery with   Streets
             Labels

Topographic   Dark Gray   Light Gray
              Canvas   Canvas

National   Oceans   Terrain with
Geographic   Labels
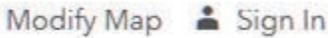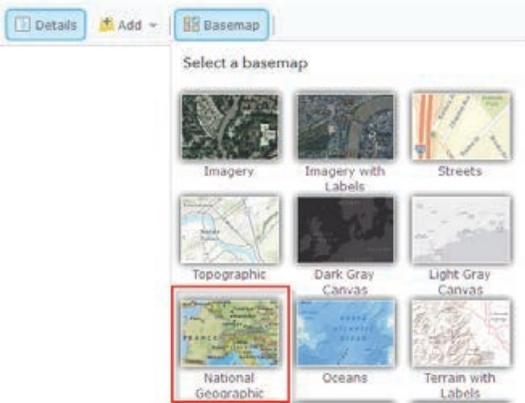
Q1 Identify the major lines of latitude.

Q2 What do you notice about the spacing of the line?

Q3 As mentioned above, the map projection used for ArcGIS Online is Web Mercator. Can you identify areas of distortion?

5. Zoom out to a world view.
6. Click + Add>>Search for layers.

📄 Details   ➕ Add ~   ▦ Basemap

Search for Layers

7. Use the following parameters in Search for Layers:
   a. Find: World Latitude and Longitude Grids by Esri
   b. In: ArcGIS Online
8. Click Add.
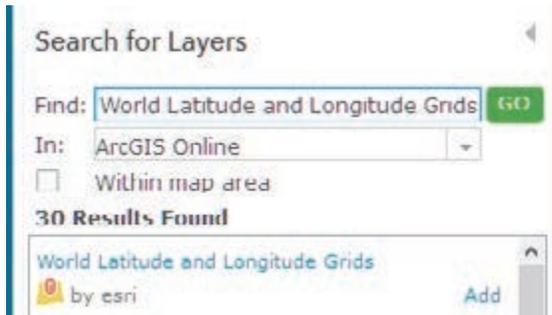
9. Click DONE ADDING LAYERS.

   The Esri basemaps are all multiscale maps that allow you to view geographic data across a range of scales—also know as zoom levels. Most data do not need to be shown across all zoom levels
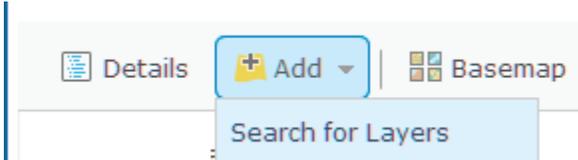
10. Examine the spacing between the latitude lines.

    Q4 What countries are above the Arctic Circle?

    Q5 What is below the Antarctic Circle?

    Q6 What continent is closest in size to Greenland?

    Q7 Why or why not is this a good projection to study the Arctic?

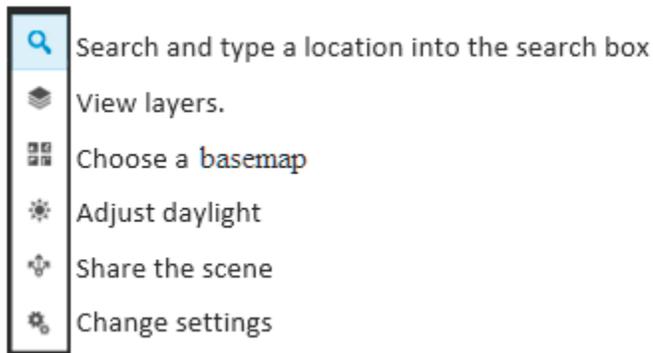In the next section of this activity, you will use a 3D representation of the earth. This is a realistic representation, and because of the unique ability to navigate, the Arctic is represented appropriately.

2. Explore the Arctic in 3D

1. Open IGIMG_Scene_Latitude_Longitude.
2. Use the Navigation tools to examine the scene.

🔍	Search and type a location into the search box
⬢	View layers.
⊞	Choose a basemap
☀	Adjust daylight
⬦	Share the scene
⚙	Change settings

3. Examine the spacing between the latitude and longitude lines.

Q8 What countries are above the Arctic Circle?

Q9 What is below the Antarctic Circle?

Q10 What continent is closest in size to Greenland?

Q11 Is the Arctic represented correctly?

In this exercise, you have looked at map data in the Web Mercator projection and displayed it on a 3D representation of the Earth.

Land Cover

Land-cover data has many analytical applications. Temporal land-cover data is even more useful. The National Land Cover (NCLD) is derived from Landsat imagery along with various other components. The Landsat imagery is classified into categories and each pixel of the classified dataset represents a land-cover type. The NLCD has 30-meter resolution and is designed to provide data every five years. Currently datasets exist for 2001, 2006, 2011, and NLCD 2016 is under development.

What you need

➢ Account not required

➢ Estimated time: under 30 minutes

1. Examine the legend that tells what type of land cover is displayed in the National Land Cover Data.
2. Click USA National Land Cover database and zoom out until you see the entire United States.

Q1 Write a detailed description of the spatial distribution of land cover in the USA. For example, the East coast states, the Gulf of Mexico states and the great Lakes states have a significant number of wetlands.

Q2 Describe the West, central US, Northeast, and Southeast.

Publication date: March 1, 2019

NLCD Land Cover Classification Legend

- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous*
- 73 Lichens*
- 74 Moss*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

* Alaska only

Image resolution versus ground accuracy

Because of the way data is stored in a GIS, it is important to distinguish between image resolution and ground accuracy. Because image data is stored as pixels, the size of the pixel determines the resolution of the image. Image resolution is typically expressed as distance on the ground. The imagery community refers to this as the ground sample distance (GSD). An image with 1-meter spatial resolution means each pixel is 1-meter X 1 meter or covers an area of 1 square meter. Ground accuracy is the degree by which a measurement reflects the true value. Both measurements can be obtained by looking at the imagery metadata.

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

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1. Click Imagery with Metadata.
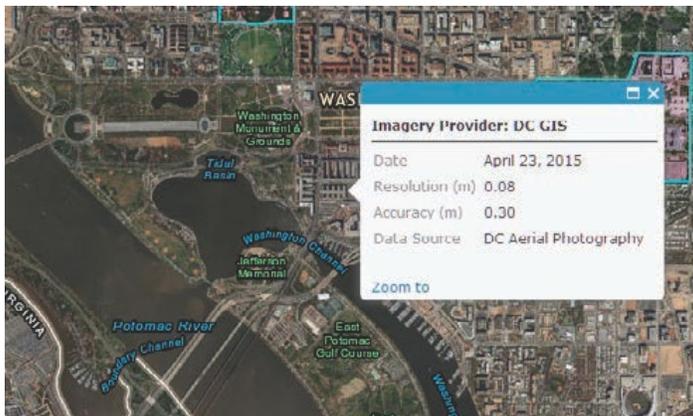

2. Zoom out to the world view.

3. Search for Washington, DC.
4. Zoom into Washington, DC until you see World Imagery Metadata appear in the contents pane.
5. Click the image. A pop-up shows you the Date, Resolution, Accuracy, and Data Source. Record this information in the chart below.

6. Repeat steps 3 to 5 for the following locations and complete the chart below:

Name	Date	Resolution (m)	Accuracy (m)	Data Source
Washington, DC				
Ayres Rock, Australia				
Machu Picchu, Peru				
Moscow, Russia				
Rio de Janeiro, Brazil				
Cape Town, Africa				
Reykjavik, Iceland				

All the images have a resolution of 0.50 m which means each pixel is .5 m X .5 m. The accuracy changes depending on the location. Remember the basemap is compiled of a mosaic of many different images taken by many different satellites at different positions around the world. After doing this lesson you should be able to distinguish between accuracy and resolution.

Earth as art: The stunning beauty of Landsat Imagery

When art experts critique a painting, they describe such things as line (delicate, bold), tone (muted, dramatic), shape (angular, elongated), movement (swirling, flowing), contrast (subtle, strong), and color (vibrant, pale). The same elements can describe Earth as Art's unique and beautiful views of our world.

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

Publication date: March 14, 2019

Earth as Art favorites

1. Click Earth as Art.
2. Use the arrows to navigate through the site's 42 photos.
3. Select your five favorite images from the collection and explain why each is a favorite by using descriptive words about at least three of these image elements: line, tone, shape, movement, contrast, and color.

Image number	Why do you like it?

Racing the High Mountains

The Haute Route Dolomites Swiss Alps is a multiday race starting from Venice, Italy, and finishing in Geneva, Switzerland. Featuring beautiful landscapes of the Dolomites and the Swiss Alps and a vertical gain of approximately 20,000 meters, the race lasts seven days and is 933 km in length. Stage 6 of 7 the race goes from Andermatt to Crans-Montana, Switzerland, and is a 142 km stretch, with a vertical gain of 3,100 meters. It has several significant cols (passes or saddles) and breathtaking scenery. GPS_FOR_EVERYONE, a website and mobile app used to track athletic activity via GPS, has asked you to create a 3D visualization using the GPS track from your Dolomite biking race. They are particularly interested in users comparing elevation to heart rate and speed.

Build skills in these areas

- ➢ Adding a modified GPS file
- ➢ Saving as a layer
- ➢ Publishing as a feature layer
- ➢ Showing in Scene
- ➢ Configuring layer to show elevation in 3D
- ➢ Investigating cols (passes saddle)
- ➢ Creating viewsheds
- ➢ Comparing heart rate to elevation
- ➢ Comparing speed to elevation
- ➢ Creating a comparison app

What you need

- ➢ Account required
- ➢ Estimated time: 30 minutes – 1 hour

Publication date: March 14, 2019

# 1. Map the GPS, save as a layer, and publish as a feature layer

You have been given a GPS file of approximately three quarters of the Stage 6 2014 Dolomite race. The points have been thinned to 2,000 so they can be published to ArcGIS Online. The points were thinned for speed of processing.

1. Sign into your online ArcGIS organizational account.
2. In the upper-right corner Search box, type esripress_ig_imagery and click Search in Groups.
3. Clear the check box that says to only search in your organization.

☐ Show ArcGIS Desktop Content

☐ Only search in Participants and Resources

4. Click esripress_ig_imagery to view group content.
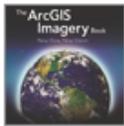
esripress_ig_imagery

Instructional Guide to the ArcGIS Imagery book.

owned by esripress_ig_imagery on February 8, 2017

Details

5. Click the Open arrow below the thumbnail for Haute6_1 and download.

Haute6_1 ✕

Stage 6 of the Dolomite Bicycle Race in 2014.
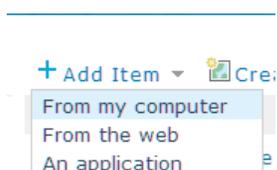
CSV by esripress_ig_imagery

Last Modified: March 9, 2017

★★★★★ (0 ratings, 0 comments, 0 downloads)

Open ▼ Details

6. Save the file Haute6_1 to a location of your choice.

Haute6_1

7. Within your organization, click My Content on the top of the page.
8. Click + Add Item>>From my computer.

+ Add Item ▼ Crea

From my computer
From the web
An application

9. Browse to the Haute6_1 file and choose the file:
   a. Add Tags: individualized tags
   b. Select the check box for Publish this file as a hosted layer.
   c. Locate features using Latitude/Longitude.
   d. Time Zones is (UTC) Coordinated Universal Time.

Item from my computer ⑦

Add an item from your computer.

File: Browse... Haute6_1.csv

Title: Haute6_1

Tags: Individualized Tags ✕
             Add tag(s)

☑ Publish this file as a hosted layer.
   (Adds a hosted layer item with the same name.)

Locate features using:

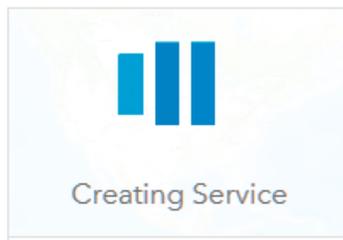◉ Latitude/Longitude ○ Address ○ None, add as table

Review the field types and location fields. Click on a cell to change it.

Field Name	Field Type	Location Fields
Creator	String	Not used
Time	Date	Not used
Name	String	Not used
Latitude	Double	Latitude

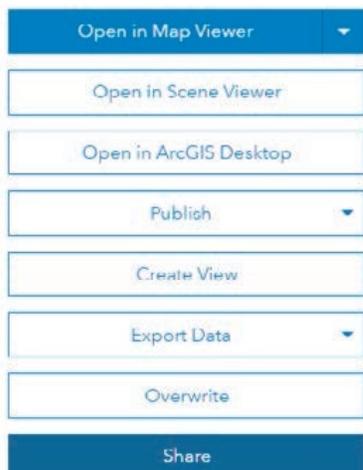Time Zone: (UTC) Coordinated Universal Time ▾ ⑦

ADD ITEM   CANCEL

10. Click ADD ITEM.

If users are working within the same organizational account, they should rename the CSV file to an individualized name before trying to upload. It is suggested that they add their initials to the file name— i.e., Haute6_1initials.
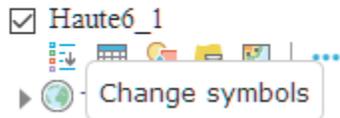
Creating Service

11. Click Open in Map Viewer>>Share>>Share with Everyone.
12. Open in Map Viewer.

Open in Map Viewer ▾

Open in Scene Viewer

Open in ArcGIS Desktop

Publish ▾

Create View

Export Data ▾

Overwrite

Share

13. Choose an attribute to show location only.
14. Click DONE.
15. Click Haute6_1>>Change symbols.

16. Click OPTIONS.
17. Click Symbols.
18. Pick a colored dot of your choice.
19. Click OK.
20. Click DONE.

2. Identify locations and cols along the route

In this section of the exercise, you will identify locations along the route. You will identify the starting point of Andermatt and Furkapass, which is one of the cols of Stage 6.
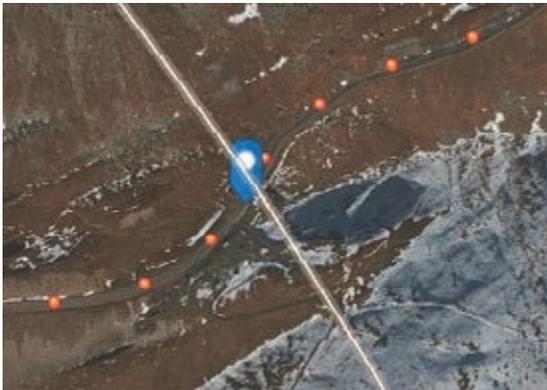
1. On the top ribbon, locate the Basemap tab. You will be using different basemaps during this section of the exercise.
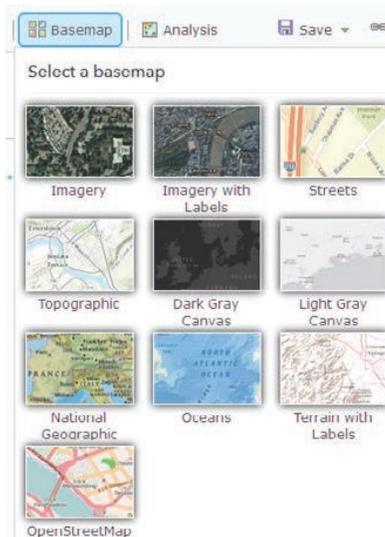
2. Change the basemap to Imagery with Labels.
3. Zoom to the northeast of the beginning point of the race and identify Andermatt.
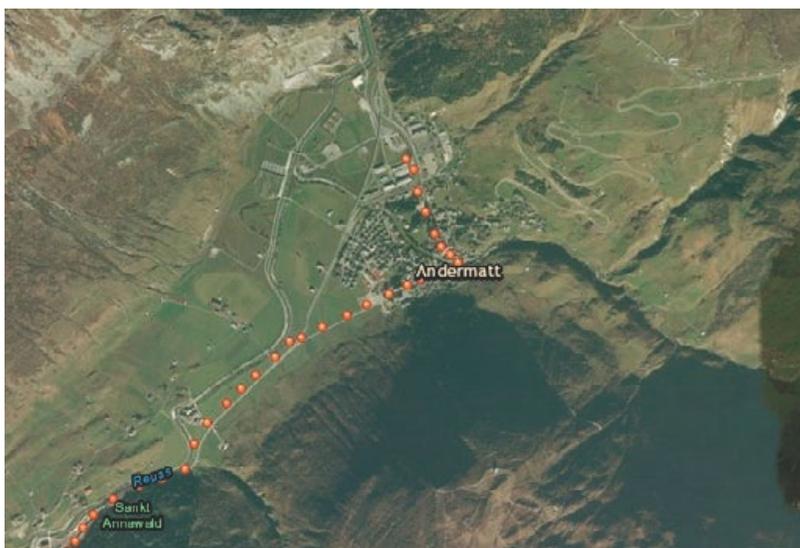
4. In the upper Search box, search for Furkapass, Valais, Switzerland.
5. Click Add to Map Notes.

Furkapass is a col (notch, gap, saddle) located along the Stage 6 trail. A col is the lowest point on a mountain ridge between two peaks. It may also be called a notch, a gap, or a saddle. Standing within a col, you should be able to see downward on two sides and upward on two sides.
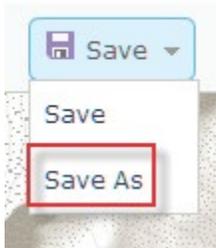
6. Change the basemap to Topographic.
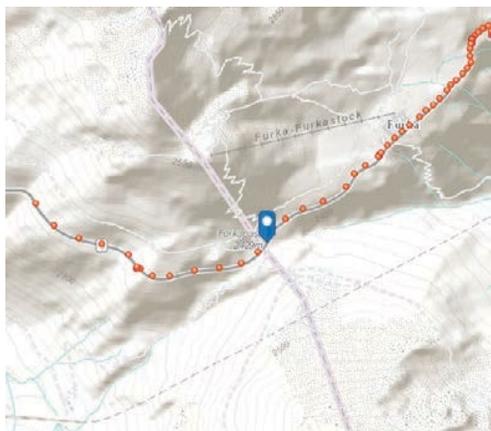
You can now see that the map note is within a notch on the map. The elevation goes up northwest to southeast, and it goes down northeast to southwest.

This is a good time to save your map.

7. Go to the upper ribbon and click Save As.

8. Use the following documentation for your map:
   - Title: State 6 of the Dolomite Ride
   - Tags: Individualized tags
   - Summary: Stage 6 of the Dolomite Ride
   - Save in folder: (Answers will vary.)
9. Click SAVE MAP.

3. Create a viewshed at Furkapass

The Create Viewshed tool uses the Esri Elevation Analysis service to determine which areas are visible from specified observer points. The specified observer point for this exercise is Furkapass. The viewshed determines which areas can be viewed from Furkapass.

Create Viewshed

Creates areas that are visible based on locations you specify.

1. Under Map Notes, click Perform Analysis.
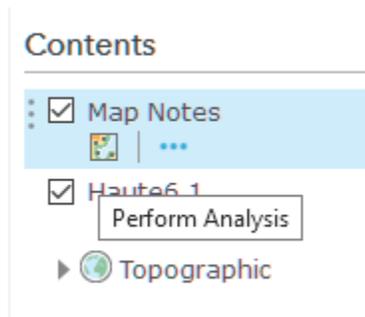
2. Choose Find Locations>>Create Viewshed, and use the following parameters:
   - Point features that represent observer locations are Map Notes (Points).
   - Visibility setting (optional) is 6 Feet (based on height of an individual).
   - Maximum viewing distance is 9 Miles.
   - Result layer name is Furkapass visible areas.
   - Save result in (desired folder).
   - Clear the check box for Use current map extent.
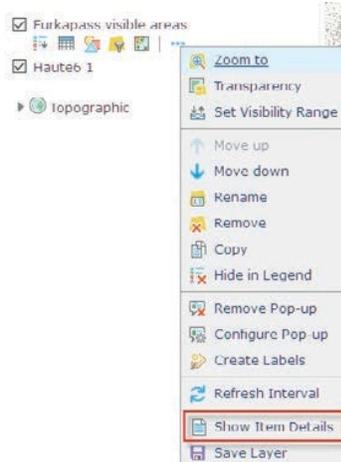3. Click RUN ANALYSIS.
4. Zoom out to see the extent of the viewshed. The areas that you see are the areas that are visible from the Furkapass col.
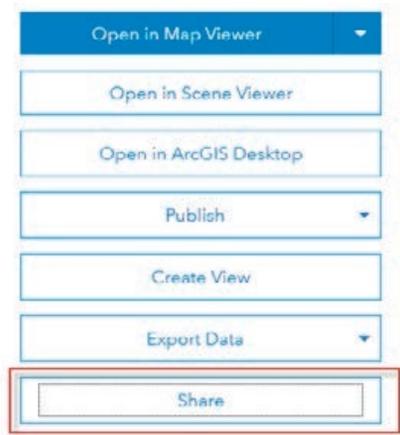
You will be using the viewshed in a subsequent 3D scene so it must be made public.

5. Click Furkapass visible areas and select Show Item Details.

6. Click Share.

7. Click Share with Everyone.
8. Click Open in Scene Viewer.
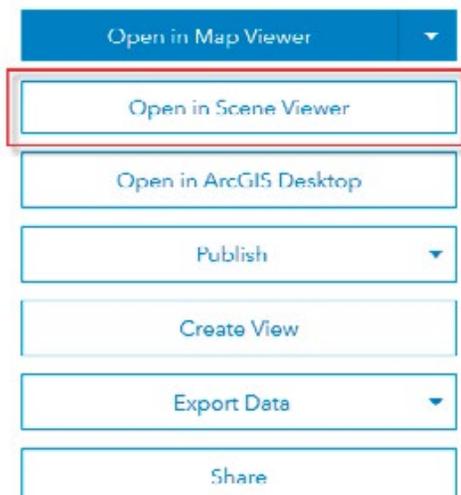
4. Display the GPS track with elevation, heart rate, and speed in Scene

ArcGIS Online 3D Scene Viewer is an app that can symbolize 3D geospatial content that includes a multiscale basemap and a collection of 3D layers, styles, and configurations that allow you to visualize and analyze geographic information in an intuitive and interactive 3D environment. You can also create web apps with a scene by using a configurable app. Different configurable apps offer various bits of functionality.

Create a scene of elevation

1. In the upper-left corner of your screen are the navigation controls. Take a few minutes to familiarize yourself with the tools. Use all the tools.

2. Pay attention to changing the basemaps.

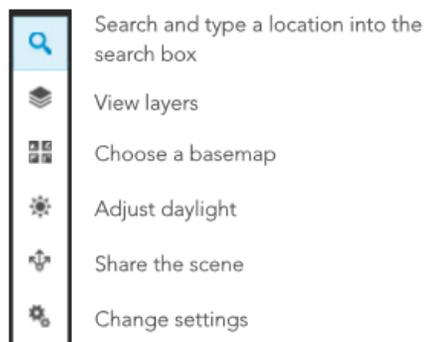3. Add a layer to the scene by clicking ADD LAYER.
4. Search for Haute6_1.
5. Click the plus sign (+) and add a layer to the scene.

   Notice that the point data for the Haute6_1 GPS track appears on the scene.

6. Click DONE.

   You will now style the layer to show elevation.

7. Click Elevation>>Layer Style.
8. Choose the main attribute to visualize as Elevation.
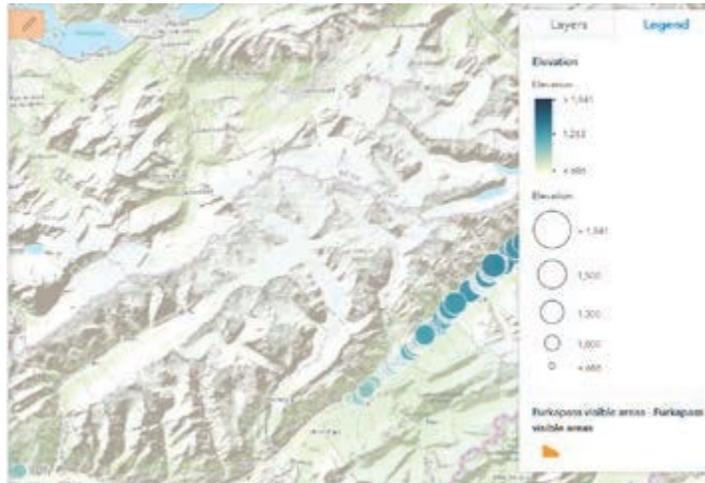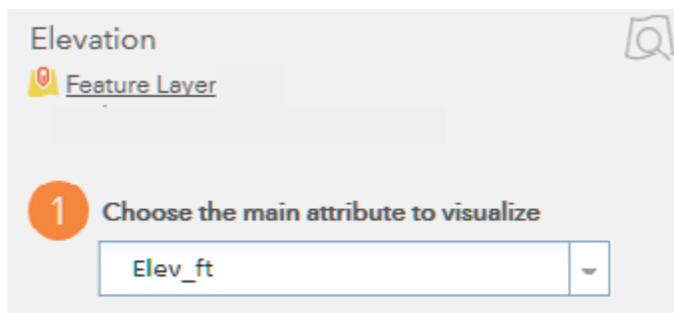
Notice that the elevation is now represented on the map both with graduated symbols and using a color ramp. The symbols are spheres, and the larger the sphere, the higher the elevation. The elevation is also shown as a graduated color ramp with the darkest blue indicating the highest elevation.

You will next choose a drawing style. You want to choose the Counts & Amounts 3D OPTIONS.

9. Click OPTIONS.
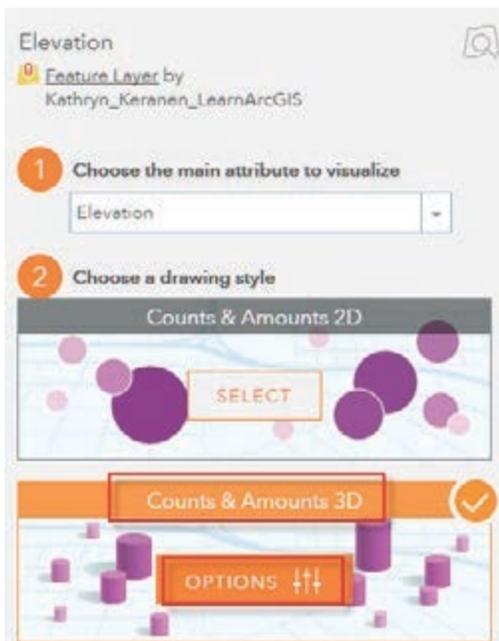
10. Click Symbol and change to cone.
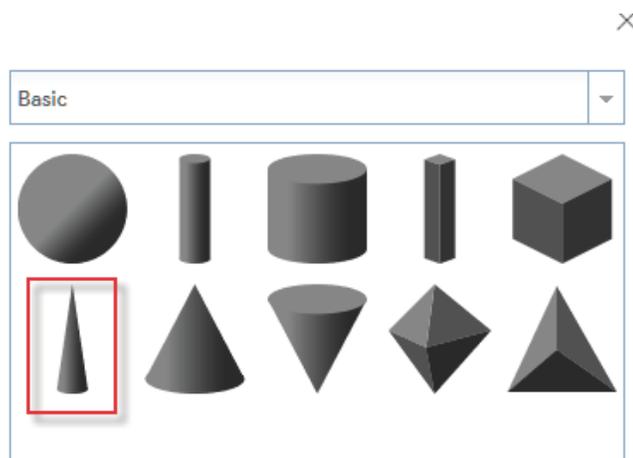
11. Change Size to Value.
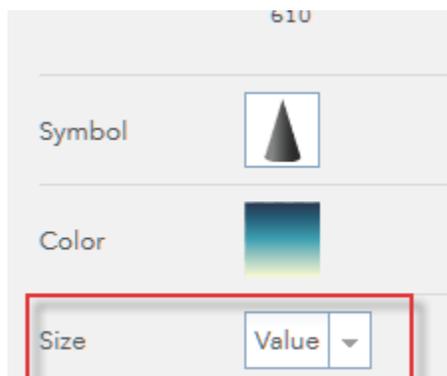
12. Click DONE.
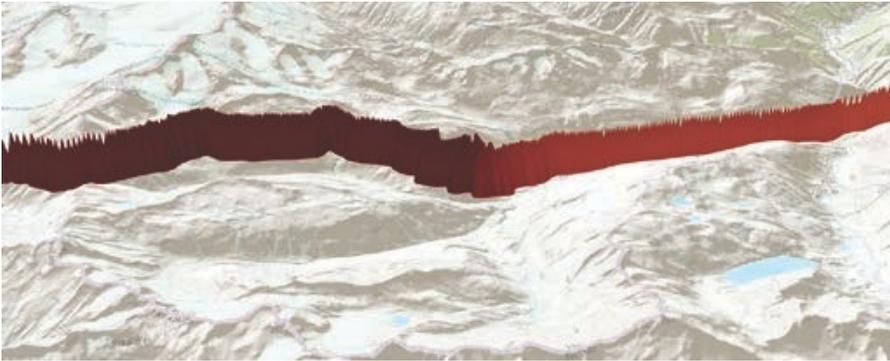
13. Click DONE again.
14. Click SAVE SCENE AS, and enter the following metadata:
   - Title: Elevation: Stage 6 Dolomite Bicycle Race
   - Summary: 3D Visualization of Elevation
   - Tags: Individualized tags
   - Click: Save as new scene (if previous scene has been saved).

You have successfully made a 3D scene showing elevation of the Dolomite Bicycle Race. You will now create two more maps, one showing speed and one showing heart rate of the racer.

Create maps showing speed and heart rate

1. In the upper-right corner, click New Scene>>New Global Scene.

New Scene ▽

⊕ New Global Scene »

🏛 New Local Scene
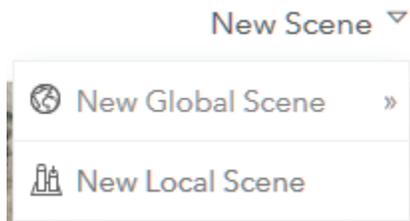
2. Repeat steps 7-24 from the previous section to create the heart rate map with the following exceptions:
   - Rename the layer Heart Rate Dolomite Bicycle Race.
   - Select red for the color.
   - Select an inverted cone for the symbol.
3. Click Save Scene, and enter the following metadata:
   - Title: Heart Rate Dolomite Bicycle Race.
   - Summary: 3D Visualization of Heart Rate of the Dolomite Bicycle Racer.
   - Tags: Individualized tags.
   - Click: Save as new scene.
4. Click SAVE.
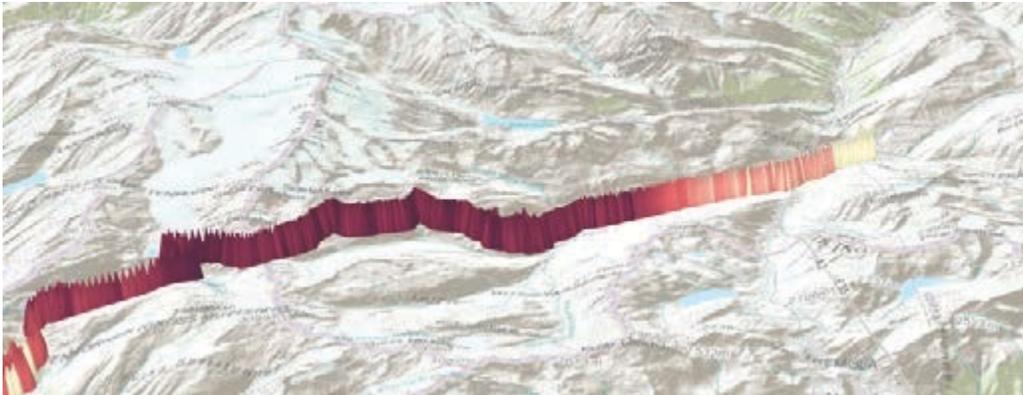
5. Repeat steps 7-14 to create a speed map.
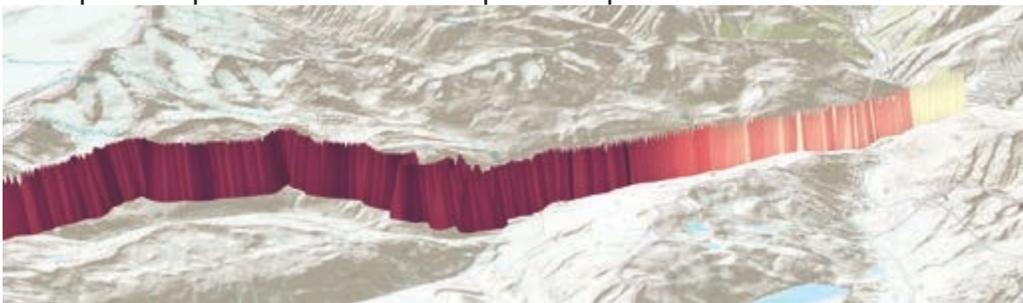
Create two comparison apps: elevation vs. heart rate and elevation vs speed

1. Go Home and click My Content.

2. Click Elevation Dolomite Bicycle Race.
3. Click Create Web App>>Using a Template.
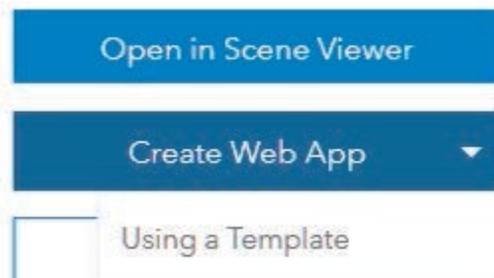
4. Select Compare Scenes and click to open.
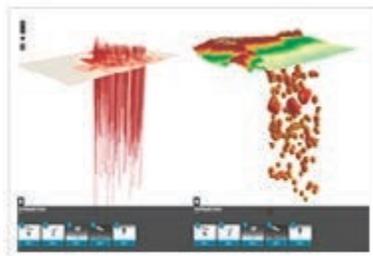
Compare Scenes

5. Click CREATE WEB APP and enter the following metadata:
- Title: Comparison of Elevation and Heart Rate
- Tags: Individualized tags
- Summary: 3D Comparison of Elevation and Heart Rate of the Bike Racer

6. Click DONE.
7. Click Select Web Scene(s).
8. Select Elevation and Speed.
9. Click OK.
10. Click SAVE.
11. Click Launch.

Q1 Write a summary comparing the variables of elevation, speed, and heart rate. Be sure to tell what sort of mathematical proportion is shown in both comparisons.

Visualizating the Shenanadoah National Park Fire in the summer of 2016

Esri's Landsat Explorer app is a powerful tool for visualizing our planet and understanding how Earth has changed over time. The app leverages the power of Landsat satellites, which gather data beyond what the eye can see. Users draw on Landsat's different bands to better explore the planet's geology, vegetation, agriculture, and cities. Additionally, the app offers instant access to the entire Landsat archive, allowing users to visualize how Earth's surface has changed over the last forty years.

The Rocky Mountain 2016 fire at Shenandoah National Park was the second largest in the park's 80-year history. The fire was believed to be started by humans in the remote South District of the park. At the fire's peak, 350 fire fighters from thirty-three states assisted in the effort. Fire suppression costs are estimated at about $4.2 million. The fire was at its worst around April 18, 2016.

The National Park Service is asking all national parks to prepare story maps combining maps, text, images, and multimedia content to increase public awareness of major fires in their park for the year 2016. The story map will be used to inform the public and to advocate for public fire safety.

Build skills in these areas

➢ Adding data to the Landsat Explorer app from an ArcGIS online account
➢ Picking dates to compare and visualize

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

Publication date: March 14, 2019

1. Identifying the park

1. Go to Landsat Explorer.
2. Sign into your ArcGIS organizational account.
3. Search for Shenandoah National Park.
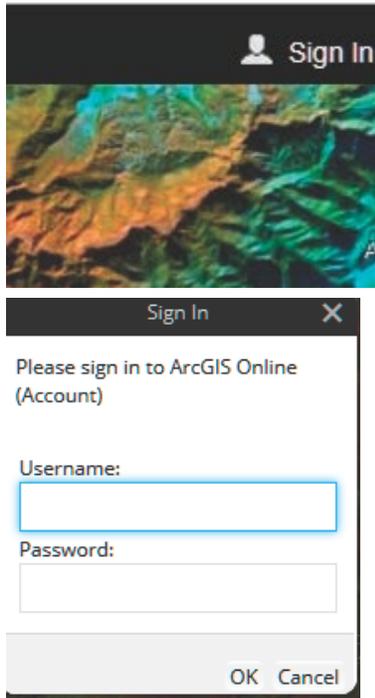
4. Click the Time Selector on the side pane, click the blue box and pick April 20, 2016. Observe the purple splotch at the bottom of the screen. This is the location of the fire.
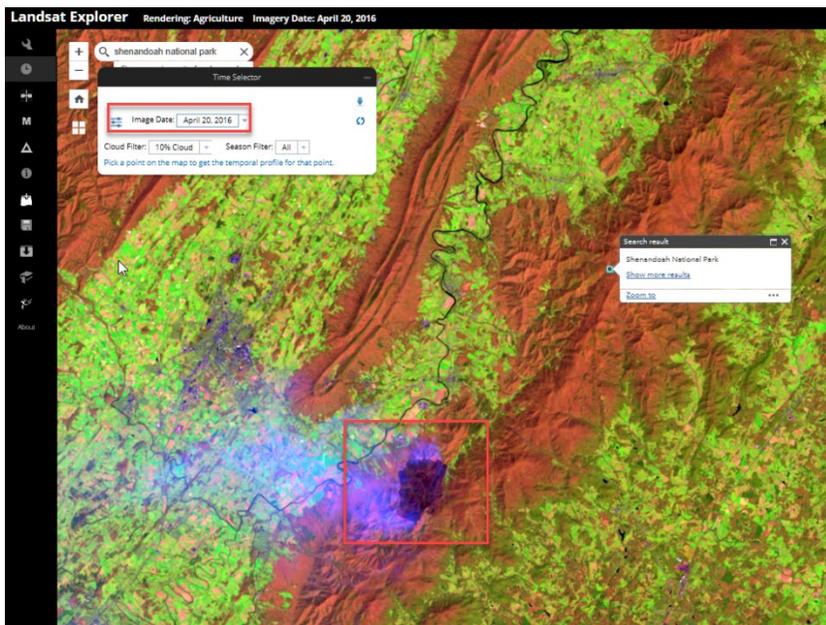
5. Click the **i** icon on the left pane and click the image. This opens more information about the scene. April 20, 2016 was the height of the fire.
6. On the left pane click Add Data form ArcGIS Online.
7. Select ArcGIS Online.
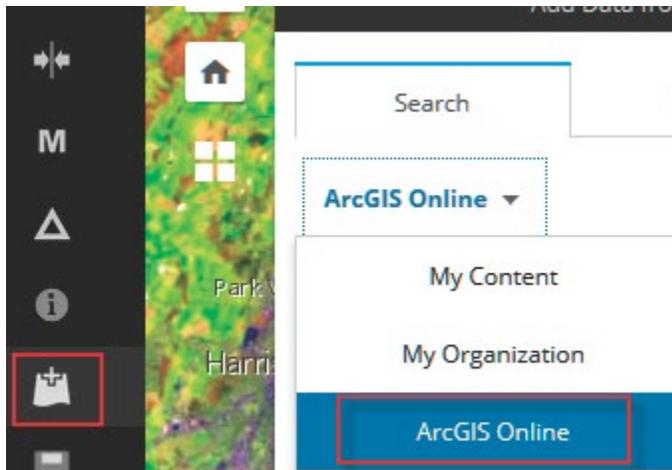
8. Search for USA Parks.
9. Select USA Parks Feature Service by esri.dtm.
10. Click Add.

> You now see a green Shenandoah National Park Boundary. After viewing the boundary click Remove.
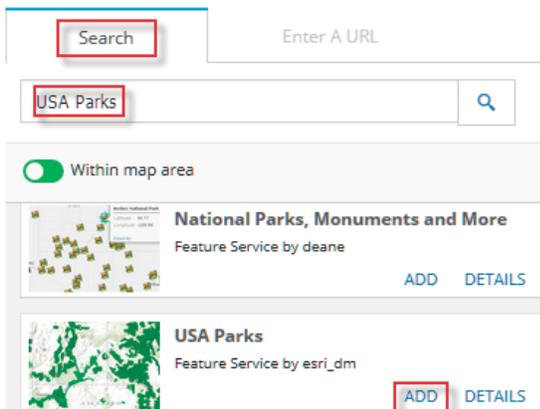
11. On the ArcGIS Online menu, close Add Data.

2. Compare images before and after the fire

To compare the Landsat images during and after the fire, you first have to enable the time selector to pick dates to visualize and compare.

1. Click the Time Selector. The Image Data is April 20, 2016.

   Q1 Describe where the fire is located within the park. Can you easily identify the fire?

2. Click the blue arrow in the right corner of the time selector menu.
2. Click the swipe icon.
3. Select October 29, 2016.

Q2 Is the fire as visible in October 29, 2016?

4. Swipe back and forth to compare.

3. Create a story map

1. Close swipe.
2. Go to the time slider and choose April 20, 2016.
3. Hold Ctrl and click The Stories icon on the side ribbon.
4. Title the story Shenandoah National Park Fire April 2016.
5. Click the blue arrow for next.
6. Add the following text.

The Rocky Mountain 2016 fire at Shenandoah National Park was the second largest in the park's 80-year history. The fire was believed to be started by humans in the remote South District of the park. At the fire's peak, 350 fire fighters from thirty-three states assisted in the effort. Fire suppression costs are estimated at about $4.2 million. The fire was at its worst around April 18, 2016.

7. Add the following link. Copy the URL link.

   Shenandoah National Park Fire

8. Click ADD.

9. Select the time slider and pick the date October 29, 2016.

The burn scar is not near as obvious. The vegetation is returning.

10. Insert this link

After the Fire

11. Click FINISH.

12. The web address is shown in the link. Sign into your organizational account to view the story map.
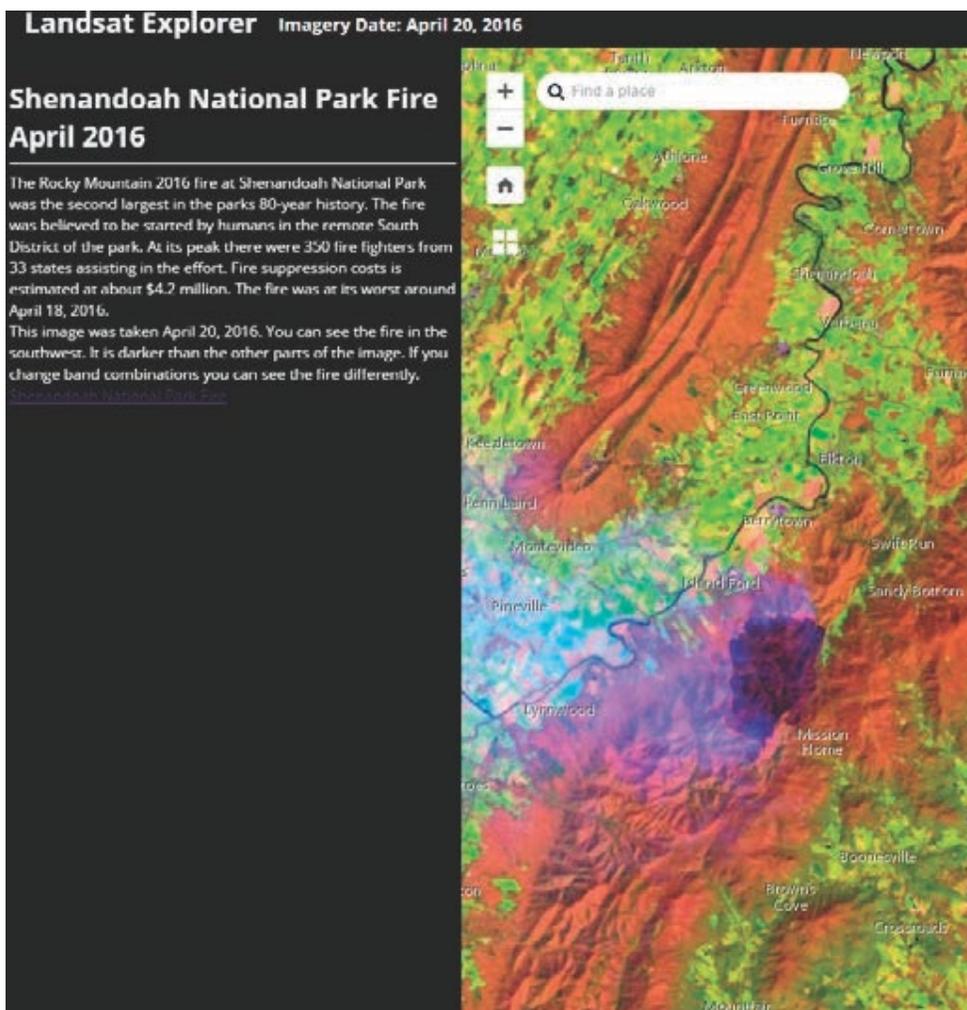
Raster is faster but vector is corrector

The old GIS adage "raster is faster, but vector is corrector" comes from the two different fundamental GIS models: vector and raster. Each of these models has its own advantages and disadvantages. The vector model uses points and line segments to identify locations on the earth while the raster model uses a series of cells to represent locations on the earth. The figure represents vector (left) versus raster (right) data.
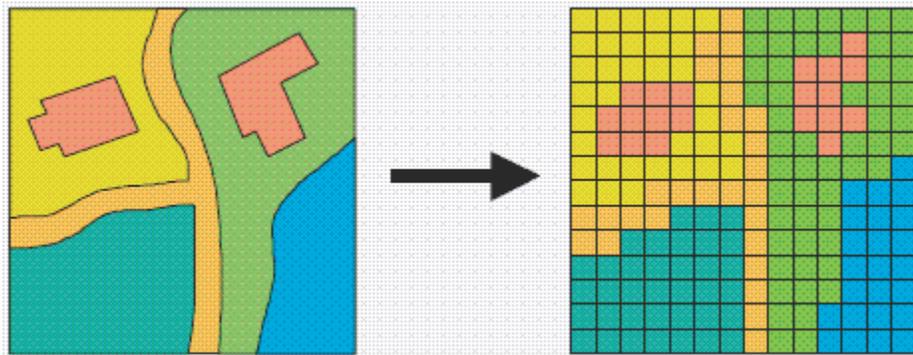
One of the most common types of raster data is land cover derived from satellite imagery. Land-cover data is produced by assigning each pixel in a Landsat thematic mapper image to one of 16 land-cover classes using a procedure known as unsupervised classification.

You have been asked to prepare a lesson that explains to beginning GIS users the difference between vector and raster data. Also, to be included in the lesson is a basic explanation of a land-cover dataset that has been derived from satellite imagery. You have chosen the Great Salt Lake in Utah to be your study area.

esri | THE SCIENCE OF WHERE

Build skills in these areas

➢ Identifying vector and raster models
➢ Understanding the process of creating land cover from satellite imagery
➢ Calculating quantitative differences between the two models

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

1. Build the map

1. Sign into your ArcGIS online organizational account.
2. Click Map on the upper ribbon.
3. In the Bookmarks search box in the upper-right corner, search for Utah Lake, Utah, United States.
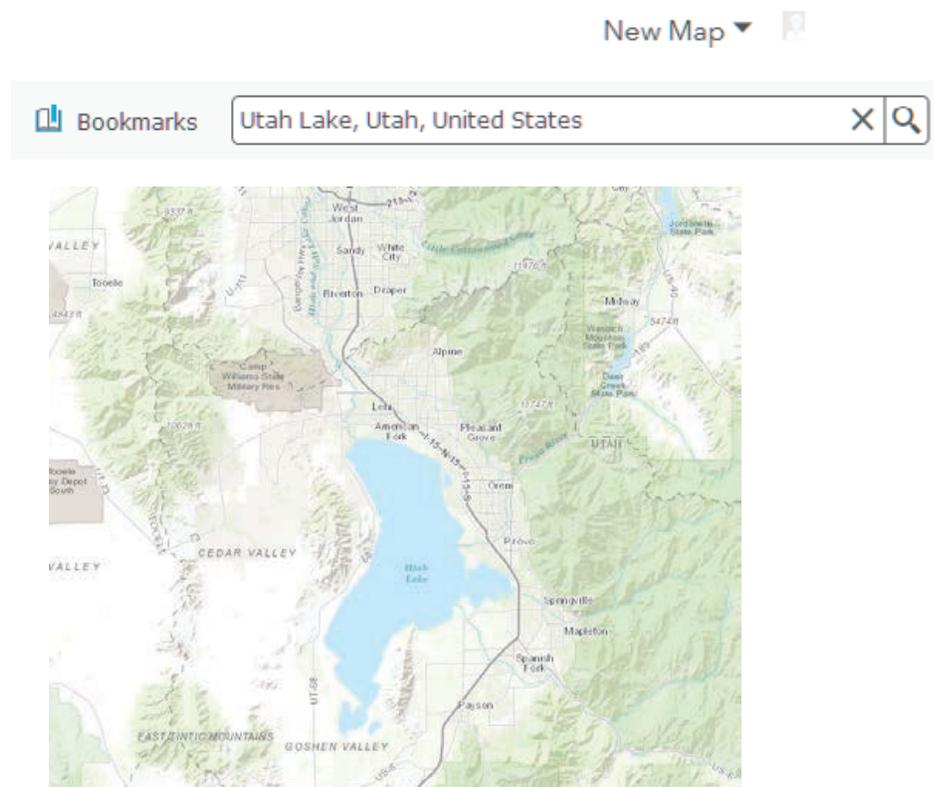
4. On the upper ribbon, change the basemap to imagery.
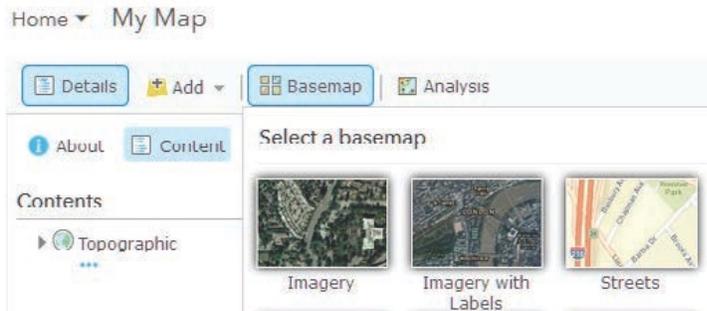
Zooming in and panning familiarizes you with the area, identifying different types of land cover and landscapes.

2. Add vectors

In this section, you are going to add and examine several vector layers to start the investigation. You will add both polygon and line vectors.

1. On the top ribbon, go to Add and search for USA Detailed Water Bodies. Use the following parameters:
   - Find: USA Detailed Water Bodies
   - In: ArcGIS Online

2. Click Add.

USA Detailed Water Bodies
- Lake or Pond
- Swamp or Marsh
- Stream or River
- Inundation Area
- Artificial Basins
- Playa
- Glacier
- Canal or Ditch
- Other
- Other
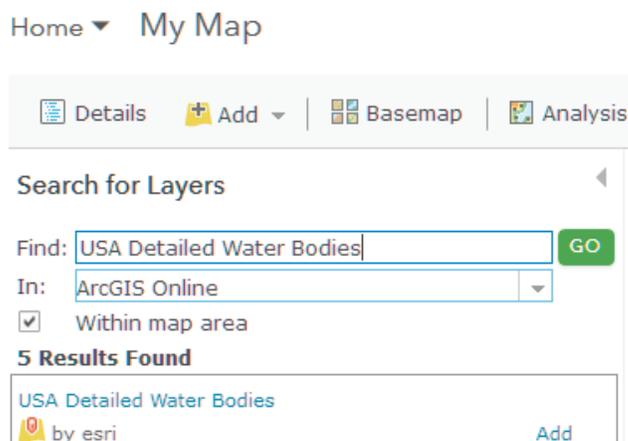
3. Expand the legend for USA Detailed Water Bodies.

Q1 What types of water are represented in the view?

Q2 Describe the border of the polygon.

Q3 Zoom into one of the sections of the polygon and describe the level of detail.

4. Following the same procedure as in steps 1 and 2, search for and add USA Urban Areas.
5. Click the three dots and set the visible range to be visible at all scales.

Once again, zoom in and examine the urban areas.

Q4 What urban areas are represented?

Q5 Describe the edge of the polygons.

6. Following the same procedure as in steps 1 and 2, search for and add Utah Major Roads Centerlines.

Q6 What type of vector files are the roads?

Q7 How well do they follow the imagery?

4

3. Add rasters

Now that you have added and examined some vector files, you will add two raster files. The first raster is land cover, which has been derived from satellite imagery. Starting with a Landsat satellite scene, an image is classified into one of the 16 defined classes of land. The procedure is represented in the figure.

Multispectral Landsat   Classified Land Cover
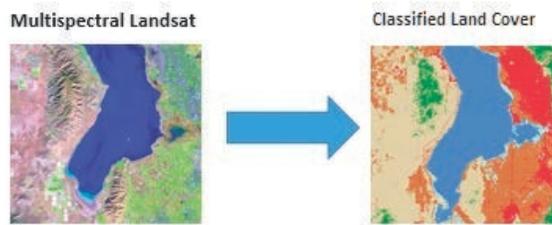
1. On the top ribbon, go to Add>>Browse Living Atlas. The Living Atlas includes beautiful and authoritative maps on many topics. It combines reference and thematic maps relating to people, Earth and life.
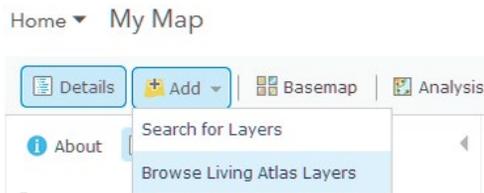
2. Search for Multispectral Landsat.
3. Click Add layer to the map.

This multispectral Landsat image has a series of spectral bands that can be displayed in various combinations. For this exercise, you want to look at the image in natural color.

4. Right click Multispectral Landsat and click Image Display.
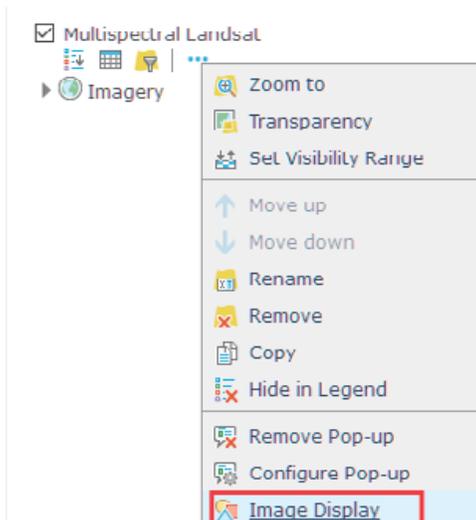
5. Select Natural Color with DRA.

Image Display

Set image display for: Multispectral Landsat

Renderer

Natural Color with DRA ▾
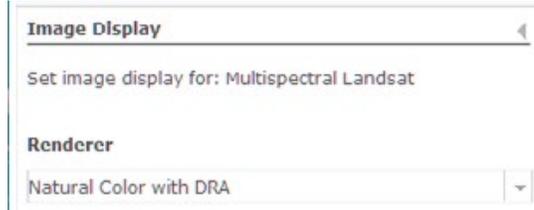
6. Click APPLY and click CLOSE.

   Turn the Multispectral Landsat on and off and look at the basemap Imagery below.

Q8 Which one is clearest?

Q9 What does this say about the resolution of the two images?

7. Now is a good time to save your map. Go to the top ribbon and click Save As.

💾 Save ▾

Save

Save As
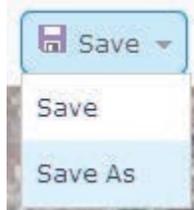
8. Use the following parameters to save your map:
   - Title: Raster vs Vector
   - Tags: use individualized tags
   - Summary: Comparison of vector and raster data.

Save Map
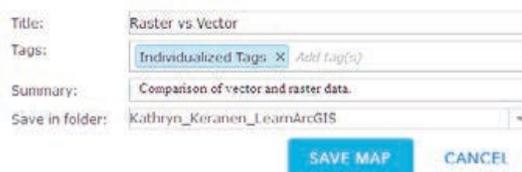
Title:	Raster vs Vector
Tags:	Individualized Tags ✕ Add tag(s)
Summary:	Comparison of vector and raster data.
Save in folder:	Kathryn_Keranen_LearnArcGIS ▾

SAVE MAP   CANCEL

9. Click SAVED MAP.
10. Go back to Add>>Browse Living Atlas and search for USA NLCD Land Cover 2011.
11. Click Add layer to map.
12. Click CLOSE.

The Multispectral Landsat image was a raster. The USA NLCD Land Cover 2011 another example of raster characteristic.

13. Zoom in close to any part of the Utah Lake.

Q10 Describe the appearance of the image. How is it different from the previous? vector files?

14. Expand the legend of USA NLCD Land Cover 2011. Each one of the numbers are a designation of a land-cover type. These land-cover types are standards set by the US Geological Survey. A designation of each number is shown in the legend on the right.

☑ USA NLCD Landscape

▣	11
▢	12
▣	21
▣	22
▣	23
▣	24
▣	31
▣	41
▣	42
▣	43
▢	52
▢	71
▣	81
▣	82
▢	90
▢	95

NLCD Land Cover Classification Legend

11 Open Water
12 Perennial Ice/ Snow
21 Developed, Open Space
22 Developed, Low Intensity
23 Developed, Medium Intensity
24 Developed, High Intensity
31 Barren Land (Rock/Sand/Clay)
41 Deciduous Forest
42 Evergreen Forest
43 Mixed Forest
51 Dwarf Scrub*
52 Shrub/Scrub
71 Grassland/Herbaceous
72 Sedge/Herbaceous*
73 Lichens*
74 Moss*
81 Pasture/Hay
82 Cultivated Crops
90 Woody Wetlands
95 Emergent Herbaceous Wetlands

4. Differences between raster and vector

Q 11 Write a comparison between the two feature types. Following are some focus questions for your analysis.

Describe the difference between the two.

- Which is gridded?
- Which is the most appealing when you zoom in?
- Which is the most accurate compared with the basemap imagery?
- How are roads portrayed in vector and raster?
- Which feature type do you think is the most time consuming to produce?
- Which type shows the most detail?
- Give two examples when it would be best to use vector data.
- Give two examples when it would be best to use raster data.

Real-time data feeds

Real-time GIS gives you the ability to connect to data streams and receive real-time data. Once configured properly, real-time feeds can be brought into your maps and provide help in everyday decision-making. Traffic cams and cameras watching wildlife make for interesting feeds. Adding live feeds to your maps provides the locational information of the live feeds.

Build skills in these areas:

▸ Constructing and working with CSV files

▸ Mapping real-time data from live camera feeds

What you need:

▸ Account not required

▸ Estimated time: under 30 minutes

What is a CSV file?

A CSV fle stands for comma-separated values. It is a simple fle format that can be created in a text editor, Microsoft Excel, or Open Offce. In this exercise, you will make a CSV fle in a text editor that includes the following headings:
Name -- location of live-feed camera
URL -- website of live-feed camera location
long -- longitude
lat -- latitude

name,URL,long,lat

Scenario

The City of Santa Clara, California, is doing a traffic study of a section of the Great America Parkway. The parkway is one of the major roads in the Santa Clara area with a lot of traffic congestion. City officials have decided to monitor the situation using live cameras. As staff GIS analyst, you have been tasked with mapping the designated web cams.

1

Download and Map a CSV file

Now that the CSV file is constructed, you must map the data.

1. Sign into your ArcGIS.com account.

2. Search for and download **IGARC2_cameras**.

3. Click Map on the upper ribbon.

4. Drag the camera.csv file to the map. The points will appear at the appropriate location.

5. Under Change Style>>Choose an attribute to show, click Show location only.

6. Click OPTIONS>>Symbols and change the symbol size to 15.

7. Click OK.

8. Click DONE.

Display the live camera feed

1. Click a point.

2. Click More Info, and the live camera feed will appear.
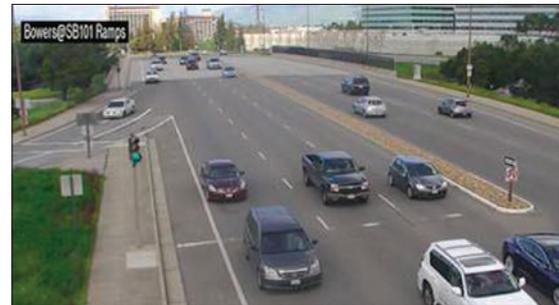
3. On the top ribbon, click Save As and enter the proper documentation for the map.

4. Click SAVE MAP.

Additional exercise

The *Raptor Resource Project* deals with the preservation of raptors. The project maintains and observes some 40 nests and nest sites. The nests are observed by live camera feeds. Following is a text file that allows you to add the live camera feeds to an ArcGIS Online map by following the instructions in the previous section of this lesson.

name,lat,lon,camera
decorah eagles,43.2755,-91.7796,http://www.ustream. tv/embed/16981684?html5ui=1
peregrine falcons,43.87102,- 91.3198,https://www.youtube.com/embed/ uQAI12FkO5U?rel=0;&autoplay=1
north nest eagles, 43.333,-91.921,https://youtu.be/ t2q89jtvEq8

Imagery application trends: Urban planning

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

The Urban Observatory is a web app that allows you to compare facts and live data about US and global cities. You can compare any three cities at one time on multiple variables or themes. The maps are synchronized so that zooming in or out in one map causes a corresponding change for the other two. In other words, you are always looking at the featured cities at the same scale.

One of the major systems connecting cities to their surrounding regions is their highway network. Urban geographers have identified several typical patterns of urban highway networks: radial highways leading from the surround to a central hub, linear patterns resulting from constraints caused by geographic barriers or obstacles (e.g. mountains, rivers), and irregular networks that have no obvious pattern (these may have historical roots that are not apparent). London, Istanbul, and New York provide examples of these patterns.
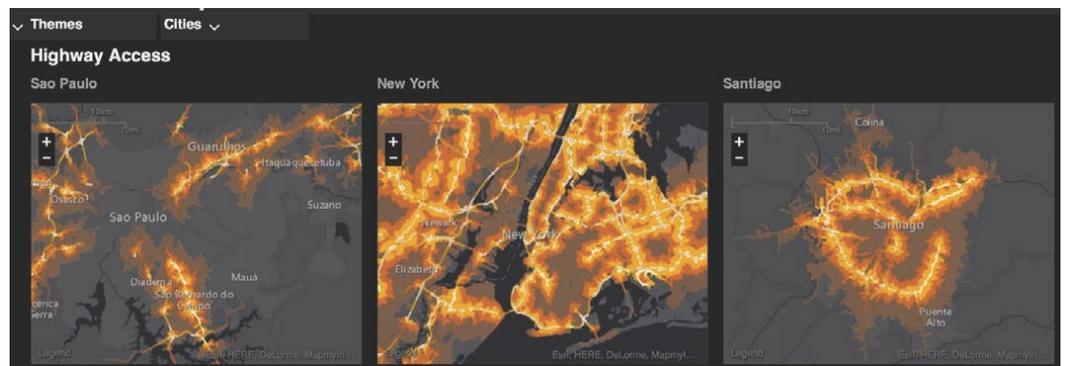
Publication date: March 14, 2019

Radial highways network
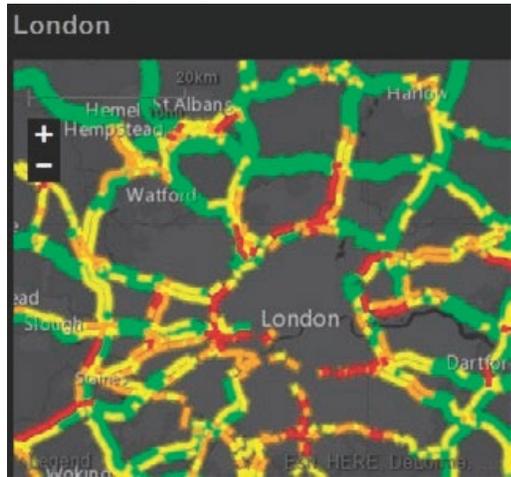
Linear highways network
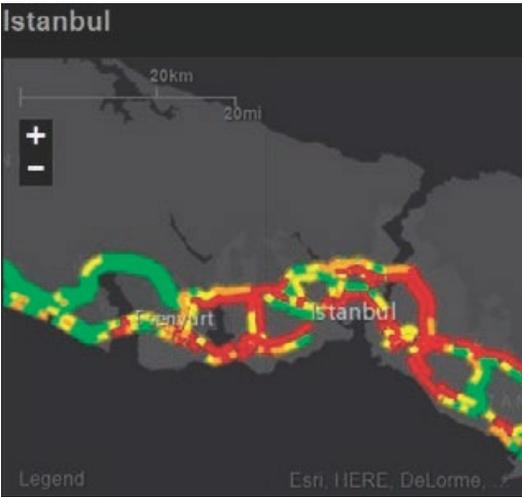
Irregular highways network
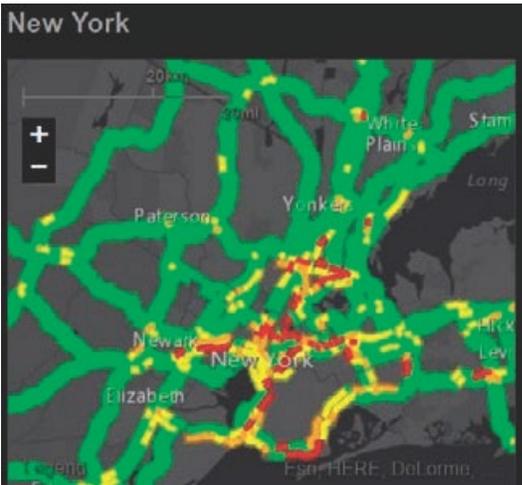
Follow the steps below to identify the highway network pattern of each of these cities.

1. Open the Urban Observatory app.
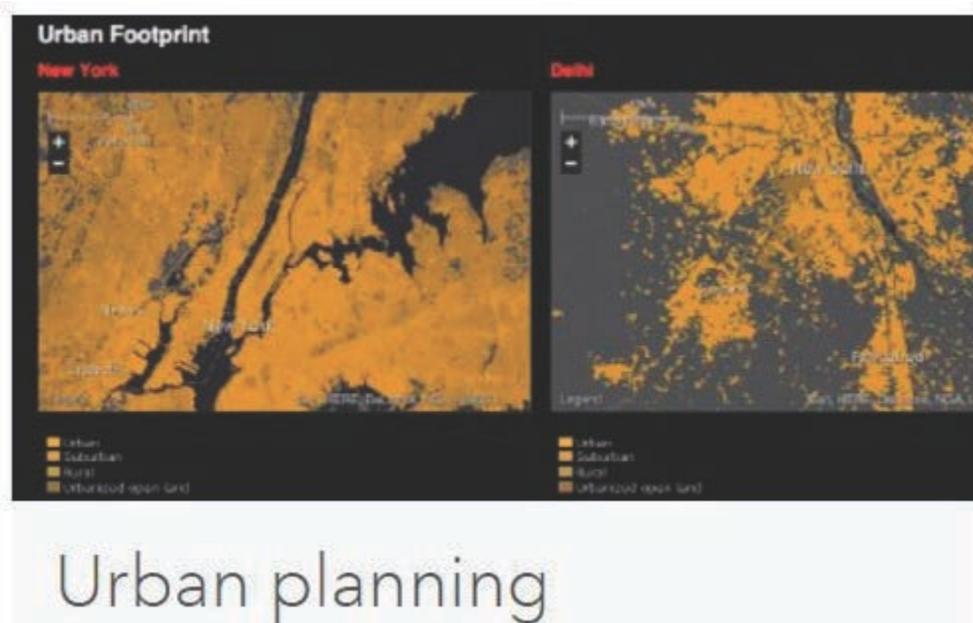
2. When the app opens, read the brief guidelines and click Start Comparing. (Note: The images below show a comparison of population density among three cities, but your app may open with a different comparison. You can ignore the difference and continue with the directions.)
3. To observe and compare patterns of urban highway networks, click Themes and select Traffic (under Movement) from the list of themes.

4. Now we want to select specific cities to observe. Above the maps, click Cities. The alphabetical list of cities is displayed. (Note: If a city name is grayed out, it is not available for the designated theme.) Click the right arrow > at the right of the list to advance the names.
5. Click Atlanta when you see it and select Map Panel 1 to display it in the left panel.
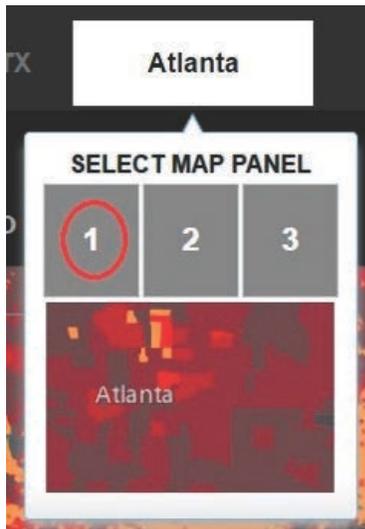
6. Add Auckland and Buenos Aires the same way, placing them in Map Panels 2 and 3 respectively. Your app should not look like this.

As you can read below the map, "this map shows the traffic conditions you can expect at this time of day in this city". Use the World Clock to find out what time it is now in each city.

7. Decide which network (radial, linear, or irregular) best describes each city and put the appropriate letter in front of the city's name in the list below.
8. When you have considered the first three cities, compare the next three: Cairo, Dublin, and Johannesburg. Add these cities to the app identifying a new city for Map Panels 1, 2, and 3.

9. Once again, decide which network (radial, linear, or irregular) best describes each city and put the appropriate letter in front of the city's name.

Matching

Which network (A, B, or C) best describes the highway pattern in each city?

_____ Atlanta   A. radial highways network

_____ Auckland   B. linear highways network

_____ Buenos Aires   C. irregular highways network

_____ Cairo

_____ Dublin

_____ Johannesburg

Challenge

Find another example of each pattern

radial highways network   _____

linear highways network   _____

irregular highways network   _____

5

Visualizing seasonal climate patterns with imagery

Every image has an acquisition date making it possible to view change over time by displaying a sequence of images that were each collected on different dates. The Seasonal Changes web app is an example of just such a sequence; it is designed to show the monthly average global snowpack depth. Test your climate and geography IQ with the following activity.

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

Test your climate know-how with the Seasonal Changes web app.
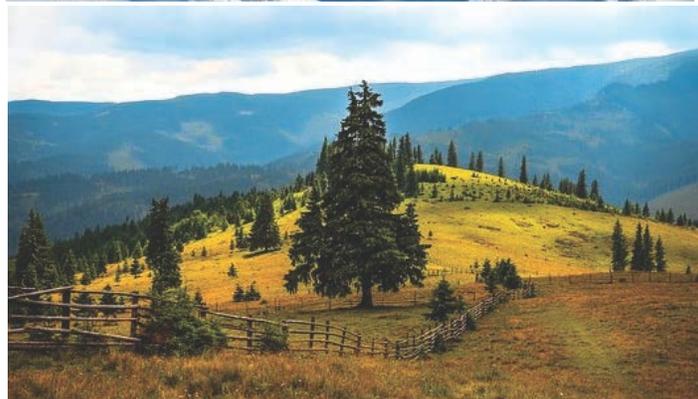
Before you look at the Seasonal Changes app, take this simple quiz.

For each pair of cities or places, identify the one that is most likely to be snow-covered in the given month by putting a check next to the name.

Month	City/place 1	City/place 2
January	Sapporo, Japan	Vienna, Austria
February	Quebec City, Canada	Copenhagen, Denmark
March	Seoul, South Korea	Murmansk, Russia
April	Barrow, Alaska, USA	Bucharest, Romania
May	Cape Dyer, Canada	Reykjavik, Iceland
June	Helsinki, Finland	Valle Nevado, Chile
July	Auckland, New Zealand	Thredbo Village, Australia
August	Whakapapa Glacier, New Zealand	Valparaiso, Chile
September	Toronto, Canada	Yellowknife, NW Terr., Canada
October	Berne, Switzerland	Okha, Russia
November	Van, Turkey	Minneapolis, USA
December	Beijing, China	Riga, Latvia

Link to the Seasonal Changes app.

Notes on using the app:

- Each map in the app has a time frame such as December–January. This simply means that the average snowpack shown on this map represents the period from the end of December to the end of January--i.e., the month of January.
- If you use the search function to locate a place, you'll need to zoom out to see its location in relation to the snowpack.

If you scored 11 or 12, you are a climate aficionado and should go straight to NOAA!\

Rasters can represent time

Seasonal Changes

Valle Nevado
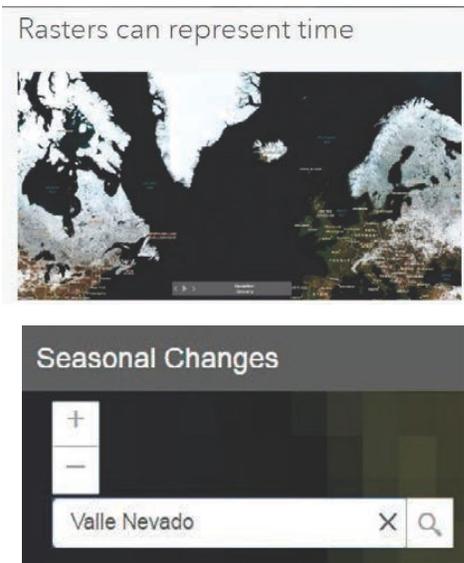
Tracking tropical ocean cycles with MODIS imagery: Tracking Super Typhoon Yolanda

Meteorologists have been using satellite imagery to map the paths taken by tropical cyclonic storm systems (hurricanes, typhoons, cyclones) for many years. Today, you can do it yourself in ArcGIS Online by accessing satellite imagery provided in the Living Atlas of the World.

The Global Meteorological Institute is compiling case studies of the deadliest and most powerful Pacific typhoons since 1950. At the top of the list is Typhoon Haiyan, known as Super Typhoon Yolanda in the Philippines. This storm was one of the most intense tropical cyclones on record. Yolanda, a Category 5 Super Typhoon, caused over 6,000 fatalities. With sustained winds of 195 mph, it was the strongest typhoon to ever make landfall. That historic landfall in the Philippines took place on November 8, 2013.

You have been asked to prepare a map to be included in the Typhoon Yolanda case study. Your map should include the following:

- Satellite imagery of the location of Yolanda from November 5, when the storm became a typhoon, to November 11, when it broke apart after making landfall in Vietnam
- A storm path consisting of points locating the eye of the storm on each date
- Map notes that include basic facts about the typhoon associated with each date

Build skills in these areas

➢ Adding MODIS imagery to ArcGIS from the Living Atlas of the World
➢ Filtering imagery to select images from specific dates
➢ Creating a sequence of map notes from imagery to illustrate a storm track and provide basic storm facts
➢ Changing a Map Note symbol

What you need

➢ Account required
➢ Estimated time: 30 minutes - 1 hour

Publication date: March 14, 2019

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1. Sign into your ArcGIS Online organization account and open a new map
2. Save your map as Yolanda 2013. Give the map appropriate tags and provide a summary.
3. Add MODIS Aqua imagery to your map.
   a. Click the Add Content to Map icon and select Browse Living Atlas Layers. Uncheck the box that says Within map area.
   b. From the All Categories list, select Imagery and Temporal Imagery.
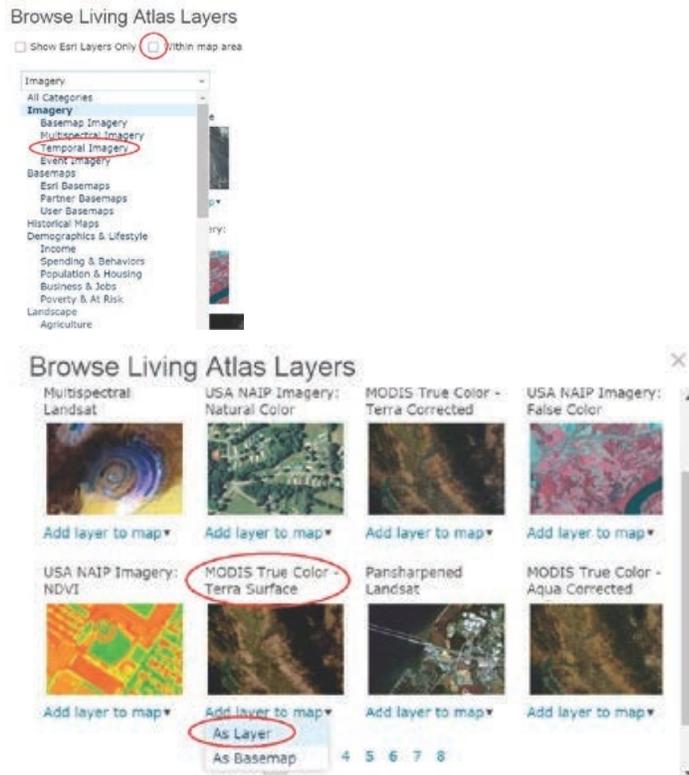
   c. On the first page of the temporal imagery list, select MODIS True Color – Terra Surface. Select Add layer to map as Layer.
   d. Click Close.

You now have a map with the Topographic basemap and one layer called Select MODIS True Color – Terra Surface Reflectance. You will need a separate layer for each of the days from November 5 through November 11 (a total of seven layers) so you can create a picture of Yolanda's path during that period.

4. Copy MODIS layer:
   a. Click the More Options icon (3 dots) below the MODIS layer and select Copy. You should now see a layer called MODIS True Color – Terra Surface Reflectance – Copy.
   b. Repeat this process five more times until you have seven MODIS layers.
   c. Save your map.

5. Rename MODIS layers:
   a. Click the More Options icon below the original MODIS layer (it does not say "Copy") and select rename.
   b. Name this layer 11/5/2013.
   c. In the same way, rename all the MODIS layer copies moving up from the bottom of the list. Name each layer for a different date: 11/6/2013, 11/7/2013, etc.
   d. Save your map.

Contents

☑ 11/11/2013

☑ 11/10/2013

☑ 11/9/2013

☑ 11/8/2013

☑ 11/7/2013

☑ 11/6/2013

☑ 11/5/2013

▸ ⊙ Topographic
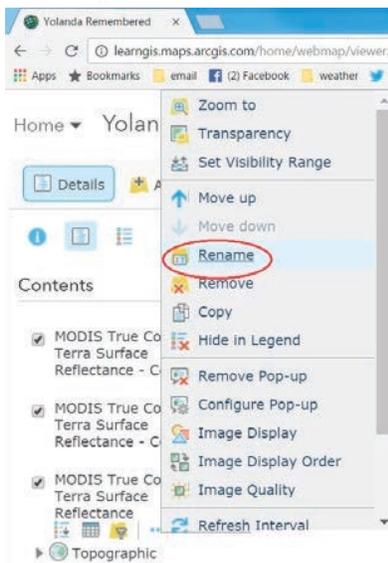
6. Re-center your map and zoom to an appropriate scale.
   a. Turn off all the MODIS layers in your map.
   b. Use the Find box to search for Philippines and center your map on the Republic of the Philippines.
   c. Close the Search results window.
   d. Zoom out slightly until the extent of your map is like the one below.
   e. Bookmark this extent and name it Yolanda.

7. Set acquisition dates for MODIS imager layers.
   a. Click the filter icon beneath the 11/5/2013 layer.

   b. Click NO, CREATE A NEW FILTER.
   c. Click ADD ANOTHER EXPRESSION.
   d. Change the filter so that Acquisition Date is on 11/5/2013 then click the date in the dropdown calendar.
   e. Click Apply filter.
   f. Turn on the 11/5/2013 layer to see imagery of the storm on that date.
   g. Save your map.
   h. Repeat these steps to change each layer's acquisition date to the date in the layer name.
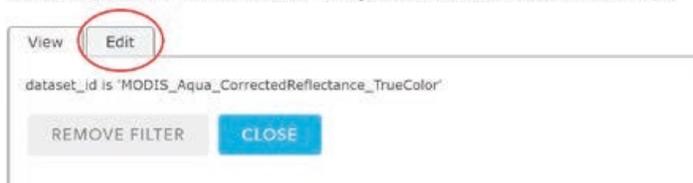
   i. Save your map.
   j. Turn off each of the MODIS layers.

8. Add a Map Notes layer:
   a. Turn on the layer names 11/5/2013.
   b. Click Add>Add Map Notes.
   c. Name the Map Note, Typhoon Yolanda.
   d. Click Create.
9. Add points for the typhoon's center on each date.
   a. Place the pushpin at the center of the large circular cloud mass to the east of the Philippines (the eye of the storm).
   b. Enter the title: 11/5/2013.
   c. Enter the following in the description box: tropical storm becomes a typhoon.
   d. Click Change symbol and select the red star in the Shapes set.
   e. Click Close.

Points	
Title	11/5/2013
	B I U A ▾ ▨ ▾ ≡ ≡ ≡ ≡ ≡
	≡ ▨ ▾ ✂ ❧ ❧
Description	storm becomes a typhoon
Image URL	https://
Image Link URL	https://
DELETE	CHANGE SYMBOL	CLOSE

10. Click Edit to stop editing and turn on the layer names 11/6/2013. Repeat the preceding steps to place a point on the center of Typhoon Yolanda for each of the remaining layers and dates.
11. Save your map when you have completed the series.
12. Use the following table to write an appropriate description for each date.

Date	Description
11/6/2013	
11/7/2013	
11/8/2013	
11/9/2013	
11/10/2013	
11/11/2013	

6

13. Create map metadata:
    a. Go to your map's Details page (information > More Details).

Home ▾ Yolanda Remem

Edit

Yolanda Remembered

Commemoration of Super Typhoon Yolanda in Tacloban , Leyte

Web Map by Lyn_Malone_LearnArcGIS

Last Modified: November 17, 2016

(0 ratings, 0 comments, 18 views)

More Details...
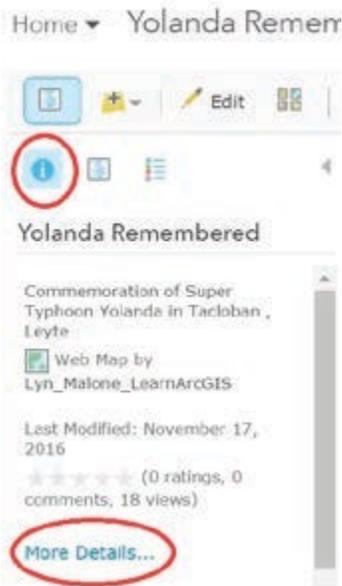
    b. Enter appropriate text in the Description box. The description should include facts about the typhoon and the reason the map was created.

    Your map is ready to be incorporated into the Typhoon Yolanda case study. It shows the location of the typhoon's eye on each day from November 5–11, 2013 and provides a note about its status on each of those days.

A world of squares

What you need

➢ Account not required
➢ Estimated time: under 30 minutes
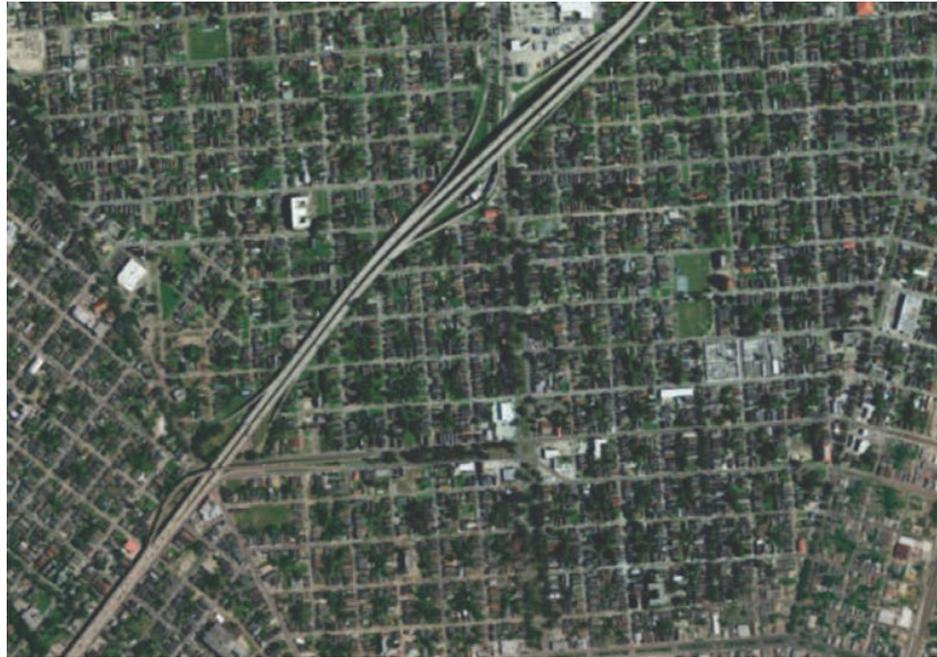
New Orleans was originally laid out as a square-block grid surrounding present-day Jackson Square. As the city grew, adjacent grids had to 'pivot' to accommodate the curved river bank as you can see in the two smaller images.

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Publication date: March 14, 2019
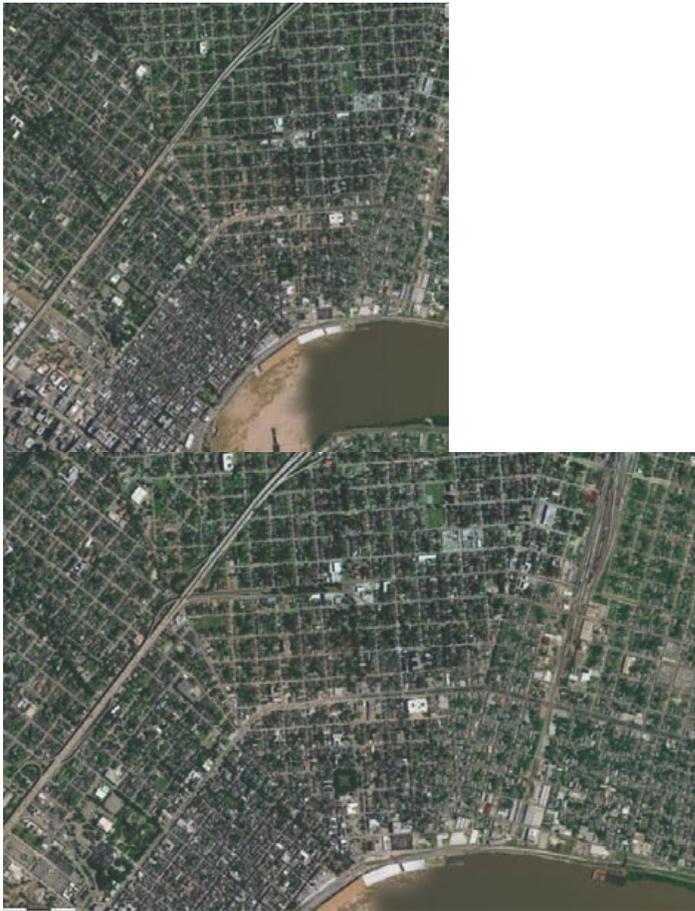
The World of Circles story map presents images of "a selection of natural and human-made circles of various sizes, locations and origins" around the world. Page through the story map to see the variety of images included.

How about squares? Can you find squares in world imagery too? Think about agricultural fields, street networks, or public plazas. What other types of squares could you find? Use the World Imagery basemap to find five examples of natural or human-made squares. Record your discoveries in the chart below. [Note: You may have difficulty finding examples of "natural" squares.

Latitude, Longitude	City/State or Province/ Country	What kind of feature is it? (street grid, building, etc.)	Bonus: What is it?

Extension activity. In your ArcGIS Online organizational account, build a Story Map Series (bulleted layout), like the World of Circles and title it World of Squares.

2

Landsat is a time machine

The Landsat program started collecting global data on Earth's land surfaces in 1972 with Landsat 1 and continues with the current Landsat 8 mission. Change is a constant and ongoing process. Since every location on Earth is captured every couple of weeks, four decades of imagery provides a unique resource to see and analyze how places change over time. Use the Esri ChangeMatters Viewer to make your own observations.

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

Changes to Lake Urmia, Iran

1. Observe land changes

1. Open ChangeMatters Viewer.

   Image 1 is an infrared image of the summit of Oregon's Mount Saint Helens in 1975, two years before it erupted. Image 2 is an infrared image of the same location in 2000, 20 years following the eruption.

   Q1 Identify three differences between the two images.

2. Image 3 shows the change in vegetation on Mount Saint Helens from 1975 to 2000.

   Q2 Use the legend beneath the map to write a brief description of those changes.

3. Use the ChangeMattersViewer to observe changes in the Great Sale Lake over 35 years.
   - In the Search box above the images, type Great Salt Lake and click Enter.
   - In the Select dates drop-down menu, select 1975-2010.

   Q3 Describe the changes in size and vegetation around the lake in this 35-year period.

   Q4 What are some possible reasons for the changes you can see?

2. Observe glacial changes

Use ChangeMatters Viewer to observe changes in Alaska's Bear Glacier between 1975 and 2010.

1. In the Search box above the images, type Bear Glacier, and select Bear Glacier, Alaska, United States when queried.
2. Check to see that the date selection is still 1975-2010.
3. Use the scale bar on the left side of the image as shown to zoom out. Zoom out about four clicks on the minus sign until your image looks like the figure shown.
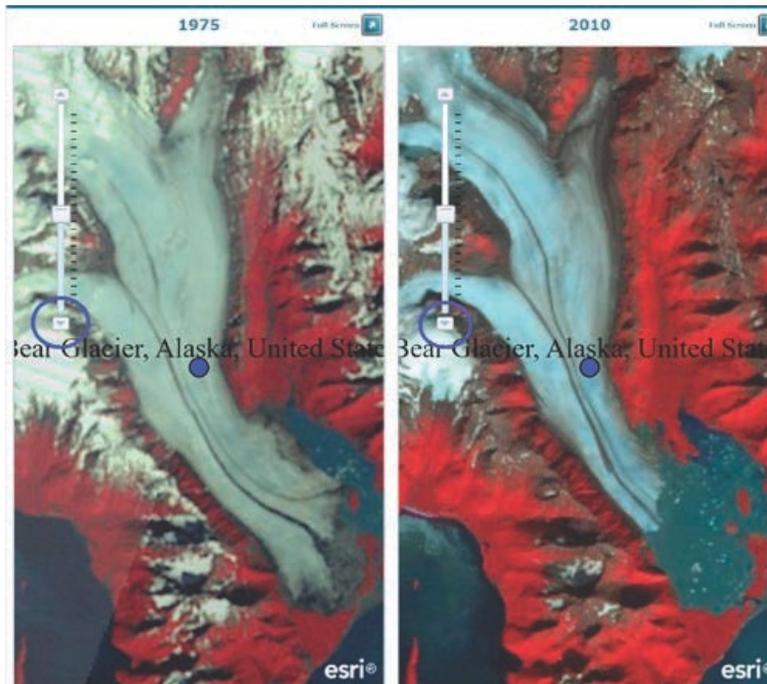
Q5 Describe three changes that occurred in the glacier in the period from 1975 to 2010.

Q6 Why do you think these changes might have occurred?

Obtaining information from imagery

Measuring the Rondonia rain forest

Satellite or aerial imagery can be described as a direct measurement or primary data source. Products derived from the primary source are considered secondary sources. Secondary sources can be derived by digitizing and obtaining vector information from imagery. With imagery serving as the basemap, you can use a mouse to perform manual digitizing, the process of converting geographic features on an analog map into digital format. As in any human procedure, errors can be introduced.

Deforestation is defined as the removal of a forest or stand of trees where the land is thereafter converted to a nonforest use. Clear-cutting is a type of deforestation logging practice in which most or all trees in an area are uniformly cut down. The practice of clear-cutting can be clearly seen from imagery in the state of Rondônia in Brazil. The deforestation in Rondônia is seen in a pattern that looks like a fish skeleton because the cutting fans out along the roads. You have been asked to provide a quick approximation of how much of Rondônia's land has been affected by clear-cutting. You have access to both high-resolution imagery and a Landsat 8 image that shows dry and wet areas.

Build skills in these areas

➢ Opening an existing online map
➢ Interpreting clear-cut forest regions
➢ Digitizing on screen
➢ Calculating percentage
➢ Interpreting Landsat 8 (Moisture Index) imagery
➢ Visualizing derived moisture content imagery

What you need

➢ Account not required
➢ Estimated time: 30 minutes – 1 hour

Investigating Rondonia

1. Click Imagery with Metadata.

2. Click Open in Map Viewer.
3. Click Content in the left panel.
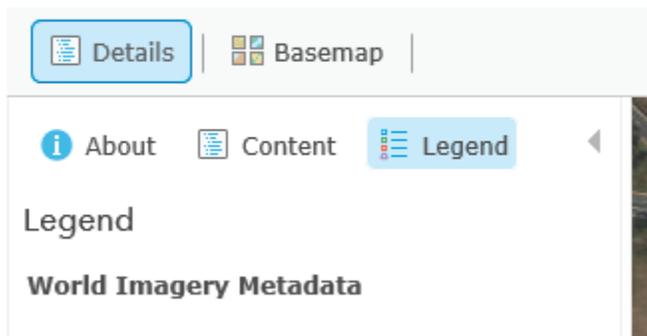
4. Zoom all the way out to the world view of the map.

5. Search for Rondonia, Brazil.

   Take a few minutes to zoom in and out and observe the fish-skeleton-like pattern of clear-cutting in Rondônia. As you zoom inward, you can see that the land is now agricultural.

6. Click Basemap on the left and change to Imagery with Labels.

Q1 What are the major cities in Rondonia?

Q2 Zoom into the city areas. Describe the urban areas.

To calculate the percentage of Rondônia that has been deforested by clear-cutting, you need to know two numbers: the total number of square miles of Rondônia and the number of square miles already clear-cut. Remember, at the beginning of the exercise, it was determined that this secondary information can be obtained from the primary image source.

7. Zoom out so the entire state of Rondonia is visible.

8. On the upper right, click Measure and then the Area icon. The unit is Sq Miles.
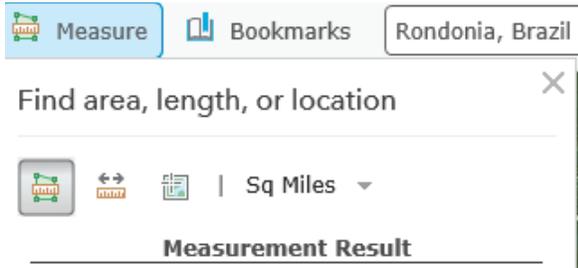
9. After clicking the Area icon, digitize around the country by selecting points and creating a polygon. When the polygon is complete, record the area.

Total area of Rondonia_____ sq miles.

10. Zoom in and digitize around the areas of Rondonia that have been deforested by clear-cutting. You need to digitize several polygons and add the areas together for a total.

Total area of deforestation _____ sq miles.

Total area of Rondonia/Total area of deforestation X 100 = _____ of deforested land.

In the previous section, high-resolution aerial imagery was used to observe Rondônia. In the next section, a Landsat 8 Moisture Index image will be used. The moisture index has been derived from the most recent Landsat 8 imagery and is an estimated level of moisture in vegetation. Wetlands and other vegetated areas with high levels of moisture appear as blue, whereas deserts appear as tan to brown. The Normalized Difference Moisture Index (NDMI) is calculated by using the near infrared (band 5) and shortwave infrared (band 6). The map is updated daily, retaining the four most recent scenes for each path/row that has cloud coverage of less than 50 percent.

11. Open The Moisture Index: How wet or dry?
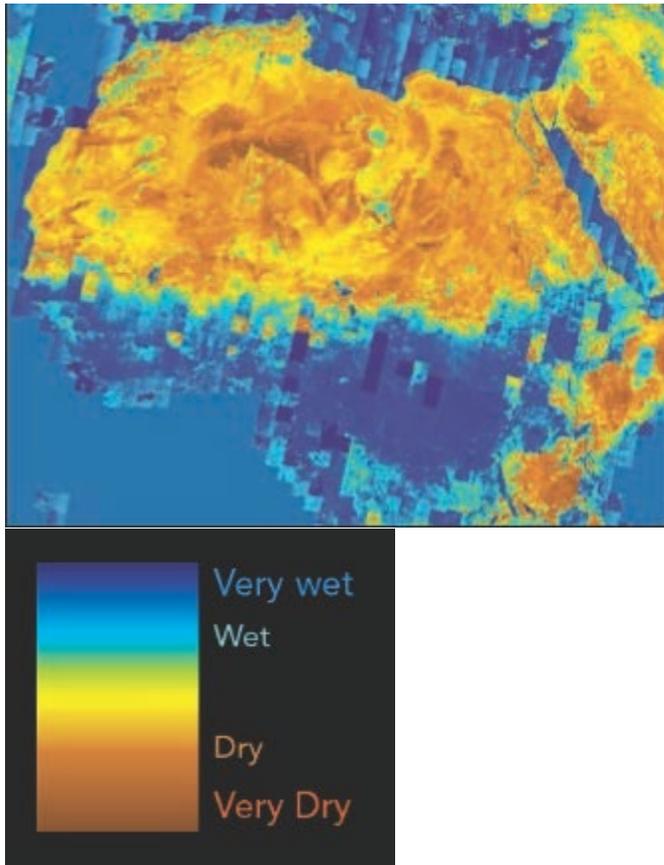
12. On the right panel at the bottom, click Data Source. This opens the Landsat 8 (Moisture Index).
13. Click Landsat 8 (Moisture Index) and then Open in Map Viewer.
14. In the upper-right search box, search for Rondonia, Brazil.
15. Below Details on the left, click Contents. This shows the two layers on the map. You can turn off the Landsat 8 (Moisture Index) to observe the outline of R0ndonia.
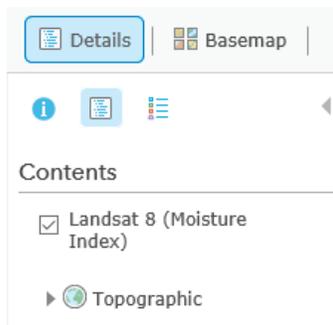
Q3 Write a description of the deforested land using the Moisture Index Legend.

16. Following the procedure explained in steps 8-10, digitize around the deforested region and perform the calculation for percentage of clear-cutting again. You may use the total area of Rondonia that you obtained previously.

Total area of Rondonia:_____ sq miles.

Total area of deforestation_____ sq miles.

Total area of Rondonia/total area of deforestation X 100 = _____ of deforested land.

In this lesson, you have identified deforestation areas using both aerial and derived remote sensing imagery. You have used this imagery to obtain measurements to quantify the area of deforestation.

Adding history to ArcGIS Online

View topographic maps from the Living Atlas of the World

In this section you will add historical topographic maps to an ArcGIS Online map from the Living Atlas of the World.

Your team has decided to create a map that will enable viewers to compare historical topographic maps of your school's surroundings at different historical dates. Your responsibility is to create the map. Others on your team will provide content based on research.

Build skills in these areas

➢ Adding historical topographic maps as layers to ArcGIS Online

What you need

➢ Account required
➢ Estimated time: 30d minutes - 1 hour

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1. Create a new map in your ArcGIS Online account

1. Sign into your ArcGIS organizational account.
2. Click Map.
3. After using the find address box to zoom to the Lanier Middle School (3801 Jermantown Road, Fairfax, VA 22030), click Add to Map Notes to place a marker there.

4. Click the map note.
5. Click Edit. This offers the opportunity to change the symbol to pushpin, etc.
6. Click on the map note in the map and change its title to Lanier Middle School.
7. Click Edit to stop editing.
8. Also rename the map notes layer in the Table of Contents, Lanier Middle School.

9. Save the map as Lanier Middle School.
10. Fill in the map information with tags and a summary (Historical topo maps of the Lanier MS area).

2. Add historical topographic maps as layers to an ArcGIS Online map

1. Click Add.
2. Click Browse Living Atlas Layers.
3. Search for Historical Maps.
4. Add the 1:62,500 group and then click the back arrow to return to the content pane.
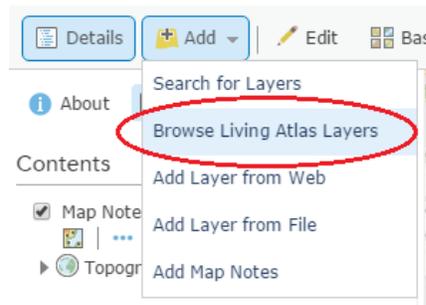
5. Click the more options symbol (three dots at the end of the layer).
6. Choose Image Display Order from the drop-down list, and in the window that opens:
   a. Leave An attribute at Date Current.
   b. Change the Highest Priority value to 1915. This means you are adding the 1915 map from the 1:62,500-scale group.
   c. Click Apply.
   d. Click Close.
7. Click more options and click Copy. You need to copy the set of maps because you want to add a second map (1944) from the 1:62,500 group.
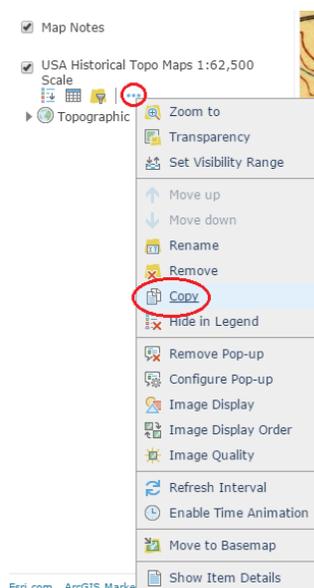
A copy of the USA Historical Topo Maps 1:62,500 has now been added to your map.

8. Go to Image Display Order on the new copy of the layer and change 1915 to 1944.
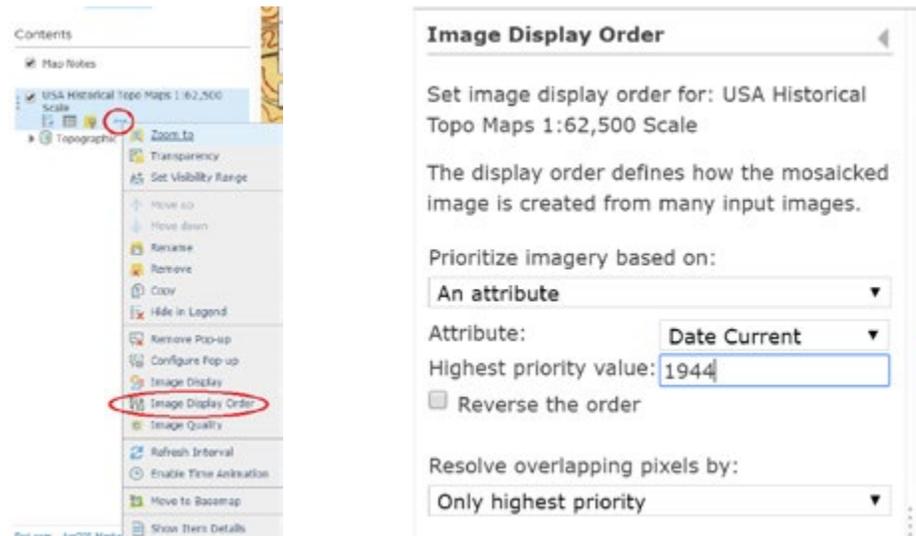
You can see the two map layers that you've added by toggling on and off.

9. Rename the layers in the Table of Contents with the appropriate year:
   a. For the first map you added (the lower one), click more options and click Rename.
   b. Change the layer name to 1915
   c. Repeat this with the layer copy.
   d. Rename this layer to 1944
10. Return to Browse Living Atlas.
11. Search for and add the USA Historical Topo Maps 1:24,000. Click back arrow to go back to the Contents Pane.

4
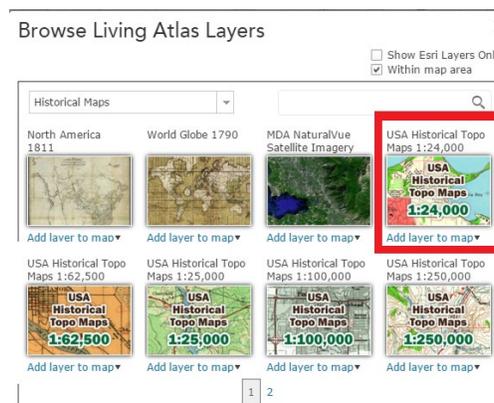
12. Use the same procedure you did with the first group of maps, to add maps from the 1:24,000-scale group. To go Image Display Order in that layer and replace 1800 with 1955 (the next map you want to add).
13. Click Apply.
14. Click Close.
15. Copy the USA Historical Topo Maps 1:24,000 layer three times because you want to add three more maps from this group (1966, 1979, and 1994).
16. Repeat the selection procedure to add each of these three layers to your map. Save your map frequently.
17. Rename the layers appropriately: 1955, 1966, 1979, and 1994.

When you have added all the layers, your map will look like this.
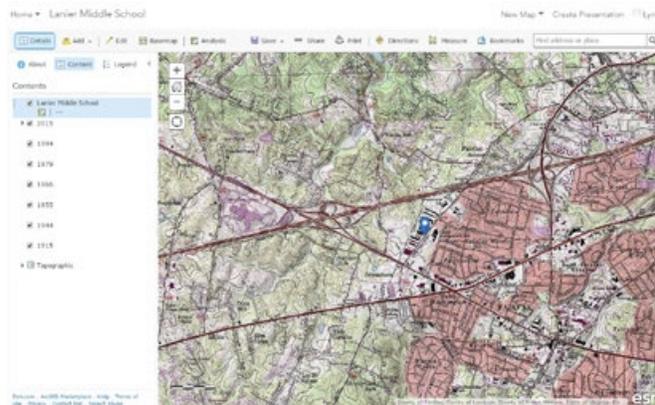
18. Save your map.

The final layer in your map will be a contemporary topographic map.

19. Go to Add>>Search for layers>>ArcGIS Online and search for USA topographic.
20. In the Search results, choose and add USA Topo Maps.

21. For each of your map layers, click More Options (ellipsis) and Hide in Legend.

Turn the layers on one at a time to see the historical progression of the site.

Enabling citizen collaboration Create an editable web layer to map graffiti: Survey123

Two uses for mapping graffiti come immediately to mind. The first use is to classify the type of graffiti that is present and the second is to specify what graffiti needs to be removed by the municipal authorities. Because graffiti has a spatial component, clusters can be found across the city representing gang, political, or religious trends.

As a GIS consultant, you have been asked to create an editable web layer that is accessible online to the public. This editable web layer will enable citizens to work collaboratively on one map. The size of the group is negligible so many citizens can work at one time. A map containing the editable web layer can be made anywhere in the world and be accessed wherever there is an internet connection. The survey collects data about types of graffiti and whether it should be removed by the municipal authorities. The editable web layer will use configured relationships to enforce data integrity.

Build skills in these areas

➢ Create a web designed Survey 123 form
➢ Create relationships within the survey
➢ Using a thumbnail
➢ Publishing and sharing a survey

What you need

➢ Account required
➢ Estimated time: 1 hour

1. Open and create a web-designed Survey123

1. Go to Survey123.
2. On the top ribbon on the right, sign into your ArcGIS Online organizational account.
3. Click Create a New Survey.
4. Using the web designed>>click Get Started.

Using the web designer

- Get started quickly
- Best for simple surveys
- Author your survey graphically

Get Started

5. Fill out the Create a New Survey template with the following:
   a. Name: Graffiti.
   b. Tags: Remove tags and add individualized tags.
   c. Summary: Survey to collect data about types of graffiti and remedial action.
   6. Click Create.

2. Add logistical questions

Below is the information the survey is going to collect about observed graffiti.

a. What is your name?
b. What is the date?
c. What is the type of graffiti?
  o Ideological
    ▪ Political (pertaining to hate groups such as Nazi or ISIS)
    ▪ Racial (pertaining to race)
  o Territorial
    ▪ Tags (gang symbols)
    ▪ Memorials (honor the slain)
  o Artistic
 d. Does the graffiti require repair?
    o Yes
    o No
 e. Where is the graffiti located? (geo-enabled location)

On the right panel, you are presented with a list of questions. They type of questions that you choose on the right panel must be dragged into the Web Designed.
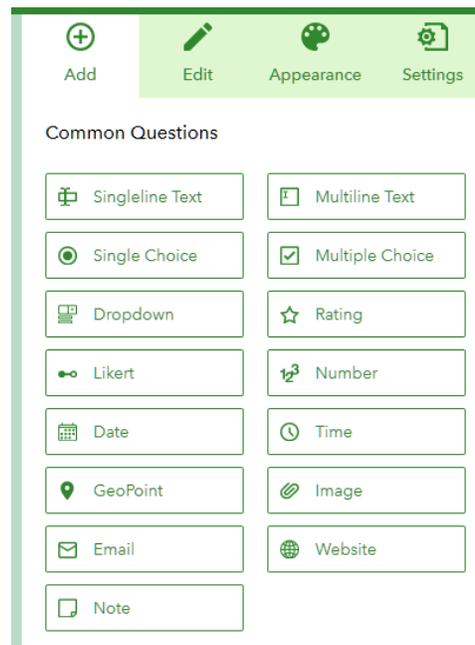
1. Click SIngleline Text.
2. Type the question: What is your name? This identified the collector observing the graffiti.
   a. Check: This is a required question.
   b. Click Save.
3. On the top of the right panel click Add.
4. Click Date.
5. Type the question: What is the date? Modify date if different from current date.
   a. Check Submitting date.
   b. Check This is a required field.
   c. Click Save.
6. Once again at the top of the right panel, click Add.
7. Click Single Choice.
8. Type the question: What is the type of graffiti?
   a. Choice 1 is Ideological – Political.
   b. Choice 2 is Territorial – Gang Related. Make the choice the default.
   c. Choice 3 is Artistic – Street Art.
   d. Choice 4 is Other.
   e. Layout is Vertical
   f. Check This is a required question.
   g. Save.

9. Once again, at the top of the right panel click Add.
10. Click Single Choice.
11. Type the question: Should remedial action be taken to remove it?
     a. Choice 1 is Yes.
     b. Choice 2 is No.
     c. Layout is Vertical.
     d. Check This is a required question.
     e. Save.
12. On the top of the right panel, once again click Add.
13. Select GeoPoint to designate a location on the Earth's surface.
14. Type the question: Where is the graffiti located?
     a. Change the Default Map to Imagery.
     b. Click the bullseye button on the map, and it will zoom to your area.
        The map will then be set for this location area.
     c. Check This is a required question.
     d. Click Save.
     e. Click preview to observe your survey.
     f. After previewing the survey, click X to return to the survey designer.
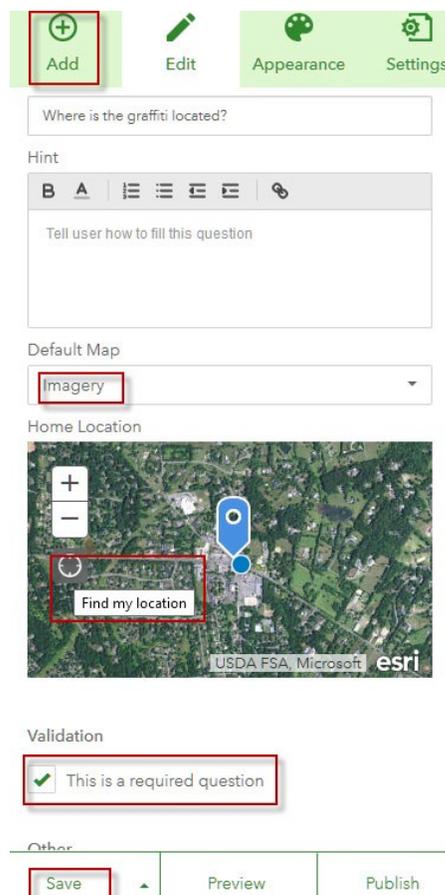
3. Construct your survey with relationships for integrity of data

One of the greatest concerns when collecting data is data integrity and efficiency. Integrity and efficiency are maintained if the collector is presented with specific choices that maintain the integrity of the attributes. You can arrange this by using the drop-down menus that you choose as a collector. For instance, as the collector in the next step, you will create a collection function that allows you to further classify the type of graffiti and whether it needs repair. This is done by setting rules. For example, if the collector selects "ideological" as the type of graffiti, then a drop-down will appear that will allow further classification of the graffiti as either "political" or "racial." If the collector chooses "territorial," then once again the data can be further classified as "tags" or "memorials." The repair question requires only a simple "yes" or "no" classification.

1. Click Add.
2. Click Single Choice and type the question: If answer is ideological choose:
    a. Choice is political.
    b. Choice is racial.
    c. Choice is other.
    d. Appearance is vertical
    e. Save.
3. Click on the "What is the type of graffiti?" question and select the set rule icon.

4. Choose IF ideological, choose "if answer is ideological choose.:
5. Click OK.
6. Click Save.
7. Click Add.
8. Click Single Choice and type the question: If answer is territorial choose:
    a. Choice is tags.
    b. Choice is memorials.
    c. Layout is Vertical.
    d. Save.

9. Click on the "What is the type of graffiti?" question and select the set rule icon.
10. Choose IF ideological, choose "If answer is territorial choose."
11. Click OK.
12. Click Save.
13. On the bottom right, click Preview and test your survey.
14. Click X in the upper right corner to close the preview.

4. Select an appearance and publish

1. Click Appearance on the top ribbon.
2. Select a Theme.
3. Have all the layout elements turned selected.
4. Click Save.
5. Click Preview.
6. Click Publish, Publishing will send the survey into the cloud where it can be accessed by collectors who can work on the map collaboratively.

   It will ask you if you want to save all changes.

7. Click Publish.

How bad is the graffiti?
Collect data with your smartphone

Your town council has decided to earmark money for the removal of graffiti. The council needs to know the location and extent of the graffiti before the town can come up with the money for a cleanup plan. Girl Scouts have been equipped with mobile devices to mark and collect information about the graffiti. The council is extremely interested in the type of graffiti that is present.

Build skills in these areas

- ➢ Download Survey123 to your mobile device
- ➢ Download Graffiti survey to your mobile device
- ➢ Collect data on your mobile device
- ➢ Observe collected survey data in a web browser
- ➢ Observe collected data in ArcGIS Online

What you need

- ➢ Account required
- ➢ Survey123 App
- ➢ Estimated time: 1 hour

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1. Download the Survey123 App to your mobile device

1. Go to the App store on your mobile device.
2. Search for and download the Survey123 mobile App.
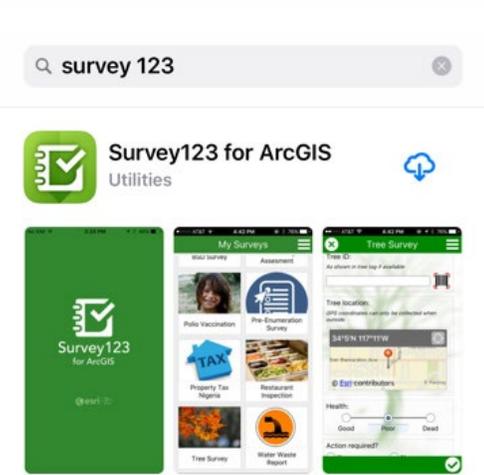
2. Access the Graffiti Survey form on a mobile device

1. Click the Survey123 icon on your mobile device.

2. Sign into your ArcGIS Online organizational account.
3. Click Get Surveys.
4. Download the Graffiti Survey by clicking on the blue cloud with the down arrow.
5. When you find Graffiti Survey download complete, click OK. This will download the survey to your mobile device.

6. After downloading, click Graffiti.
   The survey will download to your mobile device. The app will ask you:

   "Allow 'Survey123' to access your location while your location while you
     are using the app?"

7. Click Allow. This turns on the GPS in your mobile device, enabling
   location services, and you will now also see your survey. Your GPS may
   already be turn on, in which case there is no need to do this.

8. To change the basemap, click the map.
9. Click the three lines on the top right.
10. Change the basemap to World Imagery.
11. Fill out the survey form.
12. Click Continue this survey.
13. Collect the graffiti points.
14. After collecting the graffiti points, click Send NOW. This sends your
    survey points into the cloud.

3. Access the Graffiti Survey in a web browser

The web browser is where you can share your form with your organization so that others can download. This is also where you can go to review responses to your survey and download your survey data.

1. Go to Survey 123.
2. Sign into your ArcGIS organization account.
3. Click My Surveys.
4. Click the Graffiti Survey under All Surveys.

The web browser has five tabs at the top. Each tab gives you additional information about the data you have collected during your survey.

- **Overview** tells total records, participants, and dates.
- **Design** allows you to adjust your survey.
- **Collaborate** gives permission to participants to see and submit data.
- **Analyze** gives you histograms about your data.
- **Data** shows your collect points on the map.

5. Click on each of the tabs and investigate the information.

4. Access the Graffiti Survey in ArcGIS Online

1. On the bottom left, click Open in Map Viewer to open the Graffiti Survey as a map within your account.
2. Click a point on the map to access the data.

3. After opening, you can save your map with the appropriate metadata.
4. For the public to access your map, choose Share with everyone. For now, only those in your organization can view the map.

Mapping tree data
Use ArcGIS Collector App

Collector for ArcGIS allows you to use your smartphone or table to collect data.

You have been assigned the task of preparing a map using the tree collection service you prepared in the feature service lesson. Remember, this is the collection template that you need to have a group of instructors use in a training session. You now have it uploaded, shared, and ready to access on your mobile app.

Build skills in these areas

➢ Download ArcGIS Collector App to a mobile device
➢ Create a group and add a previously made editable feature service
➢ Share a map with workers in the field
➢ Collect data

What you need

➢ Account required
➢ Estimated time: over 1 hour

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1. Create a map and share with a group in ArcGIS Online

1. Sign into ArcGIS Online organizational account.
2. In My Content find the tree feature made in a previous exercise.
3. Add the tree feature service to a new map.
4. Save the map with the appropriate metadata.
5. Under Home, select Groups.
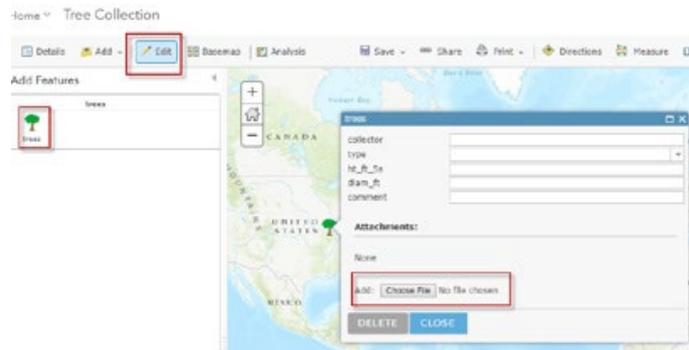
6. Click Create New Group.
7. Add the following parameters:
    a. Group Name: Tree Collection
    b. Tags: Add individualized tags
    c. Click Group members can contribute content to the group
8. If you have a .jpg image that you want to represent the group, click the icon button and add the image.
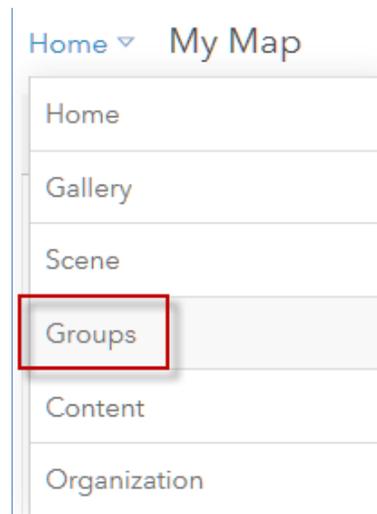
9. Return to your map in My Content and share with the group you have just created. Be sure to click Done without creating an app.
Your map is now ready to be viewed in the Collector App. The Collector App will NOT recognize a map unless it is shared with a group.

2. Download Collector for ArcGIS

To complete this lesson, you will be asked to download and learn to navigate the mobile component of GIS: Collector for ArcGIS. Collector for ArcGIS is designed to improve the efficiency of fieldwork and the accuracy of your GIS. Use your mobile device to collect and update information in the field, whether connected or disconnected.

1. On your mobile device go to the App store, search for Collector for ArcGIS, and download the App.

2. Open the mobile app to sign into your organizational account.

3. Click ArcGIS Online and sign into your organizational account.
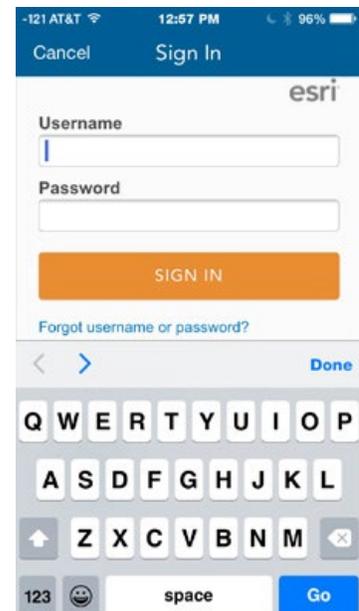
3. Accessing map and navigating and collecting

1. Open the Collector App and you will see the Tree Collection map you made and shared with the group; it's aptly named Tree_Collection.
2. Open the map and allow the Collector to access your location using the app. The Collector device has different icons on IOS and Android devices. However, all of them universally do the same thing.
3. Familiarize yourself with the Collector App with what ever operating system you are using and figure out how to do the following:
   a. Change the basemaps.
   b. Measure.
   c. See a legend.
   d. Collect a point.

The point collection is critical. As a rule, to collect a point you need to do the following regardless of the operating system you use:

- Click the GPS point.
- Fill out the collecting form.
- Submit the form.

The point you and the other collectors are collaboratively gathering on the map is save in the cloud.

Owning a feature service
Access a service definition

This lesson introduces you to service definitions. A service definition is a file that is produced every time a feature service is created. It contains all pertinent information about the feature service. It allows you to duplicate a preexisting feature service, add the service to your organization, and transfer all ownership to you.

You want to do a training session in which participants gather information about area trees. You have located a service definition that you can use as a template. The service definition that you have located provides the following information:

- Collector
- Type of tree (needle, broadleaf, palm)
- Height in estimates of 5 feet
- Diameter of canopy (estimate in feet)
- Area for comment
- Attachment ready—jpeg and png images can be be uploaded
  You will need to download the service definition and then upload and publish it to your organizational account. When published you can collect data.

Build skills in these areas

- ➢ Find a service definition template
- ➢ Download a service definition
- ➢ Publish a service definition as a unique feature service
- ➢ Collect data with the feature service

What you need

- ➢ Account required
- ➢ Estimated time: 30 minute – 1 hour

Find and publish a service definiton

1. Sign into the ArcGIS Online organizational account.
2. Click Search.

3. Search for IGARC2_tree.
4. Uncheck the Only search in your Organization tab.
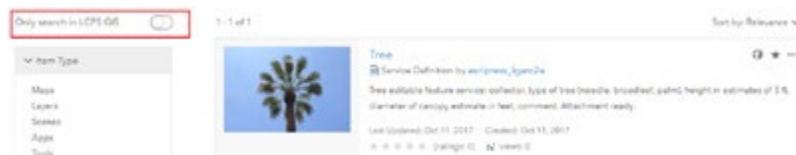
5. Download the file Tree Collection by clicking Open and save to your computer.
6. In ArcGIS Online, click My Content at the top of the page.
7. Click Add item from my computer.
8. Browse to the **tree.sd** file and choose file.
9. Be sure **Publish this file** is checked.
10. Add the appropriate individualized tags.
11. Click Add Item.
    It will take several minutes to upload and publish the tree service definition.
12. After the feature service is created, click Open and click Add layer to the map. After the feature service is added to the map, you will see the Edit icon on the top of the page.

13. Click Edit. When you click the Edit icon, the tree collector icon is exposed.
14. Click the tree icon.
15. Click the location of the tree on the map. The collection menu is exposed. The collection menu allows you to not only collect data, but the Choose File allows you to upload a jpeg or png image.

In this lesson, you have uploaded and published a service definition template designed to collect tree data.

Using Web AppBuilder for ArcGIS

Web AppBuilder for ArcGIS provides a foundation for building web applications in ArcGIS. It builds intuitive, focused apps that run anywhere, on any device, without writing a single line of code. Community leaders have asked your GIS department to create an app of the county that allows users to do and create the following:

- Scalebar
- Search
- Add data
- Basemaps
- Legends
- Measurement
- Query

Build skills in these areas

➢ Building an app using ready-to-use widgets
➢ Customizing the look of your apps with configurable themes
➢ Publishing the apps

What you need

➢ Account required
➢ Estimated time: over 1 hour

1. Create a map and share as a Web AppBuilder

1. Sign into your ArcGIS Online organizational account.
2. On the top ribbon click Content.
3. Click Create
4. Click Using the Web App Builder.

5. Document the new web app using the following parameters:
   a. Title: Basic Locational and Directional App.
   b. Tags: Remove tags and replace with individualized tags.
   c. Summary: Basic app that allows the user to find locations, measure, and add data
6. Click OK.

2. Add a theme, map, and basic widgets

1. Pick the Billboard Theme.
2. Click Map on the top ribbon.
3. Use current map view.
4. Click Widget on the top ribbon.
5. Add the following standard widgets:
   a. Scalebar
   b. Search
      1. On the icon for search, click pencil for edit.
      2. Click OK to add the Esri World Geocoder.

3. Add custom widgets

1. Click Widget 1.
2. Select Add Data.
3. Click OK and OK.
4. Click Widget 1.
5. Click Basemap gallery.
6. Click OK and OK.
7. Repeat steps 1-4 for Legend.
8. Repeat steps 1-4 for Measurement.
9. Repeat steps 1-4 for Query.
10. Click Save.

4. Preview and launch

1. On the bottom left tab, click Preview.
2. If you are happy with your work, click Launch.

In this lesson, you have created an app with both standard and custom widgets.

Imagery Is Visible Intelligence
A geographic Rosetta stone

The convergence of photography and airplane flight in the early twentieth century resulted in the ability to truly experience a birds-eye view of Earth for the first time. The emergence of photography in the mid-nineteenth century had produced early efforts with hot-air balloons and kites, but it wasn't until the achievement of airplane flight that aerial imagery came into its own. During World War I, aerial photography played an increasingly important role in both reconnaissance and map-making; by the end of the war, it had become a vital military tool for both sides.

Since that time, birds-eye views have grown to include views from planes, satellites, and, more recently, drones. The scale and resolution have improved dramatically with each iteration, and modern imagery now includes "invisible" data from sensors as well as reflected visible light. Today, geographers use remote sensors to study Earth's surface.

Remote sensing has applications for virtually every human industry, activity, and concern. Using remotely sensed data, farmers are increasing crop yields, commuters are monitoring traffic flow, and environmentalists are investigating climate change. With the rapid proliferation of unmanned aerial vehicles (UAVs), the number of remote sensing applications is growing exponentially. Imagery and remote sensing are informing decision making in every arena and will only grow in value and importance in years to come.

In chapter 8, you will compare image resolution across different scales, analyze landscape imagery to assess current weather conditions, use the Esri Landsat Explorer App to monitor hydraulic fracking activity, and use Landsat imagery to visualize the effect of a forest fire in California and vegetation damage caused by Hurricane Maria in Puerto Rico.

Introductory activities

Videos

Videos elevate motivation and enthusiasm as well as enhance discussion. The following videos represent the production of imagery as visible intelligence:

Esri Launches Landsat Explorer Web App

Esri launches Landsat Explorer web app
Geospatial Media

Esri has developed its new Landsat Explorer web app. The app helps us visualise planet Earth and understand how it has ...

0:41

Know How Landsat 8 Completes Its One Rotation to Give Brighter Imagery

Know how Landsat 8 completes its one rotation to give brighter imagery
Geospatial Media

As the earth orbits the sun, Landsat 8 positions itself too. Just to be in the sun synchro As the earth orbits the sun, Landsat 8 ...

1:16

Understanding the Landsat program

Landsat sensors have been continually generating and sharing pictures of Earth since the 1970s. It is the most persistent Earth observation program ever used. Landsat data is used so extensively that a knowledge of the history of the program and the science behind it is necessary.

Go to the NASA Landsat Science web page and answer the following questions:
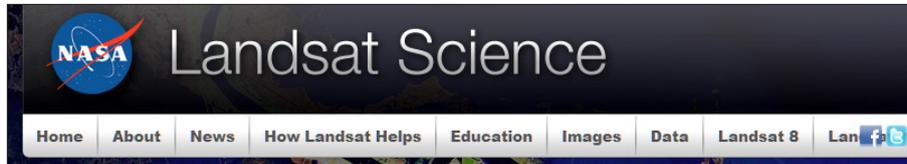
What is Landsat and when did it begin?

What are the orbit paths of the Landsat satellites?

What is the resolution of the spectral bands?

What is the resolution of the thermal bands?

What is the difference between the spectral band and the thermal band?

The ArcGIS Book, chapter 8
Questions for reading comprehension, reflection, and discussion

Teachers can use the items in this section as an assignment, an introduction, or an assessment tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

Write briefly about the historical timeline of imagery. Specifically refer to the following milestones:

- *World War II: Reconnaissance and intelligence gathering*

- *Humans exploring the moon*

- *The Landsat program*

- *The human era of GIS*

How does imagery expand your perspective?

Thought leader: Lawrie Jordan . . . ArcGIS now includes a complete image processing system.

What does Lawrie Jordan mean when he says, "We like to say that the map of the future is an intelligent image"?

List four applications of imagery.

Learn ArcGIS: Guided lessons based on real-world problems

Depict Land-Use Change with Time-Enabled Apps

Depict Land-Use Change with Time-Enabled Apps
Adding Landsat imagery to a map.
Enabling and configuring time animation.
Filtering historical satellite imagery.
Changing band combinations.
Creating and sharing time-enabled web apps.

Use historical imagery and time animation to show land-use change in Thailand.

Oso Mudslide - Before and After

Show disaster imagery by creating an app with Web AppBuilder.

Oso Mudslide – Before and After
Create an app with Web AppBuilder.
Adding metadata.

Using global imagery basemaps

Something for everyone

The Esri World Imagery Basemap and World Imagery Basemap with labels provide satellite imagery for the world and high-resolution imagery for the US and other areas around the world. The default World Imagery Basemap as shown in the drop-down menu does not contain metadata. If you add World Imagery from the search menu, there is a citation layer that provides metadata about the imagery. It is from this information that you can see the provider of the data, the date of acquisition, the resolution, and the accuracy.

The instructional GIS team of your university has asked you to prepare a lesson introducing the Esri World Imagery Basemap. The team has asked that you develop an exercise that students can do to understand the difference in resolution and accuracy at different locations.

Build skills in these areas

➢ Adding World Imagery layer with citation layer
➢ Accessing metadata of the World Imagery layer
➢ Comparing resolution across world locations

What you need

➢ Account not required
➢ Estimated time: under 30 minutes

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1. Add World Imagery Basemap with citations

1. Go ArcGIS Online.
2. Click Map to open the Map Viewer.
3. Click Modify Map in the upper right corner.
4. Click Add and Search for Layers. User the following parameters:
   a. World imagery
   b. ArcGIS Online
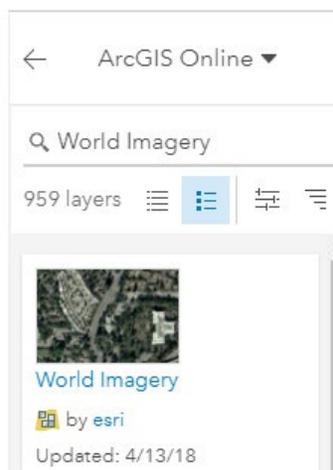
5. Add World Imagery by esri.
6. Click the back arrow to go back to the Contents Pane.
7. Click Content under Details.

8. Click World Imagery in the contents pane to expand the legend.
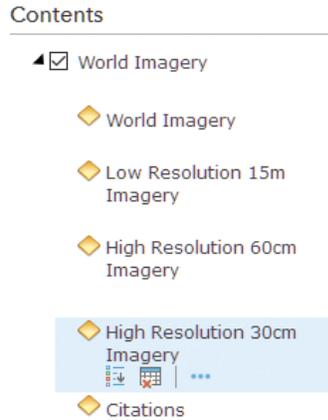
This is a multiscale image; as you zoom in, the scale changes.

Q1 What objects can be seen at the following resolutions?
Low Resolution 15 meters
High Resolution 60 cm
High Resolution 30 cm

2. Investigate locations around the world

1. In the upper right, search tab search for the locations shown below.
2. Zoom into the location until the image becomes blurry.
3. Click on the image to display the metadata.

Q2 On your own, locate the places in the following table and record the image detail:

Location	Provider	Resolution	Accuracy
O'ahu, Hawaii			
Shanghai, China			
Oslo, Norway			
Abu Dhabi, UAE			
Washington, DC			

3
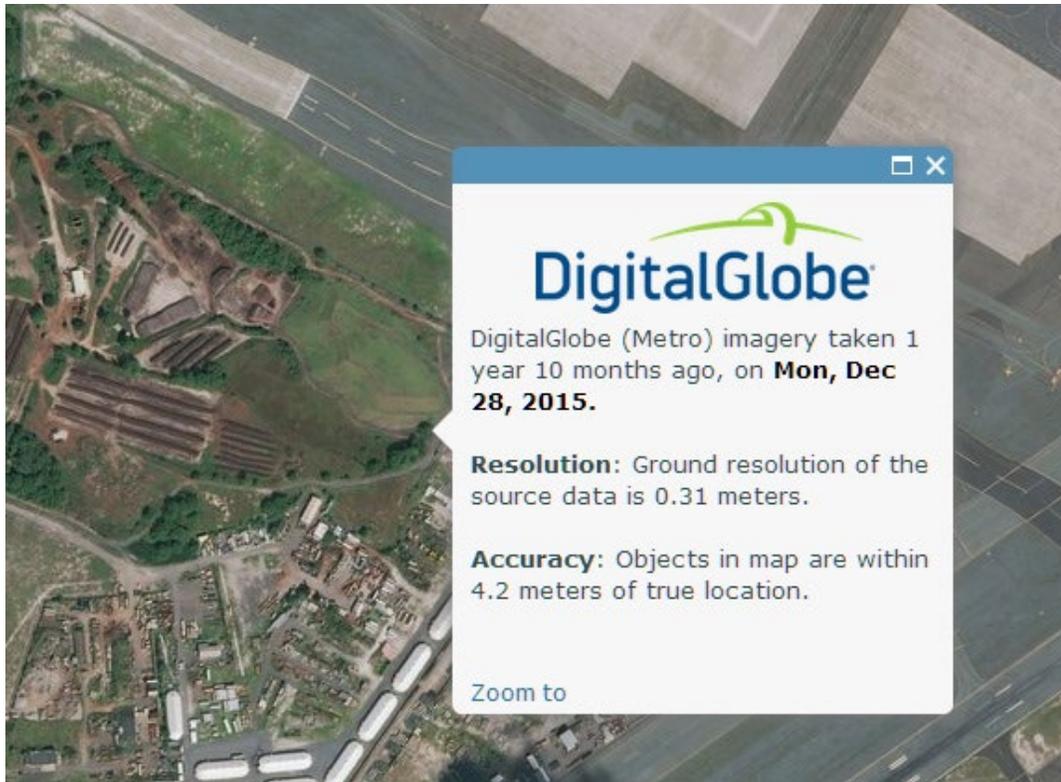
Accessing landscape layers in the Living Atlas of the World

A collection of global geographic information

In the Living Atlas of the World Layers provided by Esri, there is a group called Landscape Layers. This Layer group contains a collection of ready-to-use layers from Esri to support landscape analysis. The Landscape Layers are used to plan and manage natural resources and the relationship with the environment.

You have been instructed to become familiar with the Landscape Layers of Esri's Living Atlas of the World. You need to show your competence by adding and performing basic analysis on four layers:

- USA Geology Units
- USA Aquifers
- USA Drilling Platforms
- Current Wind and Weather

Build skills in these areas

➢ Accessing the Landscape Layers in Esri's Living Atlas layers.
➢ Doing basic analysis using four of the Landscape layers.
➢ Add as needed

What you need

➢ Account required
➢ Estimated time: under 30 minutes

Explore Living Atlas Layers

1. Sign into your ArcGIS Online organizational account.
2. Open a Map in Map Viewer and change the basemap to light gray.
3. Click Add>>Browse Living Atlas Layers.
4. Type Soils and Geology in the search pane.
5. Select USA Geology Units and add to map.
6. Click the show table to display the table of attributes and then click the back arrow to return to the Content Pane.

Two of the attributes are Rock Type and Maximum Age. You can use the filtering tool to ask questions of the USA Geologic Unit Layer.

7. Click filter and construct the following expression to show all the rock layers that are volcanic.   **Rock Type is Volcanic.**
8.   Click APPLY FILTER. Only the rocks that are volcanic are shown.
9. Open the Filter again.
10. Remove Filter and Click Edit.
11. Construct the following expression: **Maximum Age is Jurassic.**
12. Click APPLY FILTER and zoom to the USA.
13. Investigate the USA Geology Unit shown in the Contents Pane.

14. Click Add>>Browse Living Atlas Layers and search for USA Aquifers.

15. Add to map as a Layer. Click the back arrow to return to the contents pane.
16. Click Filter and construct the following expression: **Aquifer Description if High Plain aquifer**.
17. Click APPLY FILTER.

Q1 Explore the resulting aquifer and its strategic importance to the states where it is located.

18. Remove the USA Aquifers from the Contents Pane.
19. Click Add>>Browse Living Atlas Layers and search for Drilling Platforms.
20. Add to map as a layer.
21. Click Filter and construct the following expression: **Water Depth is greater than 1500**.
22. APPLY FILTER.
23. Open the attribute table.

Q2 How many platforms are at a depth of greater than 1500?

24. Click Add>>Browse the Living Atlas Layers and search for Current Wind and Weather Conditions.
25. Add to map as a layer.

This is an extremely rich dataset containing a routine weather report with data for a location temperature; dew point, wind speed, gust, and direction; precipitation; cloud cover and heights; visibility; and barometric pressure. The data can be filtered and symbolized by all their variables.

In this lesson you have explored a variety of living atlas layers.

Monitoring fracking in Denton, TX
Use panchromatic Landsat

Fracking is a well stimulation technique. Fracking involves the high-pressure injection of water or other products into a well. This injection creates cracks in deep-rock formation that allow the release of natural gas and petroleum more easily. Fracking's pros and cons have been widely debated. The process of hydraulic fracturing is highly controversial, with one side heralding the economic benefits and the other side weighing in on the potential environmental impacts of increasing earthquake activity. The town council of Denton, TX, passed a city referendum in 2014 to prohibit hydraulic fracturing. This referendum was rescinded when the state of Texas passes a bill that prohibited the banning of fracking. The Denton town council is still petitioning to stop fracking in their town. The council knows that more than 300 fracking wells exist within the city limits of Denton.

Council members have asked your remote sensing company to prepare a time-enabled visualization of the number of wells introduced into Denton since 2001.

Build skills in these areas

➢ Using Esri Landsat Explorer app
➢ Visualizing data using band combinations
➢ Filtering and selecting specific dates to analyze and compare
➢ Investigating change with time-enable data
➢ Interactively comparing two images using a swipe tool

What you need

➢ Account required
➢ Landsat Explorer app
➢ Estimated time: 30 minutes – 1 hour

1. Opening the Esri Landsat Explorer

1. Open the Esri Landsat Explorer.
2. In the upper right corner, sign into your organizational account.
3. In the search box search for Denton, TX.
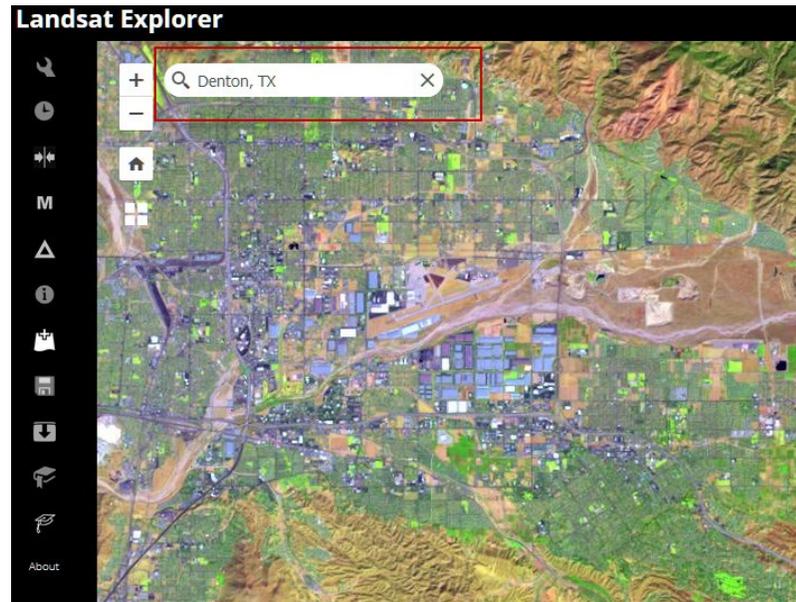
2. Render natural color band combination and add Denton city limits

1. Go to the Rendered icon on the left panel and change the band combination to Natural Color.

This band combination approximates the spectral range of vision of the human eye. The natural color band combination has been pansharpened using the 15 m panchromatic band to achieve better imagery resolution.

2
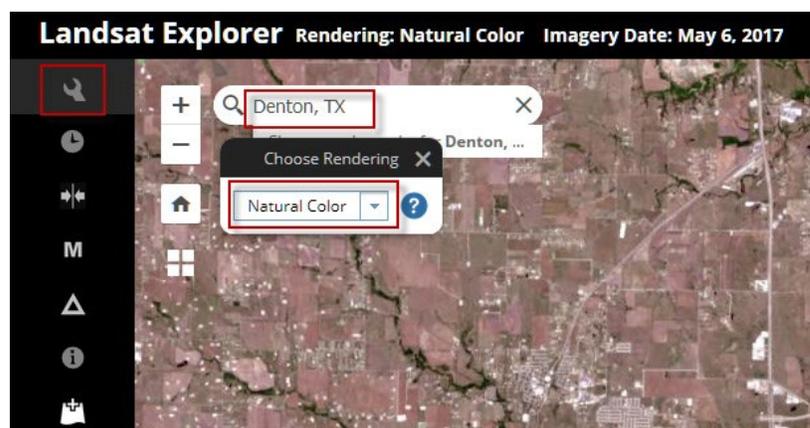
2. Go to Add Data from ArcGIS online icon and search for Denton, TX.
3. Search in ArcGIS Online for IGARC2_wells.

IGARC2_wells are the Denton, TX, boundary that defines the city limits of Denton.
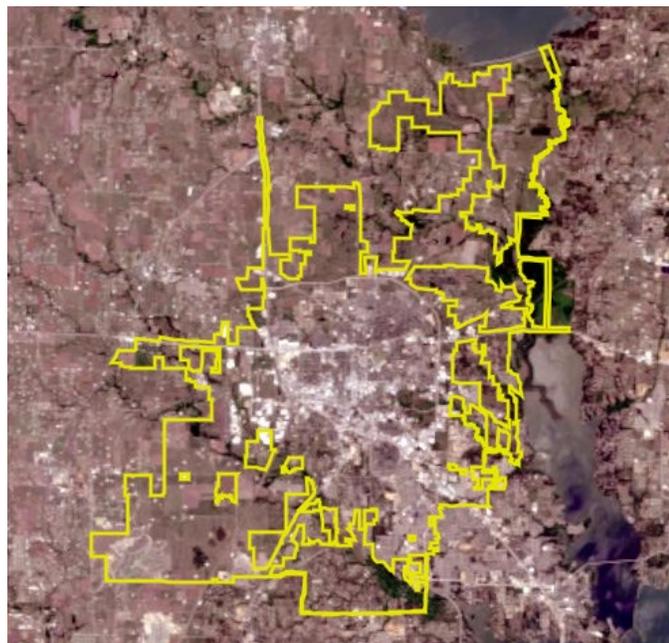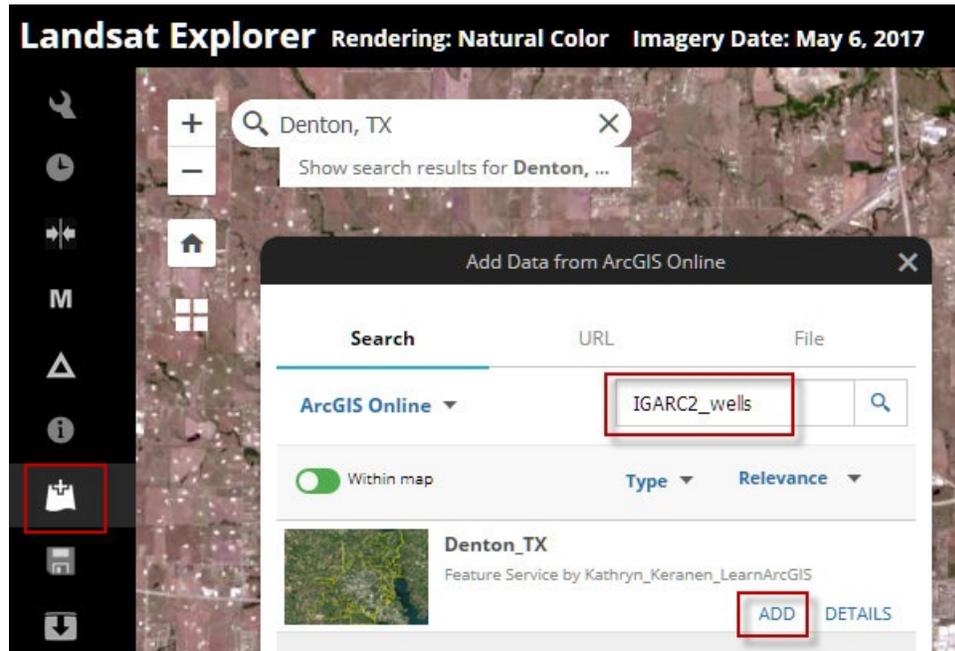
3. Identify fracking wells and compare two images from different time periods

1. Zoom into an area on the map and identify the white rectangles that are the fracking wells.

Q1 What is the date of the image that is being viewed? Hint: Use the Identify Icon.

You are now ready to use the time selector to pick dates to visualize and compare.

2. Zoom back out so you can see beyond the city limits of Denton.
3. Pick the Time Selector on the left panel. On the slider, click the show dates drop-down list and choose September 11, 2017.
4. Click the blue arrow pointing down to Set Current as Secondary Layer.
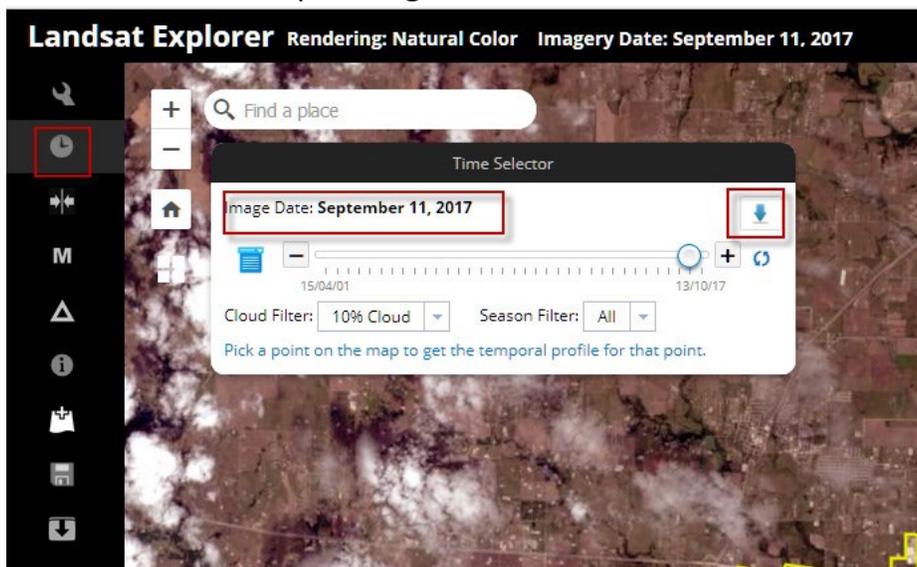
5. Click the Swipe icon on the left panel.
6. Use the time slider to select April 15, 2001, which is 16 years before the first image.
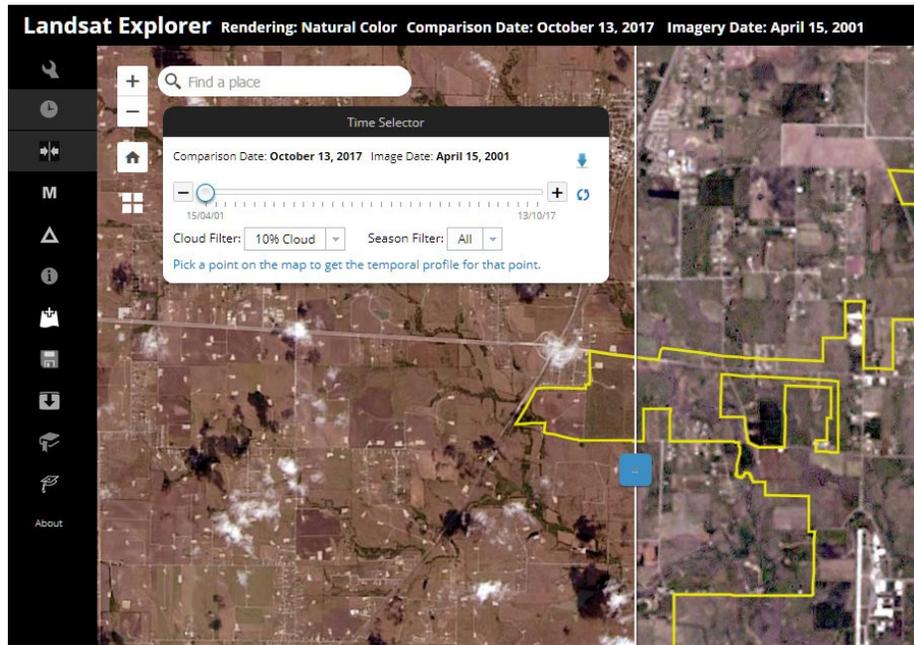
7. Swipe back and forth between the two time periods. Move the image around to different locations.

Q2 What do you observe about the quantity of fracking wells?

Q3 What area within Denton city limits appears to have added the most fracking wells?

Visualizing La Tuna Canyon fire damage: One of Los Angeles's biggest wildfires in 2017

During the fall of 2017, a series of wildfires burned across California. During the early months of 2017, significant rainfall reduced the severe drought conditions of the state. This had led officials to believe that the fire season would be near normal. However, the rain had caused a spike in vegetation growth that dried out and increased fire activity. The La Tuna Canyon fire, which began in the foothills of Los Angeles, became one of the biggest wildfires in the history of the city. The fire burned more than 7,000 acres and forced the evacuation of many communities.

The Los Angeles Fire Department wants before and after images of the La Tuna Canyon fire to impress upon the citizenry the extent of the destruction. Fire officials have asked your GIS department to research and present a comparison.

Build skills in these areas

➢ Using Esri Landsat Explorer app
➢ Visualizing data using band combinations
➢ Filtering and selecting specific dates to analyze and compare
➢ Investigating change with time-enabled data
➢ Interactively comparing two images using a swipe tool
➢ Computing the change between two dates
➢ Using a burn index to identify change

What you need

➢ Account required
➢ Esri Landsat Explorer app
➢ Estimated time: 30 minutes – 1 hour

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# 1. Open, search, and change band combinations using Esri Landsat Explorer App

1. Open Esri Landsat Explorer.
2. In the upper right corner, sign in to your organizational account.
3. In the search box, search for La Tuna Canyon.
4. Zoom into the La Tuna Canyon area.
5. Go to the Rendered icon on the left panel and change to basempa only.
6. Identify the following:
    a. Bob Hope International Airport
    b. Burbank
    c. La Tuna Canyon Road
    d. North Hollywood
7. Go to the Rendered icon on the left panel and change the band combination to Natural Color.

   This band combination approximates the spectral range of vision of the human eye. The natural color band combination has been pansharpened using the 15 m panchromatic band to achieve better imagery resolution.

2. Compare two images before and after the fire

The La Tuna Canyon fire started on September 1, 2017, and the Los Angeles Fire Department declared that it was 100 percent contained on September 9, 2017. There are Landsat images available for the La Tuna Canyon area from August 28, 2017, which is before the fire started, and October 15, after it had been contained. You are now ready to use the time selector to pick dates to visualize and compare.

1. Pick the Time Selector on the left panel. On the slider, click the show dates drop-down list and choose October 15, 2017.
2. Click the blue arrow pointing down to Set Current as Secondary Layer.
3. Click the Swipe icon on the left panel.
4. Use the show dates drop-down list to select August 28, 2017, which is before the fire was started.

5. Swipe back and forth between the two time periods. Move the image around to different locations.

Q1 As you swipe back and forth, can you identify the burn scar?

2. Change detection and Burn Index

The Change Detection tool can calculate changes in burned area.

1. Click the Change Detection icon on the left panel.
2. Change to Burn Index and Difference Mask.

The burn index uses band combinations to define areas that have burned and to index the severity.

The difference mask mode calculates the difference between the two images and when using the burn index, it is the burn/post-fire regrowth area. The change area defined is subject to the resolution to which the viewer is zoomed in to the image.

Q2 What is the burn/post-fire regrowth area?

3. Define area of interest

You can define an area of interest, which will make the measurement more accurate. The burn scar is so irregular that it will be more accurate if you just define a polygon and not try to digitize the area.

1. Click Define Areas of Interest on the Change Detection Menu.
2. Click a polygon around the area.
3. Double-click to end the area.
4. Click Apply and notice how the burn/post-fire growth area changes.

Q3 What is the burn/post-fire regrowth area?
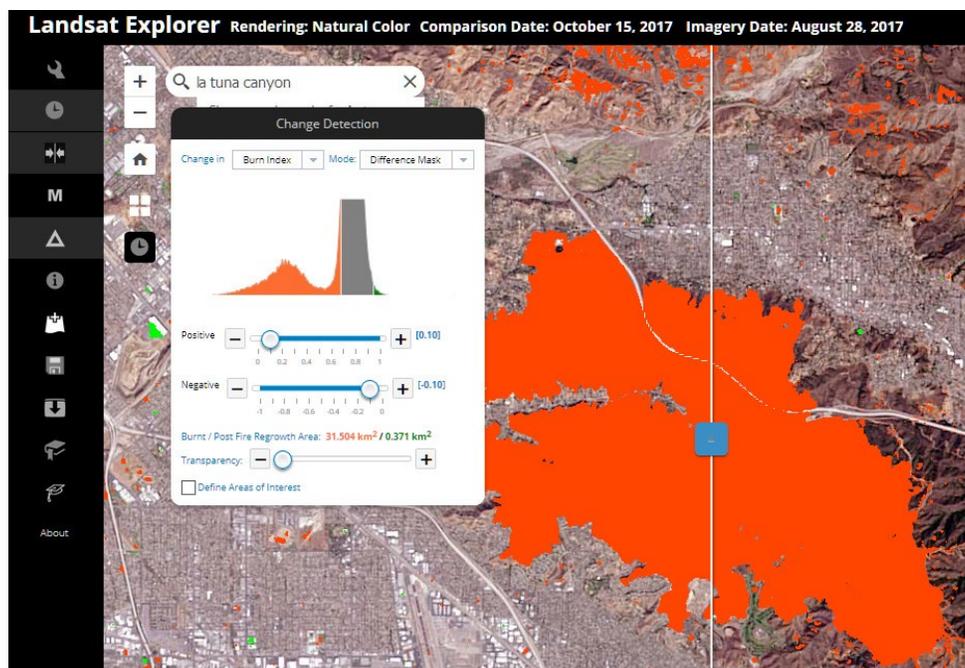
In this lesson, you have looked at data from two different time periods and compared them by a specific band combination called a burn index. Using the burn index, you have calculated the change in both the general image and a specific defined area.

Assessing Hurricane Maria damage

The browning of Puerto Rico

Hurricane Marie made landfall on Puerto Rico as a category 4 hurricane on September 20, 2017. The storm brought intense winds and rainfall that lasted for several days, damaging vegetation, pulling trees out of the ground, and blowing leaves off trees. The damage and extent of vegetation can be seen by Landsat imagery before and after the storm.

The Federal Emergency Management Agency (FEMA) is doing a post-assessment of vegetation damage caused by Hurricane Maria in Puerto Rico. The agency has asked you to compare Landsat imagery of before and after the event.

Build skills in these areas

- ➢ Adding Landsat 8 Imagery to a map
- ➢ Enabling and configuring time animation
- ➢ Filtering historical satellite imagery using different band combinations
  - ○ NDVI
  - ○ Color infrared

What you need

- ➢ Account required
- ➢ Estimated time: under 30 minutes

esri | THE SCIENCE OF WHERE
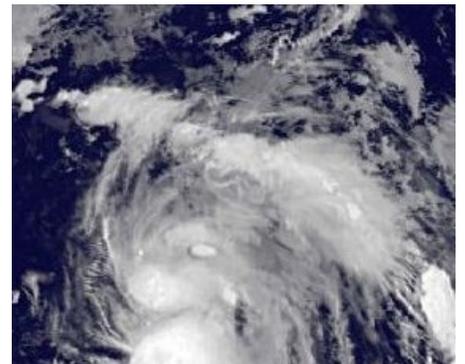
1. Create a map, add temporal multispectral data, and save

1. Sign into your ArcGIS organizational account.
2. Click Map to open the Map Viewer.
3. In the search box in the upper right of the map, search for Puerto Rico.
4. Go to Add>>Browse Living Atlas Layers.
5. Search for Multispectral Landsat.
6. Add to map as a layer.
7. Hit the back arrow to go back to the Contents Pane.
8. On the top ribbon, click Save As and add appropriate metadata.

2. Enable and configure time animation

1. In the Contents pane, point to the Multispectral Landsat layer. Click the More Options button and choose Enable Time Animation.
2. On the time animation toolbar, click the Configure button and show advanced options at the end of the Time Slider.

July 24, 1972 - July 24, 1977

3. For Time Span, change the start time to 6/1/2017, and the end time to 10/17/2017.
4. For the Time Display, change the display interval to 1 week.

5. Click OK and play the time animation again.
6. Click the first image in the map window to open a pop-up of the image.

   The acquisition date for this image was June 13, 2017, and the last image after Hurricane Maria was October 3, 2017. Next, you'll filter the multispectral layer to display only the best image from before and after Hurricane Maria landed.
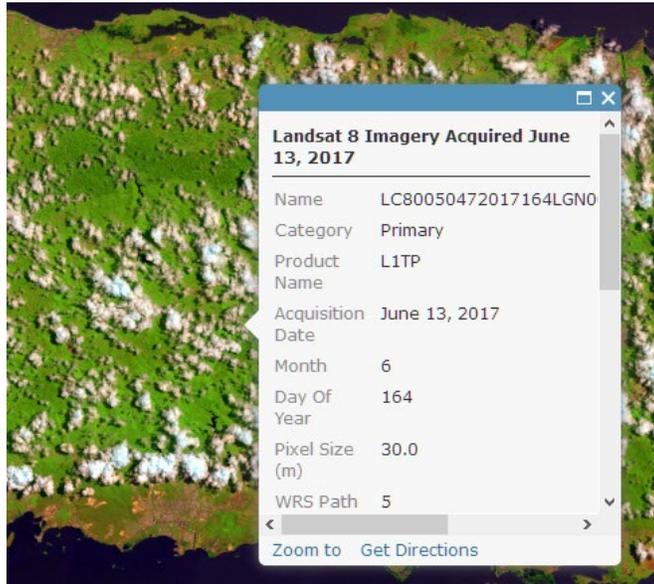
7. Click on More Options and Disable Time Animation.
8. In the Contents pane, point to the Multispectral Landsat layer and click the Filter button.
9. Delete the two expressions.
10. Configure the following expression:

   Acquisition Data is on June 13, 2017.

11. Apply Filter.
12. Click on More Options and rename the layer **Before Maria**.
13. Click on More Options and copy and paste the file.
14. Rename the copied file **After Maria.**
15. Click Filter.
16. Click Edit expression.
17. Configure the following expression:

Acquisition Date is on October 3, 2017.
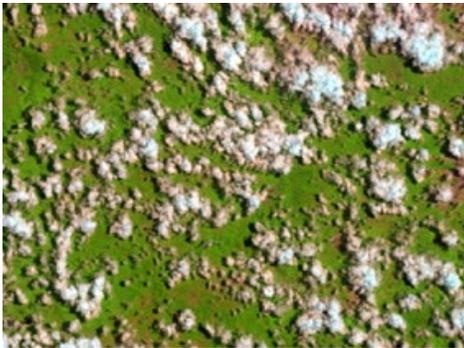
Q1 What are your observations about the before and after Maria images?

3. Change band display to NDVI and color infrared

There are two types of band combinations that are vegetation indicators. One is the normalized difference vegetation index (NDVI) with color map. The NDVI shows thick, vigorous vegetation as dark green and sparse vegetation as brown. The second band combination is near-infrared, red, green (5,4,3) with dynamic range adjustment applied on apparent reflectance. Healthy vegetation is bright red, whereas stressed vegetation is dull red.

Use NDVI band combination

The NDVI shows thick vigorous vegetation as dark green and sparse vegetation as brown.

1. Click on Before Maria>>More Options>>Image Display.
   Hint: Turn off After Maria layer.
2. Under Rendered choose NDVI colorized.
3. CLOSE.
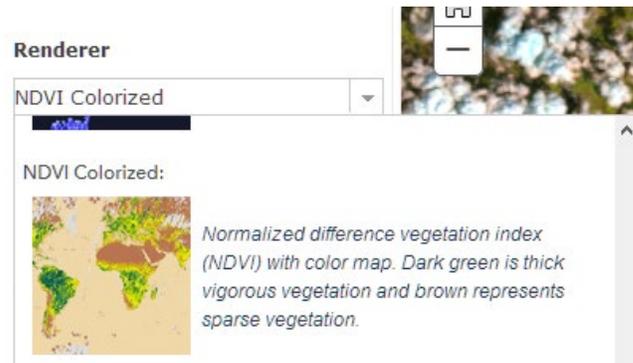
4. Repeat steps 1-3 More Options>>After Maria>>Image Display.
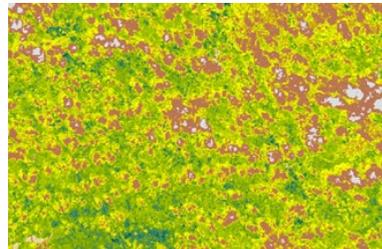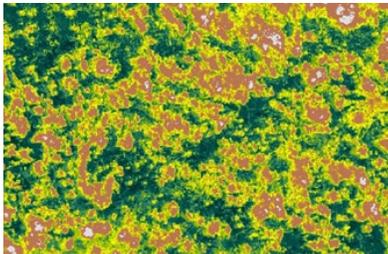
Q2 The NDVI shows thick, vigorous vegetation as dark green and sparse vegetation as brown. Write a comparison of the two images. Hint: Turn layers on and off to review differences between the NDVI for each.

Use color Infrared band combination

The color infrared combination consists of bands near-infrared, red, green (5,4,3) with fixed stretch applied on apparent reflectance. Healthy vegetation is bright red, whereas stressed vegetation is dull red.

1. Click on Before Maria>>More Options>>Image Display.
2. Under Rendered, choose Color Infrared.
3. CLOSE.
4. Repeat steps 1-3 for After Maria.
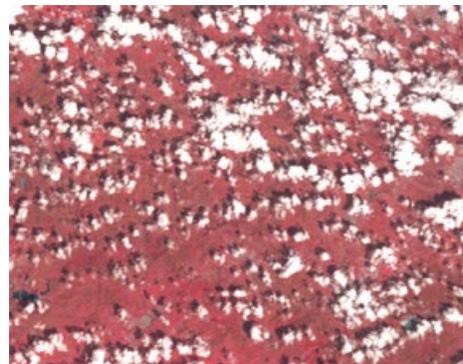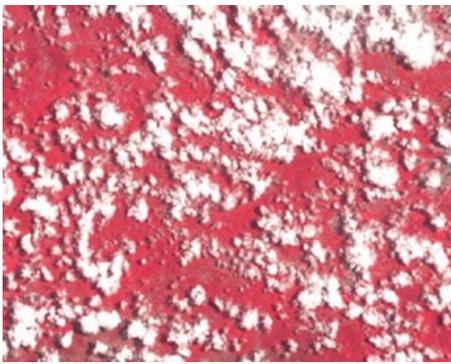
Q2 The color infrared band combination shows healthy vegetation as bright red, whereas stressed vegetation is dull red. Write a comparison of the two images.

In this lesson, you have used temporal imagery before and after Hurricane Maria to visualize the effect of the hurricane on the island of Puerto Rico vegetation.

○

Mapping the Internet of Things

Harnessing the World Wide Web of sensors

"Houston, we have a problem." That famous phrase evokes the image of a roomful of technology analysts, surrounded by computers and monitors, working feverishly to solve a problem with data coming in from a range of sources. That image, in turn, may bring to mind the Esri Operations Dashboard app and its role in our lives today. The app is designed to monitor a range of operations by providing a centralized command center focused on a specific, shared goal. It can be used to monitor daily logistical operations, such as service deliveries, or critical situational operations, such as a city's emergency response to a fire. The app also displays the statistics of specific events such as Olympic competitions or voting returns as they are reported by precinct during a critical election.

An organization can maintain continuous awareness of its operations by using the Esri Operations Dashboard to visualize field data in customized maps, bar charts, histograms, lists, gauges, graphs, and photo attachments. Live data feeds can be added to the dashboard, and data can be queried or filtered based on attributes such as time. The app is easy to configure and can be shared across the organization or publicly.

In this chapter, you will watch example videos of operations dashboards, and you will download the app to use on your computer. You will construct a real-time flood map, configure a real-time wildfire map, map the 2016 presidential election results by predominant mapping and Z-Score, and create an interactive map of 30 years of tornadoes.

Use the questions at the end of the chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 9 of *The ArcGIS Book.*

Introductory activities

These videos show the Operations Dashboard web app for event security and coastal protection:

Raceway Event Protection National Security Demo – Operations

Raceway Event Protection National Security Demo - Operations

This brief video shows the use of the operations dashboard web application for event protection. The operations dashboard works on desktops and tablets and provides a common view of an event plan before and during the event. This allows for multi-agency sharing of the situation data and plans in a command center and in the field. | in ArcGIS | November 19, 2014

Collector and Operations Dashboard for ArcGIS: Monitoring Coastal Security

Collector And Operations Dashboard For ArcGIS: Monitoring Coastal Security

This brief video demonstrates using Collector for ArcGIS and the Operations Dashboard for coastal monitoring missions. | in ArcGIS | November 12, 2014

Watch now

Aspects of a real-time GIS

Operations Dashboard for ArcGIS® is software used to monitor deliveries, services, people, vehicles, and other assets, anywhere in the world. It is designed to work with real-time data.

Write a sentence explaining each of the following aspects of a real-time GIS:

- Acquiring real-time data

- Performing continuous processing

- Communicating the results

The ArcGIS Book, chapter 9
Questions for reading comprehension, reflection, and discussion

Teachers can use the items in this section as an assignment, an introduction, or an assessment tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

How real is real time?

What are the components of a real-time dashboard?

What is the Internet of Things?

Learn ArcGIS: Guided lessons based on real-world problems

Oversee Snowplows in Real Time
Inform officials and citizens about your city's
snowplow activities as they happen.

Oversee Snowplows in Real Time
Creating a web map with real-time data.
Building an operation view.
Creating a web app.

Monitor Real-Time Emergencies

Keep track of fast-changing situations with Operations Dashboard for ArcGIS.

Monitor Real-Time Emergencies

Create web maps.

Create operation views.

Add and customize operation view widgets.

Exploring real-time data sources

Real-time data takes on many different forms and has many different applications.

You have been asked to run a seminar on real-time data sources provided by Esri. You are going to use The ArcGIS book as your text.

Build skills in these areas

➢ Exploring real-time data feeds

What you need

➢ Account not required

➢ Estimated time: under 30 minutes

Publication date: February 21, 2019

Use the ArcGIS Book

1. Go to The ArcGIS Book.
2. Go to Chapter 9
3. Scroll to Examples of real-time data sources.

Examples of real-time data sources

Real-time data takes on many different forms and has many different applications. Some of these examples link to live-feed maps and some to the item descriptions for the feeds themselves.

Active hurricanes

National Hurricane Center data describes the current and forecast paths of tropical activity

Hourly wind conditions

The Current Wind Conditions layer is created from hourly data provided from NOAA.

USGS earthquakes

Minute-by-minute earthquake data for the last 90 days comes from the USGS and contributing networks.

Q1 Examine at least three of the examples of real-time data sources and write a brief description.

Consturcting a map with real-time data
Combine streams, flood status, and 72-Hour precipitation forecast

Real-time data is as current as the data source that is updating it, whether that data is being updated every second, minute, or hour, or daily. Real time is a concept that typically refers to the awareness of events at the same rate or at the same time as they unfold (without significant delay).

Your county government has asked you to construct a USA food map that can be made available to the public to provide real-time data of the following:

- Streams
- Flood status
- National Weather Service precipitation forecast

Build skills in these areas

➢ Accessing the Landscape Layers in Esri's Living Atlas
➢ Constructing a map with several real-time services

What you need

➢ Account required
➢ Estimated time: under 30 minutes

1. Making a real-time map

1. Sign into your ArcGIS Online organizational account.
2. Click Map.
3. Change the Basemap to Light Gray.
4. On the top menu go to Add>>Browse Living Atlas.
5. Type Esri Hydro Reference Overlay in the search pane.
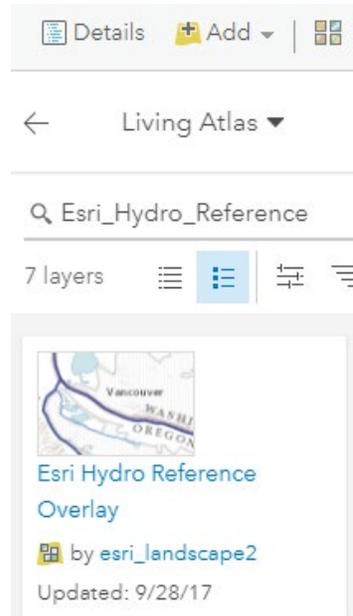
6. Click the + to Add.
7. Click the back arrow to return to the Content Pane.
8. Click Show Contents of Map under Details.
9. On the top ribbon go to Add>>Browse Living Atlas.
10. Type Live Stream Gauges (Flooding) in the search pane.
11. Click the + to Add and return to the contents pane.
12. On the top ribbon go to Add>>Browse Living Atlas.
13. Type National Weather Service Precipitation Forecast.
14. Click the + to Add and return to the contents pane.
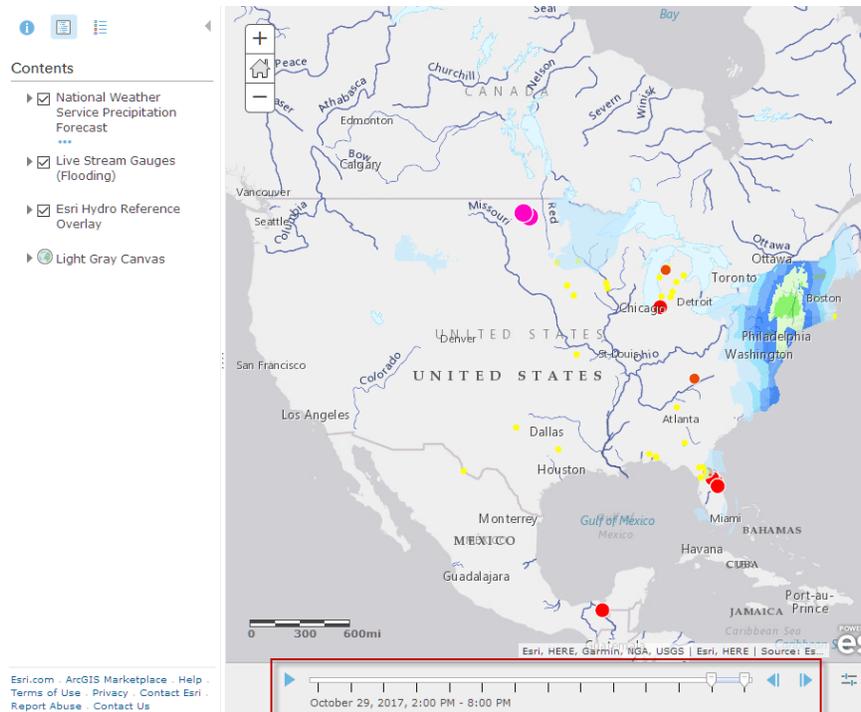
Notice at the bottom a time slider appears. The data is time enabled and shows the predicted values at six-hour intervals for the next three days

15. On the top ribbon, click Save As and save your map with the following Metadata:
    a. Title: USA Flood Map
    b. Tags: Remove tags and add individualized tags.
    c. Summary: This map shows real-time flood conditions across the US.

16. SAVE MAP.

2. Make a story map

A story map allows you to present your map with navigation tools and backgrounds.

1. Click share on the top menu bar and share with your organization.

2. After sharing your map, click CREATE A WEB APP.
3. Click Build a Story Map.
4. Click Story Map Basic.
5. Click CREATE WEB APP.
6. Change the title to **US Flood Map**.
7. Summary: This map shows real-time flood conditions across the US.
8. DONE.
9. To allow public access, check the subscriber content boxes:
  a. Click USA Stream Gauges (Flooding).
  b. Click National Weather Service Precipitation Forecast.
10. Select Web Map.
11. Save.
12. Launch.
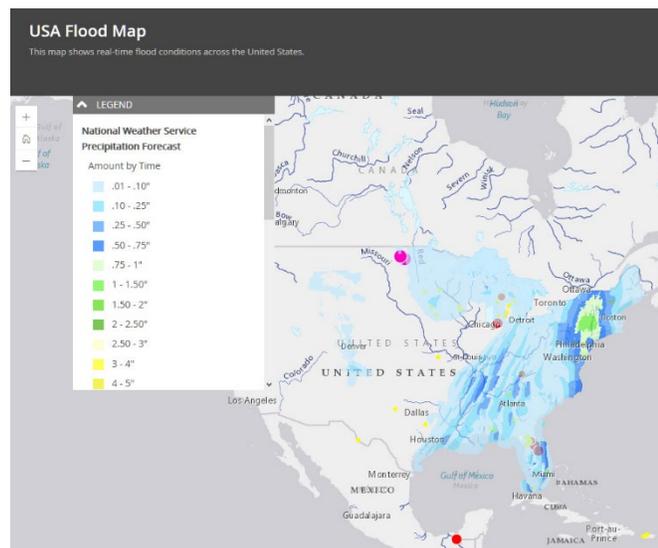
In this lesson, you have constructed a map with real-time data and used a web application to display the data. This map will satisfy the county government.

Using Web AppBuilder's Dashboard Theme
Real-time fire monitoring in California

Build skills in these areas

- ◆ Constructing a map with real-time data
- ◆ Building a Dashboard with widgets
- ◆ Sharing the Dashboard

What you need

- ◆ An ArcGIS Online organization account
- ◆ Estimated time: 30 minutes–1 hour

Scenario

USA fire managers have asked for a dashboard to manage real-time fire data. The dashboard will provide location-aware data, visualization, and analytics. They have specifically asked for:

A list of data layers Wildfires displayed by name Total active fires within zoom Filter wildfires by state Basemap Gallery

7. Go to the top ribbon and Save As using the following parameters:

- • Title: Real-Time Fire Data USA _ your initials.
- • Tags: IGARC2_fire_yourinitials.
- • Summary: Active fires in the USA.

8. Click SAVE MAP.

Create a map with real-time data

1. Sign in to ArcGIS Online organizational account.

2. Open a Map in Map Viewer.

3. Click Add>>Browse Living Atlas.

4. Search for USA Drought Intensity (Current Conditions) and add to the map.

5. Search for USA Wildfire Activity and add to the map.

6. Click the Back Arrow to return to the Contents Pane.

Hint: Results may vary because wildfires are not constant.

Create a Dashboard in Web AppBuilder

1. Click Share.
2. Click CREATE A WEB APP.
3. Using the Web AppBuilder.
4. Enter a summary.
5. Click GET STARTED.
6. Select the Dashboard Theme.
7. Select Widget.

Two widgets have already been selected (Home and Zoom Slider). In addition to these widgets, click the "eye" icon on the following widgets to unhide them:
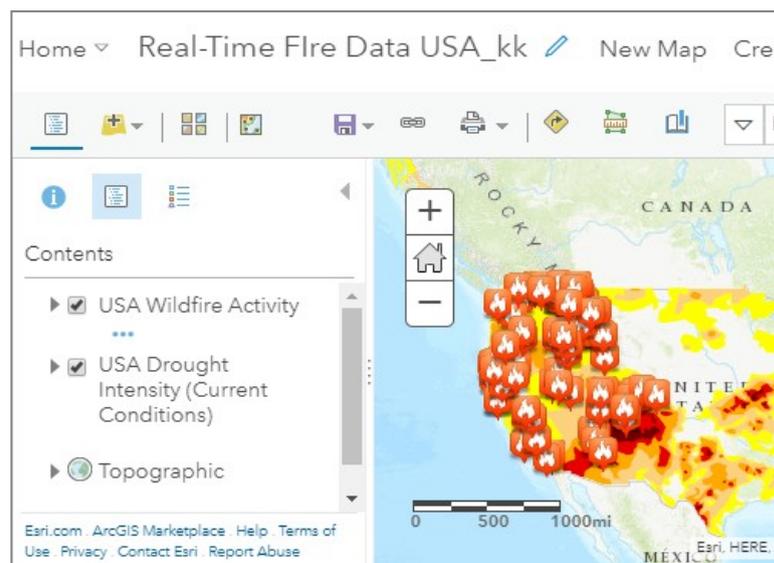Coordinate
Scalebar
Search

8. Click Save in the bottom toolbar.

You are now ready to add up to five custom widgets of your choice. All of the custom widgets involve the following steps:

1. Click Widget 1 on the left panel.
2. Select from the list of custom widgets.
3. Save your work (using the button on lower toolbar) along the way.
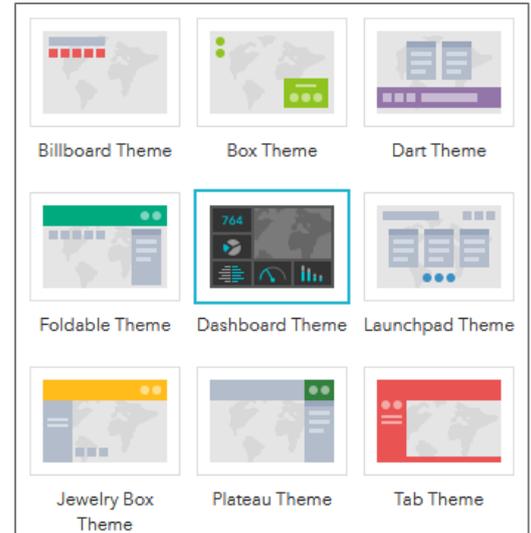
Insert a Layer List widget

1. Select the Layer List widget.
2. Keep all default settings and click OK to close the widget editor.

The layer list allows the user to turn the layers on or off, and also to uncollapse to view the legend.

Insert an Info Summary Widget

1. Click the next empty widget, previously Widget 2 but now called Widget 1.
2. Select the Info Summary widget and click OK.
3. Click Add Layer, expand USA Wildfire Activity, and choose Active Fire Report.
4. Check the checkbox for Expand List on Startup.
5. Click OK to close the widget editor.

Notice that this widget is scalable and the data changes as zooming occurs. Clicking on a fire in the list highlights that fire on the map.

Insert an Infographics Gauge widget

To use the Gauge widget you first have to add an extra data source to the project.
1. Click Attribute on the top menu.
2. Click Extra Data Source.
3. Add new>>Layer.
4. Uncollapse USA Wildfire Activity.
5. Select Active Fire Report. Click OK twice to close the data source menus.
6. Select the next available widget (Now labeled Widget 1).
7. Choose the Infographic widget.
8. Choose the Gauge template.
9. When asked to set the data source, click Extra Data Source and choose Active Fire Report.
10. Click OK to begin editing the gauge.
11. Click TITLE OF THE INFOGRAPHIC and change to USA Active Fires.
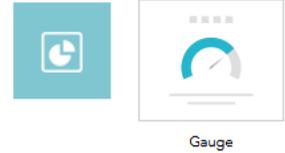12. Click Description and change to Active Fires within the USA.
13. Click OK to close the widget editor.

Insert a Filter widget to filter Fires by State

1. Click Widget 1.
2. Select the Filter widget and click OK.
3. Add a New Filter.
4. In the layer selector, uncollapse USA Wildfire Activity and choose Active Fire Report.
5. Label: Filter Wildfires by State.
6. Click Expressions.
7. Add Expression:
   State (String) is Unique [use the gear button]

8. Check the box for Ask for values.
9. Prompt is: Choose a State.
10. List values: All unique values of this field.
11. Click OK to close the widget editor.
    To apply the filter you have to move the tab.
    Notice how the other widgets work together.

Insert Basemap Gallery Widget

1. Click Widget 1.
2. Select the Basemap Gallery widget.
3. Click OK to close the widget editor.
4. Save your work one last time.

Layer

Active fire report

Info	Expressions	Options

+ Add expression   + Add set

Display features in the layer that match the following expression

| State (String) | ▾ | is | ▾ | - empty - | ▾ | ⚙ |

☑ Ask for values

Prompt   Choose a State

Hint

List values: All unique values of this field
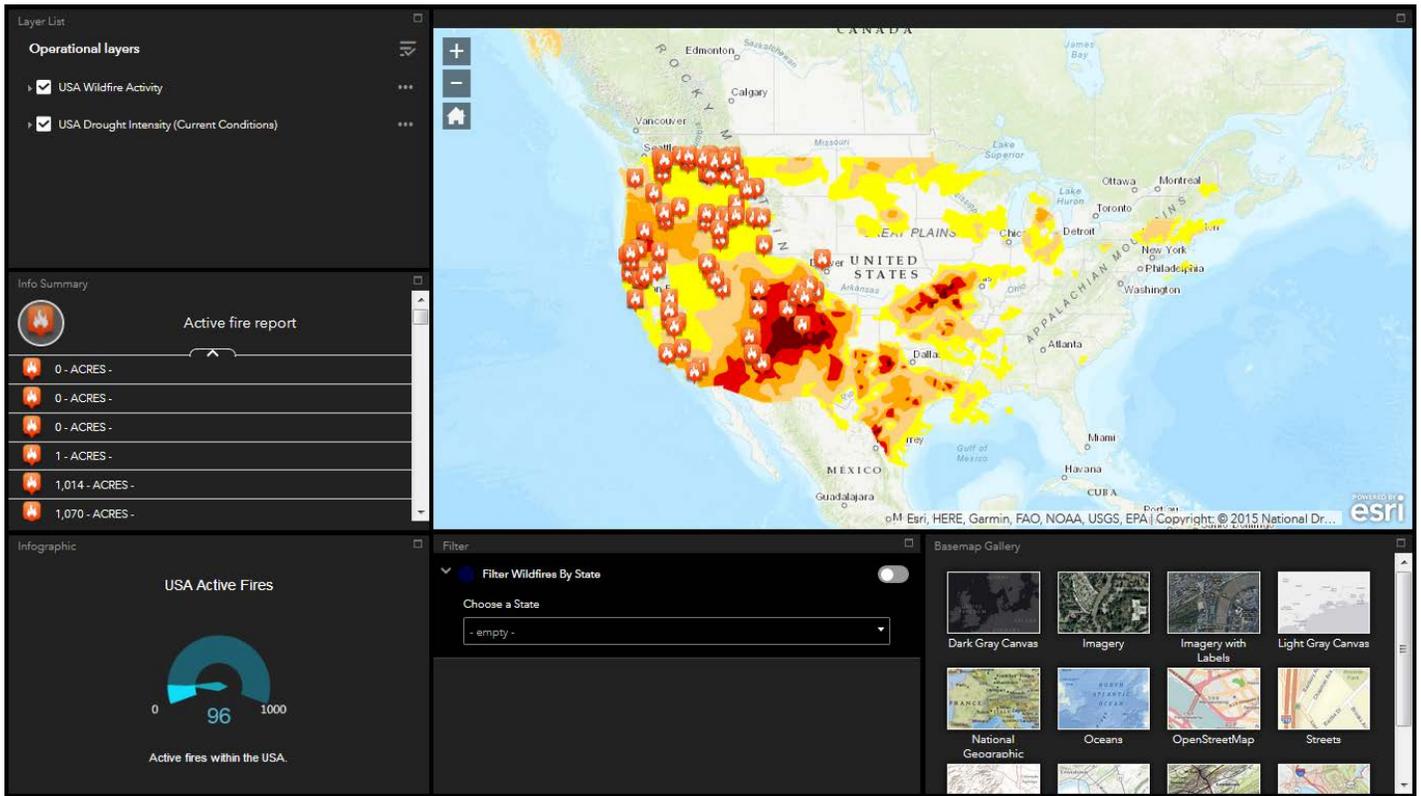
In this lesson you have created a dashboard using real-time fire data. The dashboard includes widgets that allow basic questions to be asked of the data.

EXTENSION: Make another dashboard using World Traffic Service.

Visualizing 2016 presidential election data
Apply predominant mapping, Z-score

The 2016 presidential election in the US ended in surprise victory for Republican candidate Donald Trump. GIS can offer a geographic perspective of the election results and can provide information to upcoming candidates concerning the "where" of the electoral contest.

Officials with both the Republican and the Democratic national committees have contracted you to provide them with a visual representation of the 2016 presidential election data. They want to geographically and mathematically display the election results in various ways. You have contracted to visualize the data using predominant mapping and a Z-Score.

Build skills in these areas

➢ Visualizing election 2016 data using predominant mapping
➢ Visualizing election 2016 data with calculated Z-score
➢ Using Arcade expressions

What you need

➢ Account required
➢ Estimated time: over 1 hour

esri | THE SCIENCE OF WHERE

1. Finding and saving a map with 2016 population data

1. Sign into your ArcGIS Online organizational account.
2. Open Presidential Election 2016.
3. On the top tab click Save As.
4. Save using the following metadata:
    a. Title: Presidential Election 2016_yourinitials
    b. Tags: Remove tags and add individualized tags
    c. Summary: Presidential election results by county for 2016
5. Click SAVE MAP.

2. Predominant category

Category compares attributes that share a common subject and unit of measurement to see which has the highest value. Color shows the predominant category, and transparency shows the relative strength of the predominance.

1. Click the style icon under election 2016.
2. Choose an attribute: % GOP.
3. Add attribute.
4. Choose an attribute: % DEM.
5. Choose Predominant Category.
6. Click OPTIONS.
7. Right Click GOP and change to red.
8. Right Click DEM and change to blue.
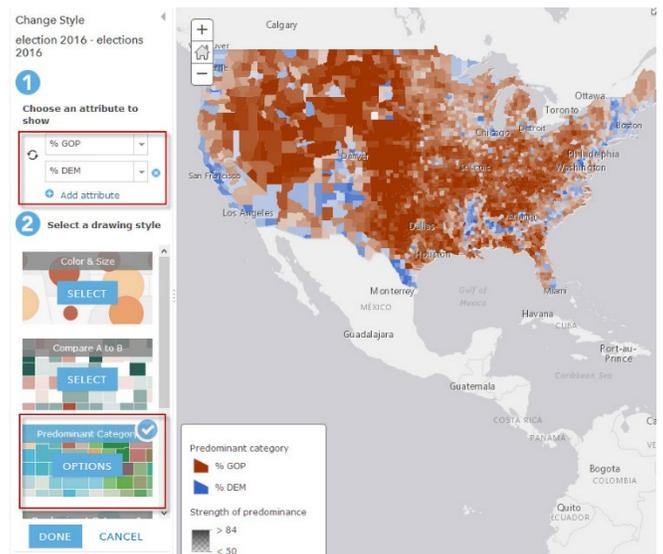
Q1 What does the map tell you about voting patterns in the 2016 presidential election?

3. Predominant mapping category and size

This type of predominant mapping is the same as predominant mapping by category except that it adds the additional variable of size, showing the sum of the categories. With predominant mapping by category and size, you can show three variables on the map.

1. Select Predominant Mapping Category and Size.
2. Click Counts and Amounts>>OPTIONS.
3. Click Specify size range.
4. Change the size to Min of 4 px and Max of 15 px.
5. Click OK.
6. Click DONE.
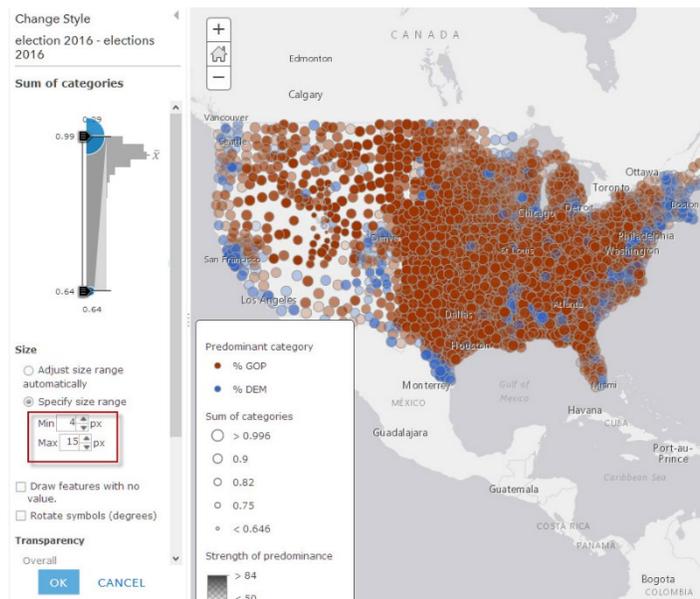
7. On the top tab, click Save As and save your map using the following metadata:
   a. Title: Presidential Election 2016 Predominance_yourinitials.
   b. Tags: Remove tags and add individualized tags.
   c. Summary: Visualization of Presidential Election 2016 results using predominant mapping.
8. Click SAVE MAP.

4. Z Score

A Z-Score is a numerical measurement of a value's relationship to the average in a group of values. If a Z-score is 0, it represents the score is identical to the average score. Z-Scores may also be positive or negative, with a positive value indicating the score is above the average and a negative score indicating it is below the average. Positive and negative scores also reveal the number of standard deviations the score is either above or below the average. One standard deviation either plus or minus accounts for about 68 percent of the people, in this case representing 68 percent of the people either voted Democratic or Republican.

5. How to calculate Z-Score of %DEM…open and save new map

- Data you want to examine (in this case, % DEM).
- Subtract the average of % DEM from % DEM.
- Divide the subtraction figure by the standard deviation (% DEM – average)/standard deviation.

1. Open Presidential Election 2016.
2. On the top tab click Save As.
3. Save using the following metadata:
   a. Title: Presidential Election 2016 Z-Score_your initials.
   b. Tags: Remove tags and add individualized tags.
   c. Summary: Presidential election results visualized by Z-Score.
4. Click SAVE MAP.

6. Find the average and the standard deviation of % DEM....calculate Z-Score

1. Right click election 2016 and open the attribute table.
2. Scroll right to the field % DEM.
3. Right-click on % DEM and click Statistics.
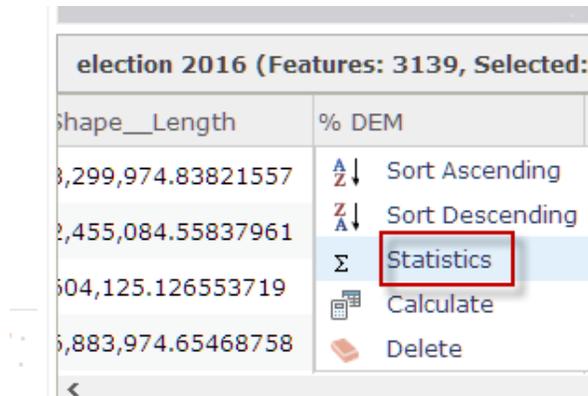
4. When you display the Statistics, write down the Average and the Standard Deviation.

5. Click CLOSE.
6. Click the style icon under election 2016.

7. Scroll down and select New Expression.
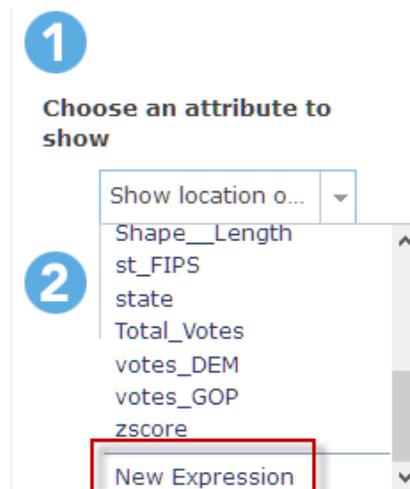
8. Click Edit and Name this Expression: Z-Score & DEM.
9. Click Save.
10. Type the following expression. Click Globals to display attributes.

(($feature.DEM_per)-0.3174)/0.1527

11. Click Save.
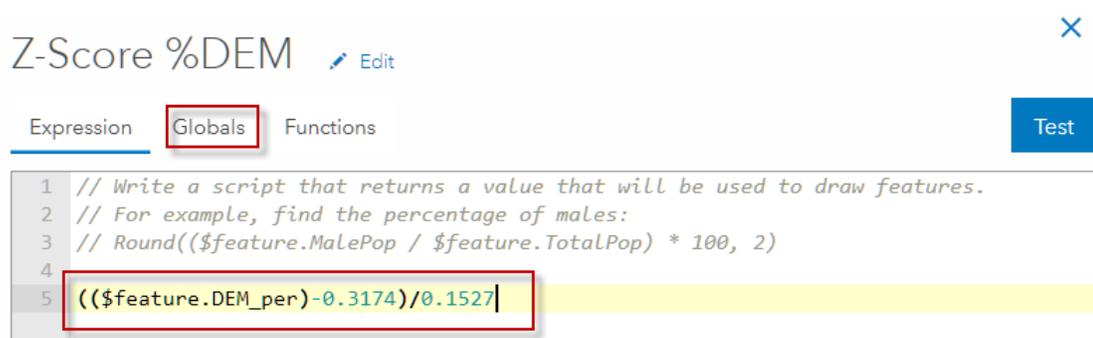
12. Click Counts and Amounts (Color).
13. Click OK.
14. DONE.
15. Click Options and change the name of the layer to Z-Score % Dem.
16. OK.

Q2 What does the Z-Score legend represent?

7. How to calculate Z-Score of % GOP

1. Right click and copy the Z-Score % DEM.
2. Under Options rename the file Z-Score % GOP.

8. Find the average and the standard deviation of % GOP....calculate Z-score

1. Open the attribute table and click % GOP.
2. Click Display Statistics.
3. Record the Average and the Standard Deviation.
4. Click Add attribute.
5. Select another New Expression and title it Z-Score GOP.
6. Type the following expression:

(($feature.GOP_per)-0.6354)/0.1559

7. Click OK.
8. Click Counts and Amounts (Color).
9. Click OK.
10. Click DONE.

You can visualize these by turning the layers on and off.

11. Click Save.

In this exercise, you have visualized the presidential election data in 2016 by predominant mapping and Z-Score. You have made observations about the spatial distribution of the political parties' voting preferences on your map.

Clustering to extract information: Analyze 30 years of tornadoes

Clustering allows you to visually extract meaningful information from a dataset that has many points. Clustering is applied dynamically at multiple scales, and you can adjust the number of point features grouped into clusters using the provided slider.

The Weather Channel is doing a segment on tornadoes and has asked for an interactive map of the past 30 years of tornadoes within the US.

Build skills in these areas

➢ Configuring clustering on a point layer
➢ Configuring clustering pop-up

What you need

➢ Account required
➢ Estimated time: under 30 minutes

Open a web map and search for data

1. Sign into your ArcGIS Online organizational account.
2. Click on Map to open the Map Viewer.
3. Click Add >>Search for layers>>in ArcGIS Online.
4. ArcGIS Online.
   Type "tornadoes" owner:t3gkeranen in the search pane.
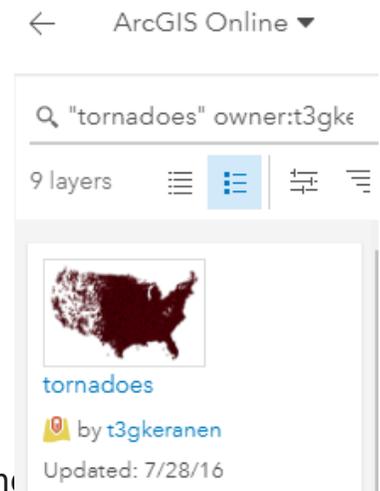
5. Add tornadoes to the map.
6. Click the back arrow to go back to the Content Pane.
7. On the top ribbon, click Save As and save the map with the following metadata:
   a. Title: Sixty Years of Tornadoes_yourinitials.
   b. Tags: remove the tags and add individualized tags
   c. Summary: Sixty years of tornadoes in the United States
8. SAVE MAP.
9. Click the table icon below tornadoes.

   Q1 How many tornadoes are shown?
   Q2 How many years of data do the tornadoes represent?

9. Close the table by click the X in the upper right corner.

   This map has too many points and points on top of points, so individual states cannot be seen.

10. Click the Clustering icon below the tornadoes layer.
11. Use the slider to decide how much clustering you want to use. Less clustering yields more dots on the map, and more clustering yields fewer. Clustering is multiscalable so the clusters update as you zoom in and out.

    In this lesson you have used clustering to help visualize large point datasets.

10
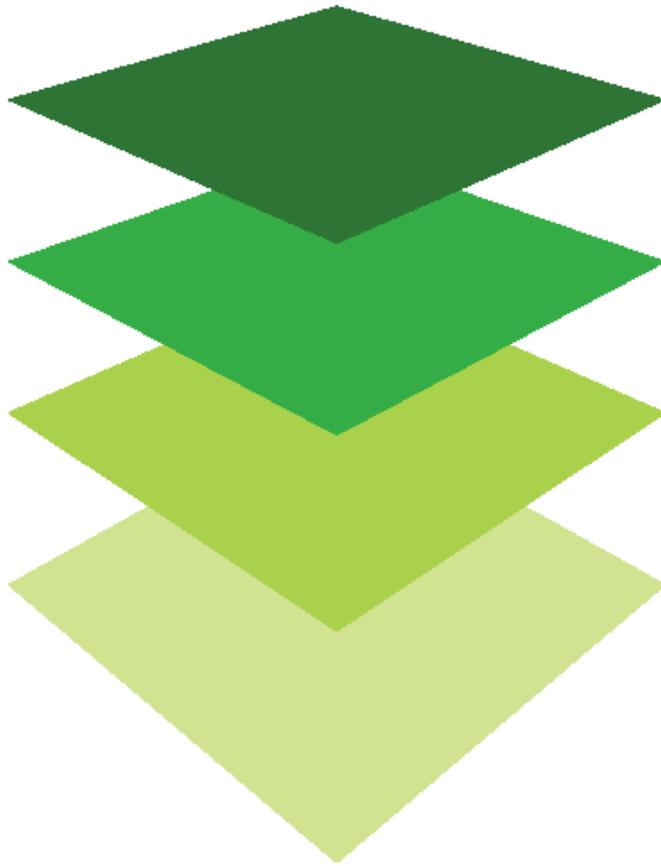
GIS Is about Community
Web GIS is the GIS of the world

GIS is the prototypical team sport. Contributions from numerous members, hailing from a range of backgrounds and playing many different roles, meld to pursue a shared goal. The GIS game is played at local, state, national, and ultimately, global levels. For example, a state's Audubon Society is using GIS to identify endangered habitats with the help of data from its environmental management department along with bird counts collected by local observers.

Cloud computing and the mobile/app revolution have increased the ability of members of the GIS community to work together and collaborate through data sharing. Just as significantly, technological advances have also expanded the GIS community far beyond the world of professional GIS users. Today, the community potentially includes nearly everyone on the planet. To join in, all you need is a smartphone, tablet, or computer. Whether at work or at home, every time you access data from the cloud, store smartphone photos online, or use a mobile device to report a power outage, you are engaging with and contributing to the global GIS community.

In this chapter, you will create your own web app for data collection using the Web AppBuilder and create a crowdsource story map about ethnic diversity in your community.

Use the questions at the end of the chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 10 of *The ArcGIS Book*.

Introductory activities

These videos show how California uses ArcGIS Online for improved emergency response and how a crowdsourced traffic and navigation app helps commuters and decision-makers.

ArcGIS Online Case Study: Emergency Management—Cal OES

Waze: The Crowdsourced Traffic App Reducing Daily Commute

Activity
Building smarter communities

Communities across the globe today are facing many specific issues, and ArcGIS is a well-established and reliable tool used to help address these issues.

1. Examine the following initiatives and identify the data collected and used and the type of analysis performed.

2. Complete the table below:

Initiative	Data Collected	Analysis
Reduce Vector-borne Disease		
Reduce Homelessness		
Reduce Opioid Addiction		

The ArcGIS Book, chapter 10
Questions for reading comprehension, reflection, and discussion

Teachers can use the items in this section as an assignment, an introduction, or an assessment tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

Identify some of the unique characteristics of the professional GIS community.

What are some of the opportunities that an ArcGIS organizational account provide to its members and to the organization overall?

What are the core elements of geodesign as a planning methodology?

What do the three apps shown under social GIS and citizen science have in common?

What does Clint Brown mean when he says GIS is collaborative?

What does Lauren Bennett mean when she says spatial analysis is changing everything?

Learn ArcGIS: Guided lessons based on real-world problems

Monitor Whales with a Multilingual Survey
Creating a Survey123 form.
Building expressions.
Sharing a survey.
Using a survey with a mobile device.
Adding survey data to a web map.
Analyzing survey data.

Using the Web AppBuilder to Measure Wi-Fi strength

Educators are always looking for compelling and useful ways to engage their students and facilitate learning. A map designed to record Wi-Fi strength at various locations provides an opportunity for students to collect data collaboratively and compare data across a broad geographical range.

Your county GIS department received grant funding to examine the current Wi-Fi resources available within the county. They have enlisted volunteers to use a collaborative map to record Wi-Fi collection. They have hired you to build the map.

Build skills in these areas

➢ Downloading an existing service definition
➢ Uploading service definition and publishing as a layer
➢ Creating a map
➢ Creating a web app using the Web AppBuilder

What you need

➢ Account required
➢ Estimated time: 1 hour

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1. Find and publish a service definition

1. Sign into your ArcGIS Online organizational account.
2. Click Search in the upper right corner.
3. Search for IGARC2_wifi.
4. Uncheck the Only search in your Organization tab.
5. Download the file wifi by clicking Open and save to your computer.
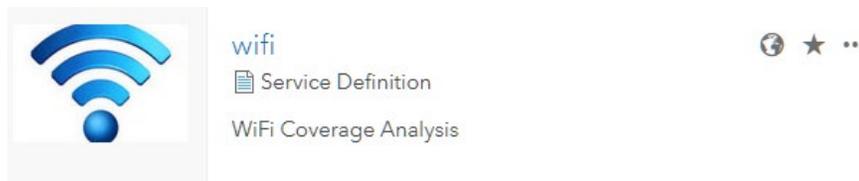
6. In ArcGIS Online click Content at the top of the page.
7. Click Add Item From my computer.
8. Browse to the wifi.sd file and choose file.

> A .sd fle is a service definition, standalone file that stores information about a service. You can use the service definition file to publish a feature service.

9. Be sure the Publish this file as a hosted layer box is checked.
10. Remove existing tags and add individualized tags.
11. Click Add Item.

> It will take several minutes to upload and publish the tree service definition.

12. After the feature service is created, click Open in Map Viewer.

> After the feature service is added to the map, you will see the Edit icon on the top of the page.

13. Click Edit. When you click the Edit icon, the Wi-Fi is to be recorded. The collection menu is exposed.
14. Click the Wi-Fi icon in the Table of Contents.

15. To add a new location, click the location where the Wi-Fi is to be recorded. The collection menu is exposed.

16. Go to the top ribbon and click Save As.
17. Save the map with the following metadata:
    a. Title: Wi-Fi Strength_yourinitials
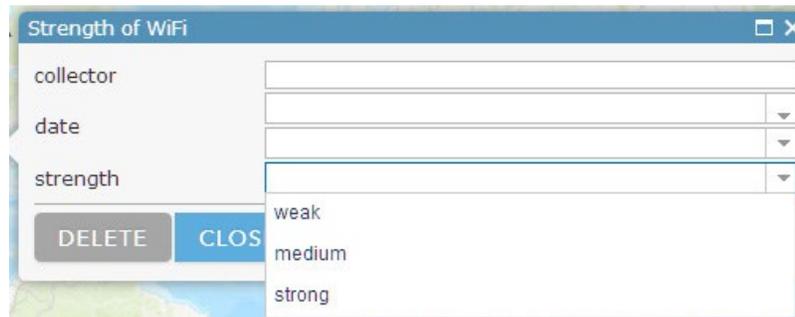   b. Tags: Remove tags and add individualized tags.
    c. Summary: Editable feature service to collect Wi-Fi Strength.
18. SAVE MAP.

2. Create a web application using Web AppBuilder

Web AppBuilder for ArcGIS® is an intuitive application that allows you to build web apps without writing a single line of code. It includes powerful tools, and as you add the tools you can see them right away in the app. Below, you will create an app that allows you to collect data on Wi-Fi signal strength.

1. On the top ribbon click Share.
2. Decide whether you want the map to just be seen within your organization, a specific group within your organization, or everyone (public). Click the appropriate box.
3. Click CREATE A WEB APP using the Web AppBuilder tab.
4. Enter the summary: App to collect strength of Wi-Fi signal.
5. Click GET STARTED.
6. Select the Billboard Theme.
7. On the top ribbon click Map tab.

8. Set Default extent to an extent that is slight larger than your collect points. This is to define the extent to be less than the entire world.
9. Choose the Wi-Fi Strength map you have just constructed.
10. Click OK.
11. On the top ribbon click the Web AppBuilder widget tab. Add the following widgets:
    a. Coordinates
    b. My Location
    c. Scalebar
    Notice you could also add an overview window and a widget to return to your defined extent as set previously.
12. Click Save.
13. In the lower part of the Widget tab, click the gray Widget 1 to configure it.
    a. Select Edit as the option for this widget.
    b. Next make some edit configuration changes if you wish. For example enable undo and redo as well as cut and reshape.
14. Click OK.
15. Click Widget 3 and select Layer List.

    The Layer List widget displays operational layers on the map and provides basic functionalities, such as turning the layer on and off, zooming to items, showing transparency items, moving up and down, opening with an attribute table, and showing the description or item details.

16. Click OK and OK.
17. Slick Save.
18. Click Launch.

    In this lesson you have downloaded a service definition, published it as a feature service, created a web map, and created a Wi-Fi collection app using Web AppBuilder that allows participants to locate and enter the strength of Wi-Fi successfully.

Elevation profiles

An elevation profile is a depiction of a two-dimensional cross-sectional view of a landscape. It provides a side view of a terrain's elevation along a line drawn between locations on a map. ArcGIS Online displays an elevation profile for a selected feature or a measure line along a web map.

Elevation profiles provide understanding of elevation and landforms. You have been asked as an instructor to provide your students with material that expands their knowledge of elevation and landform features through using elevation profiles.

Build skills in these areas

➢ Using the image service Terrain to show elevation profiles
➢ Showing change in elevation using an elevation profile
➢ Describing landscape of the United States using an elevation profile
➢ Identifying physical features using an elevation profile

What you need

➢ Account required

➢ Estimated time: 30 minutes – 1 hour

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1. USA profile

1. Sign in to your ArcGIS online organizational account.
2. In the top right corner, search for esripress_ig_imagery group.
3. Uncheck Only search in Participants and Resources.
4. Click the esripress_ig_imagery group.
5. Click Elevation Profile Map.

Elevation Profile   ✕

Elevation Profiles

Web Map by esripress_ig_imagery

Last Modified: February 9, 2017

★★★★★ (0 ratings, 0 comments, 36 views)

Open ▾   Details
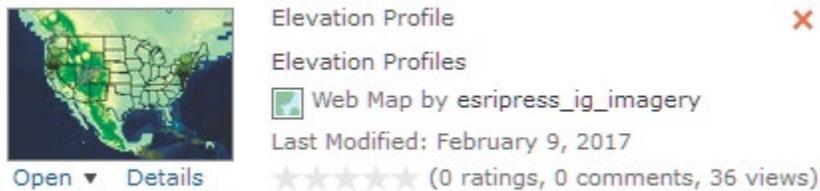
6. Click the pencil icon to draw a line on the map that generates a profile.

The first profile gives a view of the conterminous United States.

7. Click the large green map note on the Pacific Coast and draw the profile line to the large green map note on the Atlantic Coast. Double-click to stop drawing the line. It will take several seconds for the elevation profile to draw.

Double-click to complete

8. Move the pencil to hover over the line in the profile pane and move your mouse to view the numeric values of the elevations of the transect.

Min: 44 Max: 13,177 Start: 4,856 End: 73 Change: -4,782
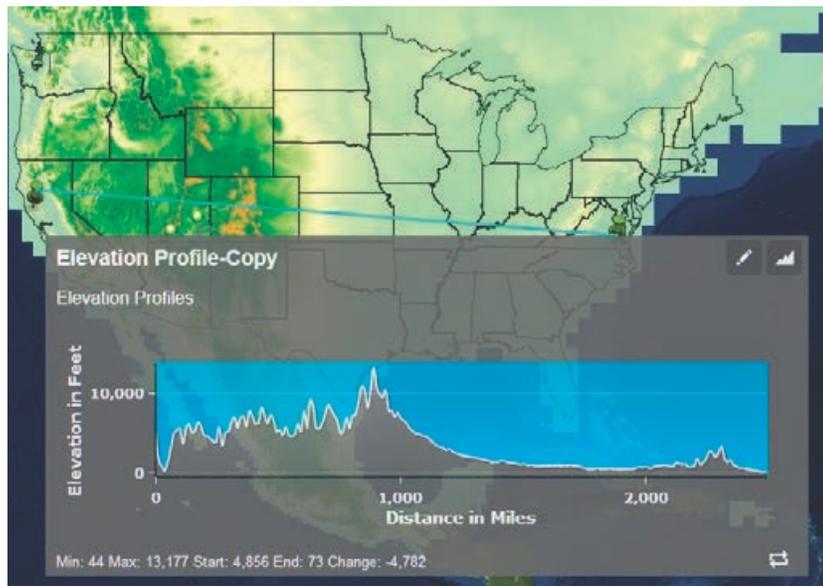
Q1 What are the units for the x-axis and y-axis?

Q2 On the profile and the map, try to identify the elevations of the following features:
- *San Joaquin Valley*
- *Rocky Mountains*
- *Appalachian Mountains*
- *Great Plains*

2. Landform profiles

Different land forms have different profiles. Draw a profile through each of the following landforms. The landforms are designated by stick pins. Sketch a picture of the profile and write a definition of the landform and how it relates to the profile. The landforms are each represented by a unique map note.

Point 1 Mount Rainer
Point 2 Grand Canyon
Point 3 Merrick Butte

Landform	Sketch	Elevation	Definition
Mount Rainier			
Grand Canyon			
Merrick Butte			
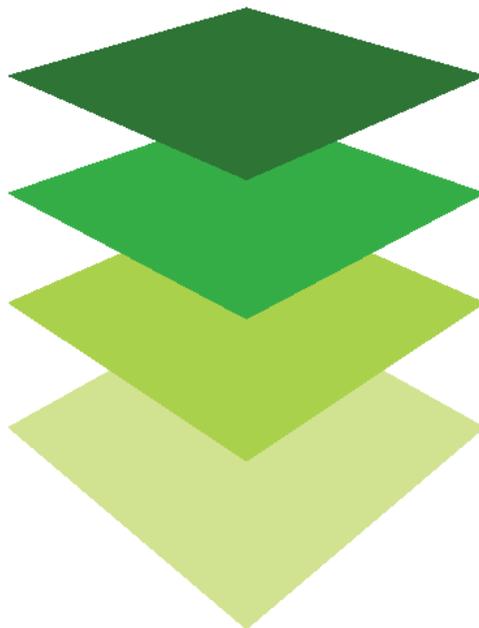
Using a mask to define flooded areas in Cedar Rapids, Iowa

Remote sensing data is used to monitor and assess food damage. It has been used to increase the efficiency of food monitoring as well as food management. Flooded areas need to be isolated. Using the mask tool a food layer can be created based on values.

Cedar River is the second largest city in Iowa. In September 2016 Cedar River was hit by a food caused by the remains of the Pacific Hurricane Paine. The river crested at 23 feet on Tuesday, September 27 causing the evacuation of over 5,000 people. The governor of Iowa is calling for a state of emergency and wants to know the number of acres of flooded land. He has asked the Cedar Rapids GIS department for a quick estimate.

Build skills in these areas

➢ Isolate flood areas based on pixel values
➢ Present both a qualitative and a quantitative presentation of the flooded area
➢ Isolate specific areas to evaluate

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour
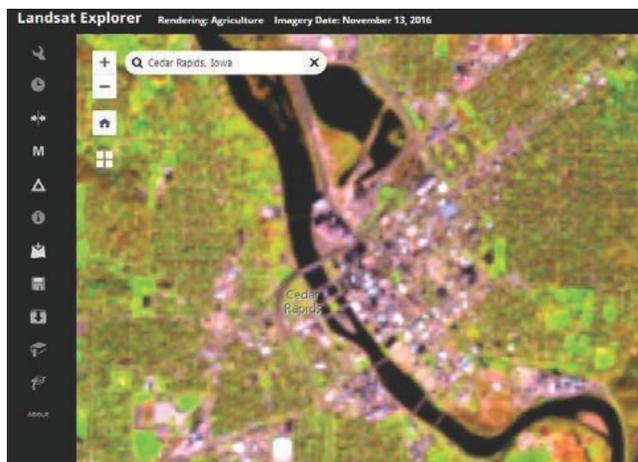
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1. Identifying Cedar Rapids Iowa

1. Go to Landsat Explorer.
2. Click Sign in and sign in to your organizational account.
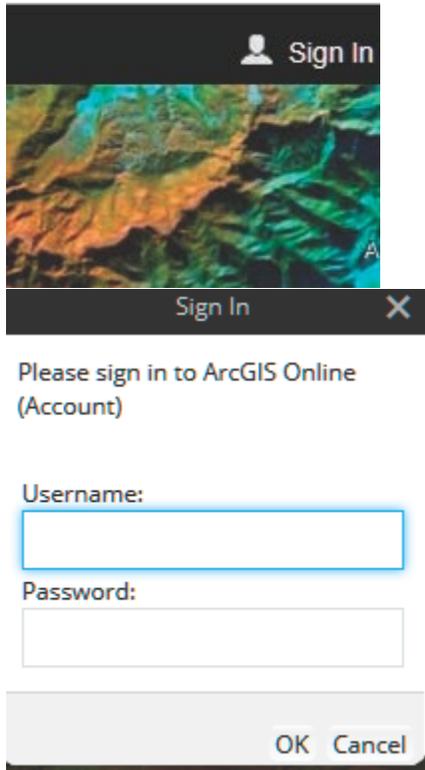
3. Search for Cedar Rapids, Iowa in the search tab. This will take you to Cedar Rapids.

4. Go to the Rendered icon on the left panel and change the band combination to Color Infrared to show healthy vegetation as bright as red.
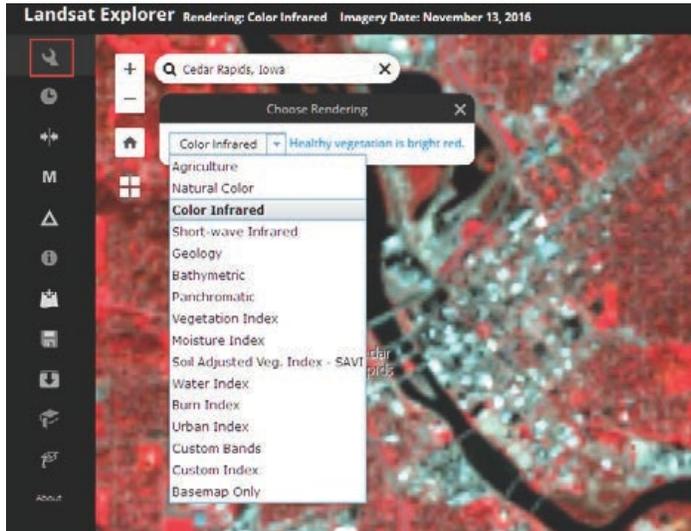
Examine the image remembering that bright red is healthy vegetation.

Q1 Does the city of Cedar Rapids lie on both sides of the Cedar Rapid River?

Remember the gray to bluish gray section of the image is developed land. Notice the bridges going across the river.

Q2 What do you think the very bright sections of red are?

2. Using a mask to calculate flooded area of Cedar River

1. Use the time slider to select the date November 13, 2016.
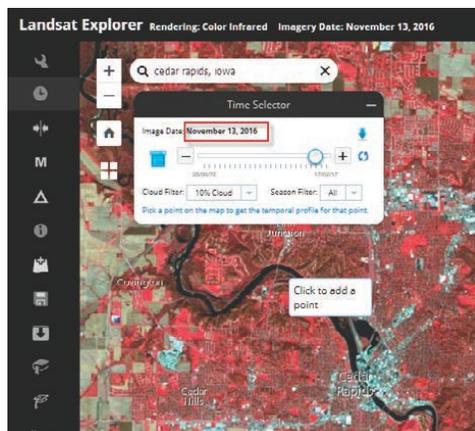
2. Click the Mask icon on the left panel and select the water index.
3. Move the mask slider to about 0 to 1 to isolate the water. The slider
   isolates pixels with similar spectral reflectance values.
4. Record the Area Covered.
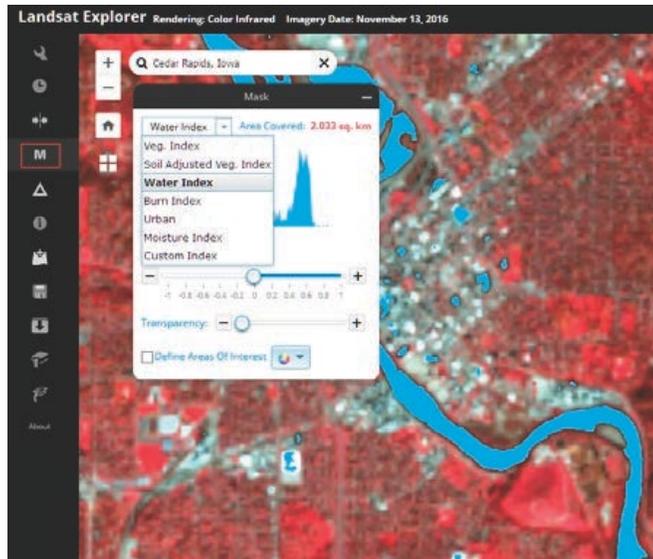
5. Click Mask again to close mask.
6. Select the time slider on the side panel and select the date September
   26, 2016, which was at the height of the flood.

7. Select mask again with the water index and the same values.

8. Record the area covered by the mask.
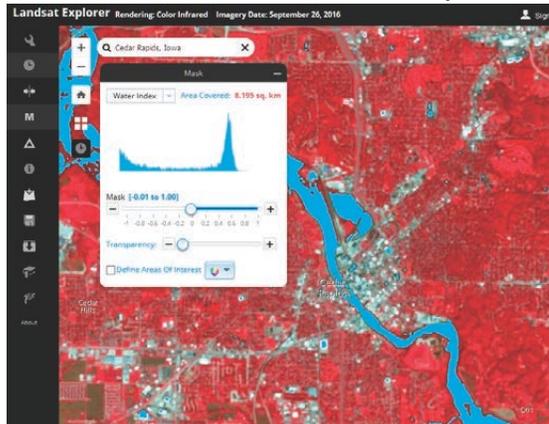
9. Compare the amount of water at the height of the flood (September 26) and on a non-flood day (November 13, 2016).

Note: The Area Decrease/Increase numbers will depend entirely on your view extent, how zoomed in you are, and how big your browser window is.

3. Isolating the city of Cedar Rapids

In this next section, you will repeat the above process concentrating on just the city limits of Cedar Rapids.

1. Click Masks.
2. Click Define Areas of Interest.
3. Click to start drawing and digitize around the Cedar Rapids area.
4. Double click to end the polygon.
5. Click Apply.
6. Change the Mask to be 0.00 to 1.00.

7. Record the Area Covered.
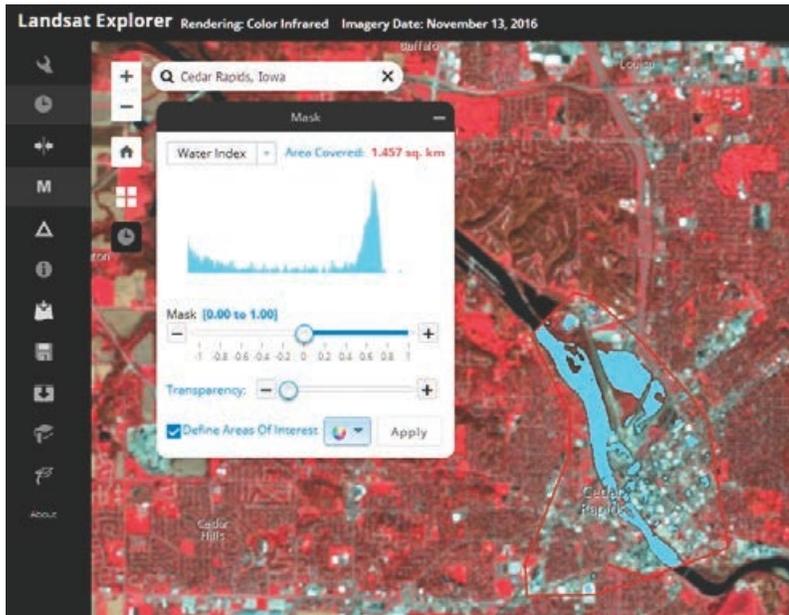
Q3 How much land was flooded in the designated area?

Change detection after Hurricane Matthew in Les Cayes, Haiti

Remotely sensed data is useful in detecting and mapping changes caused by many types of natural hazards. Detecting and mapping the changes allows the recorded results to be integrated into the planning process for recovery. Remote sensing data provides a broad scale view of change detection.

Hurricane Matthew hit southwestern Haiti as a Category 4 storm on the morning of October 4, 2016, and left widespread damage to an already impoverished nation. Les Cayes is one of Haiti's major ports with a population of around 70,000. Les Cayes was hit hard by the hurricane with nearly 90 percent of the buildings either destroyed or damaged. You have been asked to map and calculate change both qualitatively and quantitatively to the port of Les Cayes. Since Hurricane Matthew hit on the morning of October 4, you will need a pre- and post-image to that data.

Build skills in these areas

➢ Using the pull-down menu to pick dates to compare
➢ Computing change between two dates both qualitatively and quantitatively
➢ Using various band combinations to visualize change

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

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Change in Les Cayes, Haiti

1. Go to Landsat Explorer.
2. In the upper right corner, click Sign In and sign in to your organizational account.
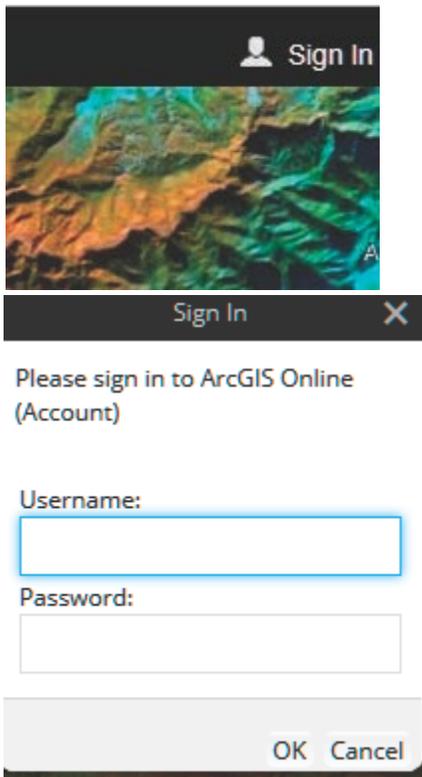
3. Search for Les Cayes, Haiti.

4. Go to the Rendered icon on the left panel and change the band combination to Color Infrared to show healthy vegetation as bright red.

Observe the high concentration of vegetation to the west of the river.
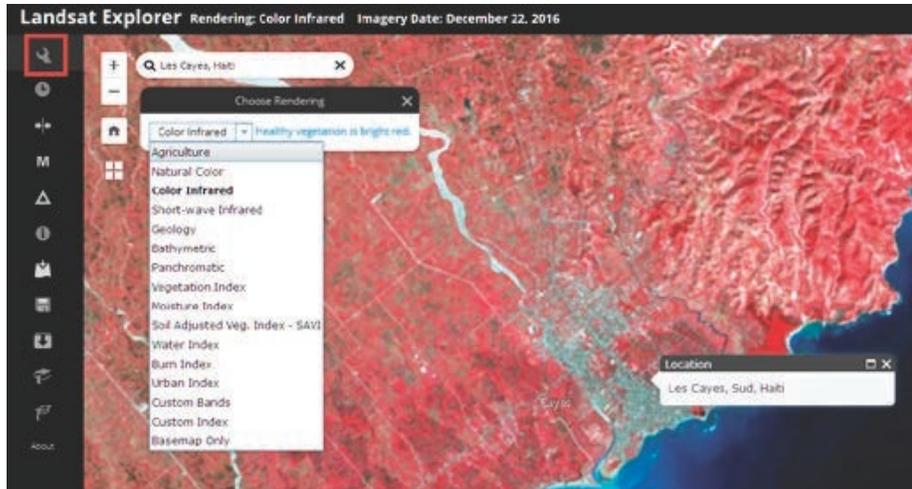
Now use the time selector to pick dates to visualize and compare.

5. Zoom into the city of Les Cayes.
6. Pick the Time Selector on the left panel. Use the drop-down menu to select individual dates.
7. Click the blue arrow pointed down to Set Current as Secondary layer.
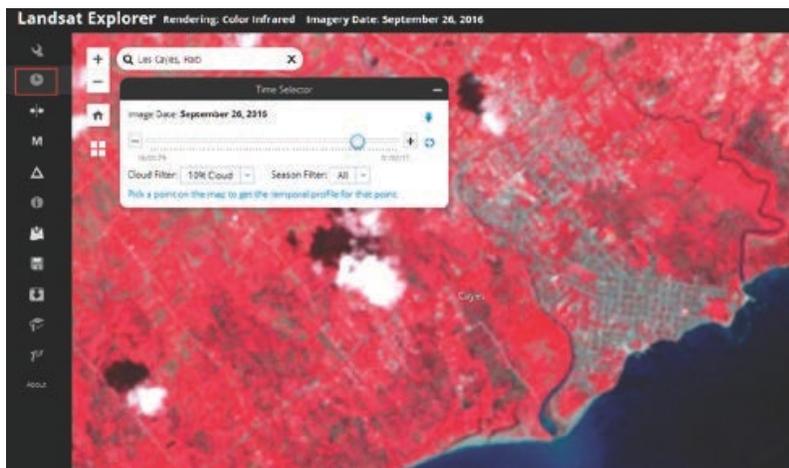
Notice the bright red that shows healthy vegetation and the grayish color that shows developed area. Also, notice the Ravine du Sud River and the discharge going into the ocean.

8. Click the Swipe icon on the left panel.
9. Use the pull-down menu to select October 12, 2016, which is after the hurricane.
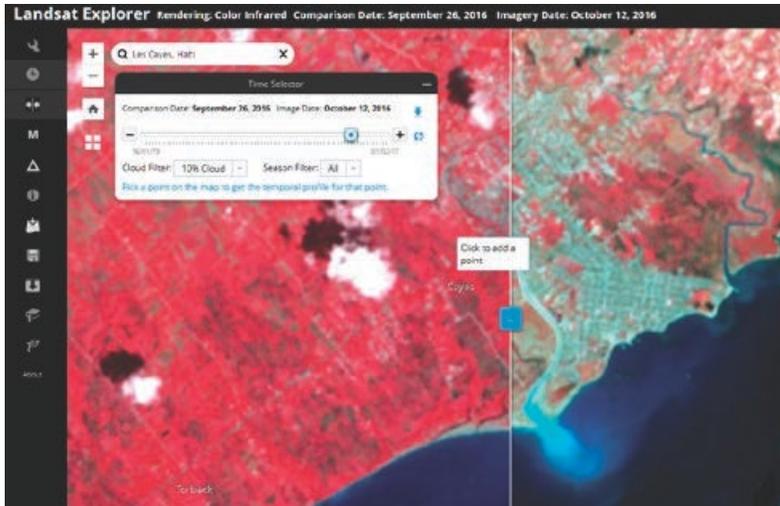
Once again look at the bright red color and the gray and the Ravine du Sud River discharging into the ocean. Also, take note of the beach areas. Describe the differences that you see. Use the swipe tool to compare the two scenes.

To make quantitative measurements, you must compare the differences between the two scenes with a numerical value. The change detection tool will compute the change in spectral reflectance between the two dates. The change detection tool has three modes for change detection: difference image, difference mask, and threshold mask.

- Difference Image mode illustrates all the changes in the select2016ed index between the two dates. Increases are shown in green and decreases are shown in magenta.
- Difference Mask mode also calculates the difference in spectral refectance between the two images. Here, you can use the different sliders to adjust how big the change between two images must be to show up in green or magenta. The transparency slider sets the opacity of the change layer.
- Define Area of Interest allows the user to draw and calculate change for a custom are of interest.

To make your calculations you will be using the Difference Mask.

10. On the left tab, click the Change Detection icon. The Change Detection tool can calculate changes in vegetation health (NDVI). The tool is telling how the spectral reflectance has changed from the before to after date of the arrival of Hurricane Matthew.

4

11. Change the mode to Difference Mask.

Q1 Taking the default for positive and negative values, how many square kilometers between the scenes have decreased?

Q2 What type of land cover has changed the most? Where?

   Note: The Area Decrease/Increase numbers will depend entirely on your view extent, how zoomed in you are, and how big your browser window is.

12. Click the box to Define Areas of Interest.
13. Draw a polygon around a specific area of Les Cayes. You are particularly interest in the section of the city that is nearest the ocean and you should include both sides of the river and some of the beach areas.
14. Click Apply.
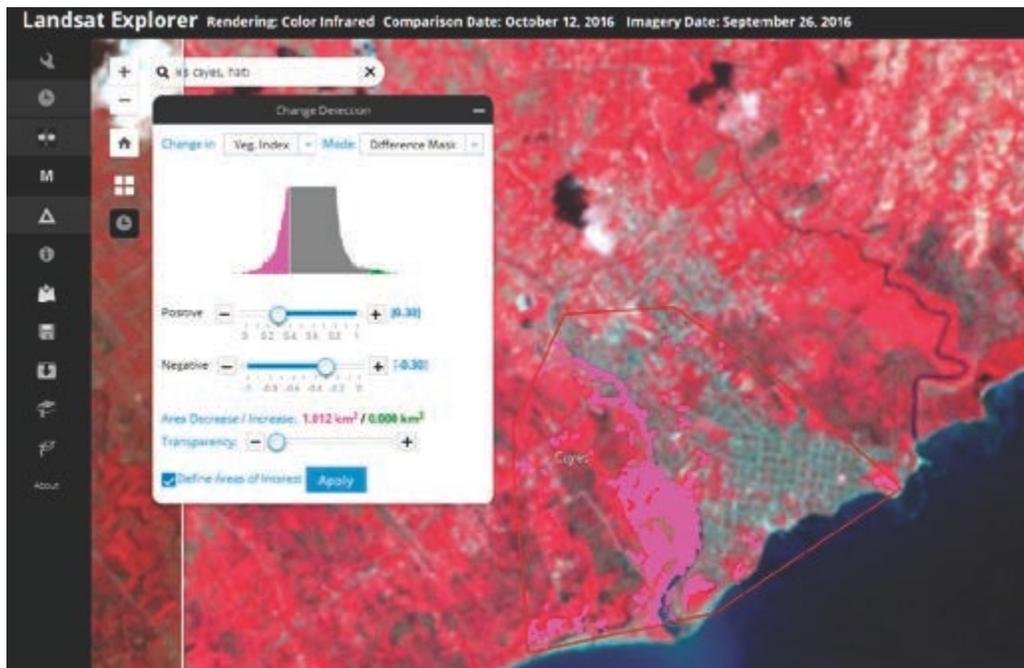
Landsat Explorer app

Over the past 43 years, Landsat has amassed over four million scenes of data, taking images of every location on earth every 16 days. Using the Landsat app, you can explore historic images to see how places change over time and look at images using different combinations of spectral bands. In this exercise, you will investigate three features of the Landsat Explorer app.

You have been asked to demonstrate the Landsat Explorer app to a group of learners without previous experience using Landsat. You need to analyze four different locations. You must qualitatively and quantitatively examine the location

Build skills in these areas

➢ Opening the Landsat app
➢ Finding locations using addresses
➢ Using different spectral band combinations
➢ Analyzing various spectral profiles
➢ Accessing metadata about the imagery

What you need

➢ Account not required
➢ Estimated time: 30 minutes to 1 hour
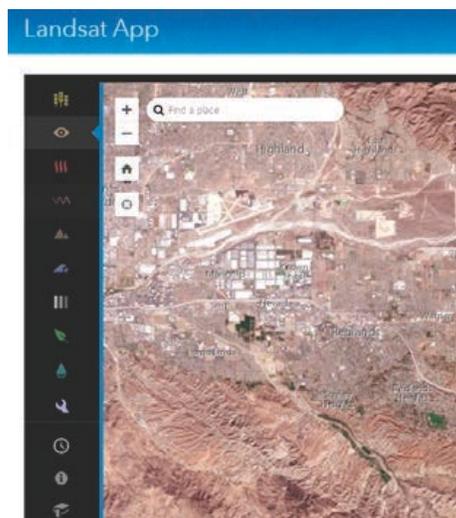
1. Features of the Landsat Explorer app

1. The app provides quick access to the following band combinations:
   - Agriculture: Highlights agriculture in bright green. Bands 6,5,2
   - Natural Color: Sharpened with 25m panchromatic band. Bands 4,3,2+8
   - Color Infrared: Healthy vegetation is bright red. Bands 5,4,3
   - SWIR (Short Wave Infrared): Highlights rock formations. Bands 7,6,4
   - Geology: Highlights geologic features. Bands 7,4,2
   - Bathymetric: Highlights underwater features. Bands 4,3,1
   - Panchromatic: Panchromatic image at 15m. Band 8
   - Vegetation Index: Normalized Difference Vegetation Index (NDVI). (Band5-Band4)/(Band5+Band4)
   - Moisture Index: Normalized Difference Moisture Index (NDMI). (Band5-Band6)/(Band5+Band6)
2. The Time tool enables access to a time slider and temporal profile for different indices based on a selected point. The Time tool is only accessible at large zoom scales. It also provides temporal profiles for Normalized Difference Vegetation Index (NDVI),   Normalized Difference Moisture Index (NDMI), and an Urban Index.
3. The Identify tool enables access to information on the scenes and can also provide a spectral profile based on a selected point.

2.   Washington, DC – urban area

1. Open the Landsat Explorer app.
2. Search for Washington, DC, District of Columbia, United States.

The Landsat view opens in Natural Color. In this view, you can clearly see the bridges, highways and concentrated developed land.

3. Change the Band combination to color infrared, which shows healthy vegetation as bright red. Click the third icon down on the left panel.

4. Locate Arlington Cemetery and the golf course to the West of Addison Heights. If Addison Heights is not immediately visible, zoom in another level.
Spectral profiles indicate the value of each pixel for each band. They are essentially plots of the reflected radiation of different objects. Objects behave differently with different wavelengths and therefore they have different spectral profiles. In this next section, you will examine the spectral profile of water, developed land, and healthy vegetation.

5. Click i (for information) and click on water in the image.

You get information about the Landsat scene as well as a spectral profile. Typical spectral profiles are shown as well as the profile of the pixel you selected. Notice that the values are relatively low throughout all the bands. This is because water absorbs light and does not reflect as much as other objects.

3
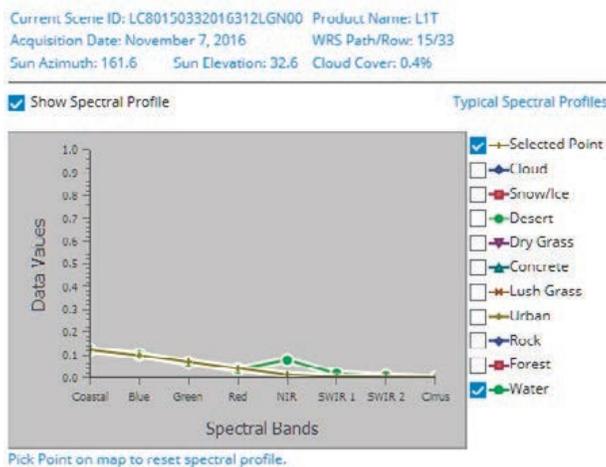
6. Click i and get a spectral profile of developed land.

Q1. Describe the spectral profile curve for development land, paying attention to where the profile spikes.

7. Click i and get a spectral profile of healthy vegetation.

Q2. Describe the spectral profile curve for healthy vegetation. Why does it spike to the NIR band?

8. Check all the Typical Spectral Profiles.

Q3 Looking at all the Spectral Profiles, write a summary of how spectral reflectance is reflected in the spectral profiles of different objects.
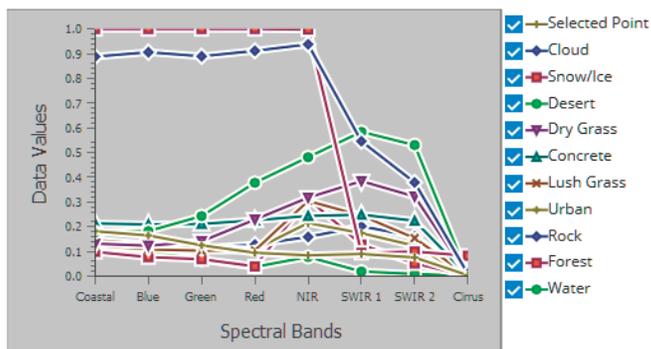
3. Wadi As-Suh, Saudi Arabia—agricultural Area

Circular irrigation is a method of crop irrigation in which equipment rotates around and waters crops with sprinklers. In this section of the exercise, you will identify areas of circular irrigation and examine them using both the vegetation and moisture indexes.

1. Search for Wadi As-Sirhan, Saudi Arabia

2. Show the image using the Vegetation Index that shows healthy vegetation in dark green.
3. Show the image using the Moisture Index where moisture-rich areas are bright blue.

Q4 Which band combination shows the circular fields the best?

4. Princess Charlotte Bay, Queensland, Australia—ocean area

Coral reefs, under threat from environmental conditions, can be monitored by remote satellite imagery. Using remote sensing data, coral reefs can be classified by structure and type and these classifications can be compared temporarily to show change. Find and identify the coral reefs in the area identified.
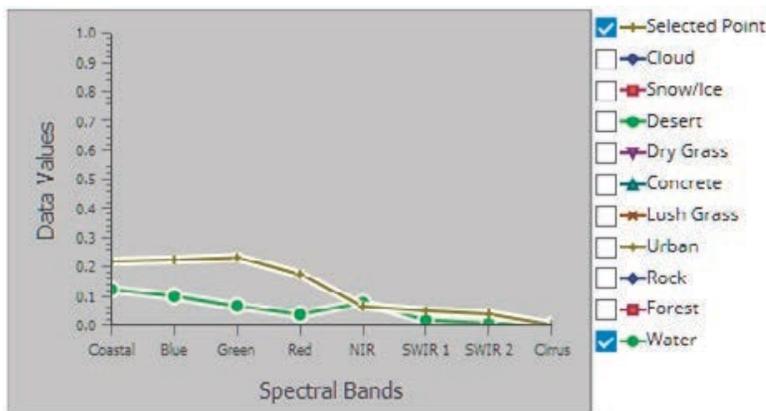
1. Search for Princess Charlotte Bay, Queensland, Australia.
2. Display the image using the Bathymetric band combination.

Q5 What color displays the coral reefs?

Q6 Calculate a spectral profile for the ocean.

Q7 Calculate a spectral profile for the coral reef.

Q8 How do the two spectral profiles compare?

5. Abu Dhabi – desert area

Eolian formations are found in places where wind is the cause of erosion and deposition.
Eolian sediments are usually materials that consist of sand and silt-sized particles. Remote sensing can provide valuable information about regional geomorphologic features caused by wind. The study of eolian formations helps us understand climate and the forces mold it.

1. Search for Abu Dhabi, United Arab Emirates and zoom until you see an image that matches the image shown here.
2. Display using the geology band combination.
3. Zoom out and look for the eolian formations.
4. Describe one pattern of an eolian formation.
5. To observe the dunes and orientation better, display as Panchromatic for a sharper image in black and white.

How far can you see?

The viewshed tools identifies areas that can be seen from an observation location. It is useful when you want to know how visible objects might be, such as different landscape features.

You are a retired couple that wants to relocate and build a home in Lake Junaluska, North Carolina. You have contacted a real estate agent in Waynesville, North Carolina, who has three pieces of land for sale near the lake. You have asked a GIS analyst to determine which of the three proposed house sites has the best view of the lake.

Build skills in these areas

- ➢ Filtering layers with logical queries
- ➢ Using the Create Viewshed tool
- ➢ Visually analyzing imagery

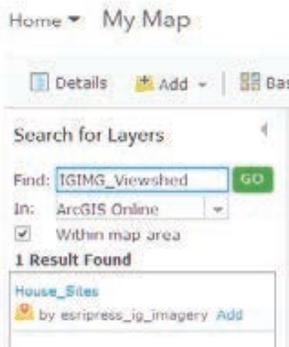## What you need

- ➢ Account required
- ➢ Estimated time: over 1 hour

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1. Build the map

1. Sign into your online ArcGIS organizational account.
2. Click Map on the upper ribbon.

Home   Gallery   Map   Scene   Groups   My Content   My Organization

3. Click + Add.
4. Search for Layers with the following parameters:
   a. Find: IGIMG_Viewshed.
   b. In ArcGIS Online
   c. Clear the Within map area check box.

Home ▼ My Map

☐ Details   ↥ Add ▾ | ▦ Bas

Search for Layers

Find: IGIMG_Viewshed   GO
In: ArcGIS Online   ▼
☑   Within map area
1 Result Found

House_Sites
by esripress_ig_imagery Add

5. Click Add.
6. Search for layers again and search for IGIMG_lake.

Search for Layers

Find: IGIMG_lake   GO
In: ArcGIS Online   ▼
☑   Within map area
1 Result Found

IGIMG_lake
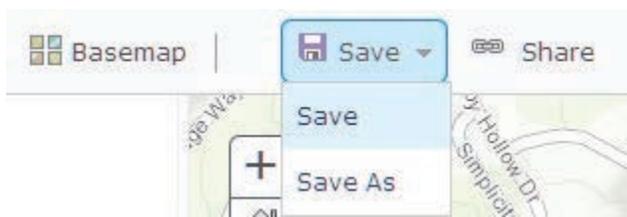by esripress_ig_imagery Add

7. Click Add.

This layer shows Lake Junaluska, which is the view that the potential homeowners want to see from their house site.

8. Click DONE ADDING LAYERS.
9. On the top ribbon, change the basemap to Imagery.
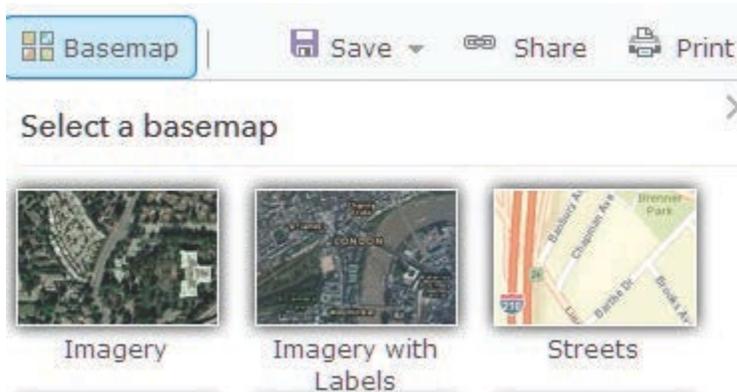
10. Click Save As on the top menu.

11. Use the following parameters:
    a. Title: Viewsheds for House Sites in Lake Junaluska, NC
    b. Summary: Viewsheds for House Sites in Lake Junaluska, NC
    c. Tags: Individualized tags
12. Click SAVE MAP.
13. Click DONE ADDING LAYERS.

Now that the study area has been identified including the three house sites, the viewsheds must be calculated from each of the house sites.

3

2. Create viewsheds from each house site

The Create Viewshed tool uses the Esri Elevation Analysis service to determine which areas are visible from specified observer points.

You must create a viewshed for each house site independently. Use the filter tool to select a feature layer in the map. You will select one house site at a time.
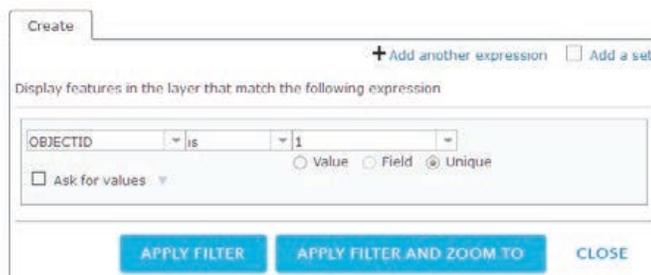
1. Click House Sites>>Filter.
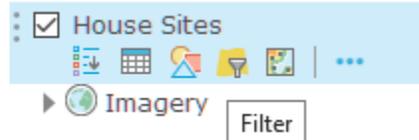
2. Construct the expression shown in the figure:
   (OBJECTID is 1).
   There are three OBJECTIDs. Each one represents a different house site.

3. Click APPLY FILTER.

   The filter isolates or selects one house site, and you are now ready to create the viewshed from house site #1.

4. Click House Sites>>Perform Analysis.

5. Click Find Locations>>Create Viewshed.
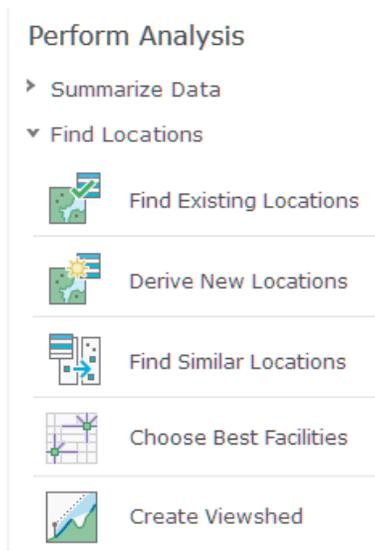
6. Use the following options in the Create Viewshed menu:
   - Point features the represent observer is House_Sites.
   - Height of observer location is 13 feet. (This is the height above ground of your observer location. In this case, set to 14 feet, which represents an eight-story building and a five-foot person.)
   - Set the Maximum viewing distance at 1 mile. This is a cutoff distance where the computation of visible areas stops.
   - Result layer name should be Viewshed_1.
   - Clear Use Current Map Extent.
7. Click RUN ANALYSIS.

   The resulting feature shows the viewshed from House Site #1.

8. Repeat steps 1-7 for House Site #2, with the following modifications:
   - Click Filter>>Remove Filter.
   - Create expression for OBJECTID is 2.
   - Run viewshed using the same parameters as the house site #1.
   - Name the viewshed Viewshed_2.
   - Clear the Current Map Extent.

You need to make Viewshed_2 a different color.

9. Click Change Style.

10. Click OPTIONS.
11. Click Symbols.
12. Select a different color.
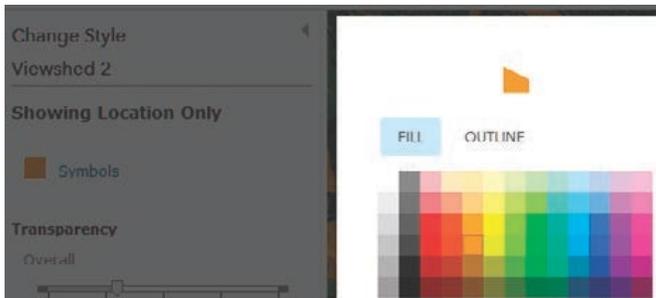
13. Click OK.
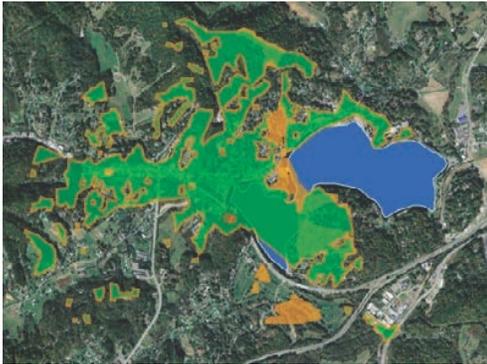
14. Repeat steps 1-13 for house site #3.

You have now created a viewshed from each of the three house sites.
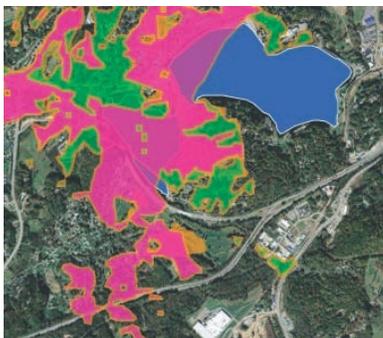
3. Intersect views with the lake

Now that the viewsheds have been created, you must isolate what section of the lake can be seen from each one. To isolate areas of the lake, you must combine two layers (viewshed and lake) into a single layer. To do this, you will use an overlay method called intersect. When you use intersect, it will result in only those features or portions of features in the overlay layer that overlay with features in the input layer.
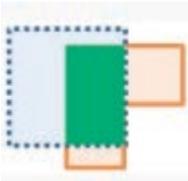
1. Click Lake Junaluska.
2. Click Perform Analysis.
3. Click Manage Data.
4. Click Overlay Layers.

Perform Analysis

▸ Summarize Data

▸ Find Locations

▸ Data Enrichment

▸ Analyze Patterns

▸ Use Proximity

▾ Manage Data

　Dissolve Boundaries

　Extract Data

　Merge Layers

　Overlay Layers

Overlay Layers　❶

❶ **Choose input layer**

Lake Junaluska ▾

❷ **Choose overlay layer**

Viewshed_3 ▾

❸ **Choose overlay method**

Intersect　　Union　　Erase
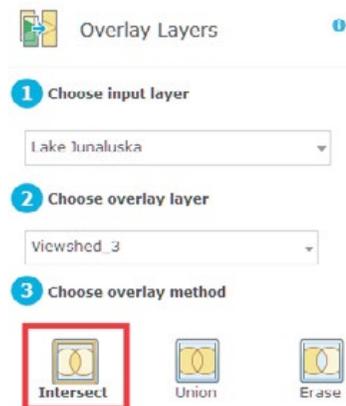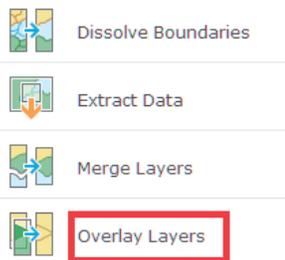
5. Click Intersect and use the following parameters:
   - Choose input layer: Lake Junaluksa.
   - Choose overlay layer: Viewshed_1.
   - Output: Areas.
   - Result layer name: Lake_View_1.
   - Clear Use Current Map Extent.
6. Click RUN ANALYSIS.
7. Click DONE.
8. Repeat steps 1-7 for House Site 2 and Viewshed_2.
9. Repeat steps 1-7 for House Site 3 and Viewshed_3.

In this exercise, you created three viewsheds and intersected them with Lake Junaluska to provide the retired couple with a visual representation of what part of the lake they will be able to see from each of the three house sites. From this information, the couple can make an informed decision.

9

Using the Landsat Arctis app

Landsat Arctic is a web app for accessing Landsat imagery covering the Arctic region. The layers are updated daily with new Landsat scenes. It uses a polar projection allowing visualization of the Arctic region without distortion. The app allows access to different band combinations, and it is time enabled.

You have been asked to develop a lesson that shows the Landsat Arctic app in comparison to Scene. You have been instructed to use latitude and longitude as your locational finders.

Where are you when you are looking at the Arctic App? To see where you are on the globe, you must first zoom out. However, when you zoom out, the Arctic App distorts. The Arctic App is built to be used with the polar projection.

It is beneficial to open both the Landsat Arctic app and an Arctic scene view at the same time. The Arctic scene view will be used for reference.

Build skills in these areas

- Opening the Landsat Arctic app
- Opening Arctic Scene View
- Recording latitude and longitude
- Comparing polar projection with ArcScene View
- Locating the Arctic Circle
- Identifying and exploring Arctic locations

What you need

- Account not required
- Estimated time: under 30 minutes

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1. Compare views

1. Open Landsat Arctic app.
2. Open Arctic Scene View and zoom into the Arctic Circle.
3. Arrange the two apps side-by-side on your computer screen.
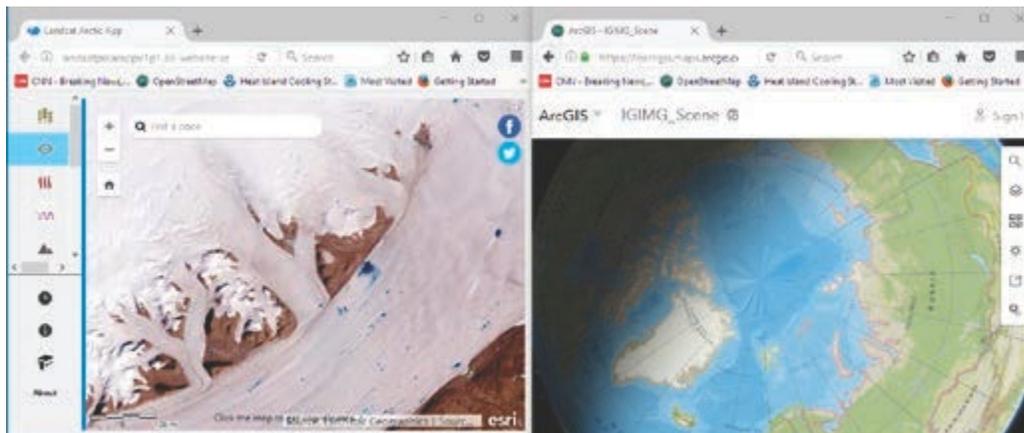
4. Using the i icon, click the middle of the scene in the Landsat Arctic app and record the longitude and latitude.

2

When you zoom out of the app, you will see the Arctic polar projection, but it is difficult to see where you are. The squares that you see are the Landsat scenes that are being fed into the app.
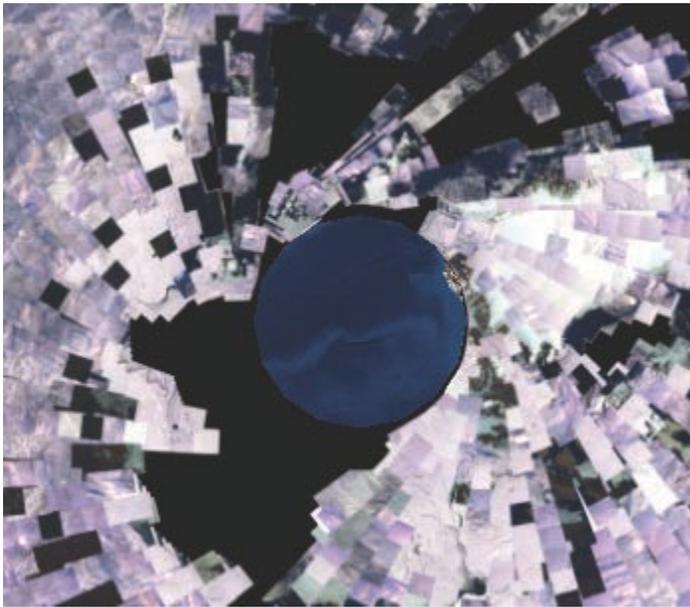
5. To return to the opening view of the Landsat Arctic app, type the longitude, latitude coordinates in the Search box, or click the Home button.
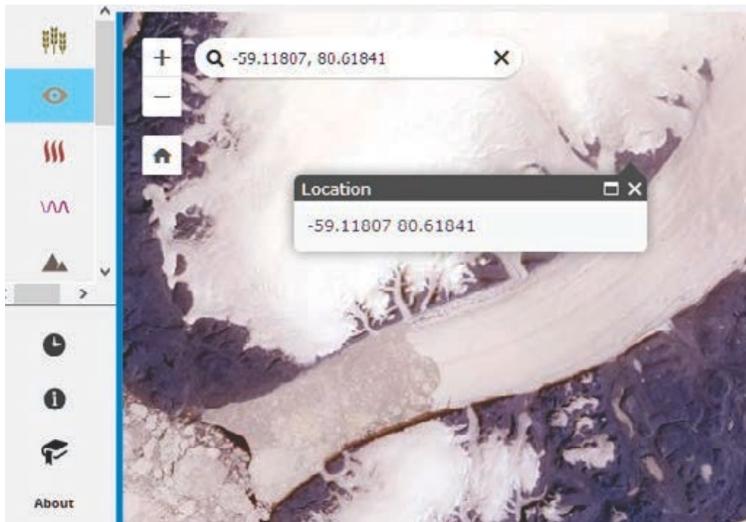
6. Now return to Arctic Scene View and type the same coordinates in the Search box.
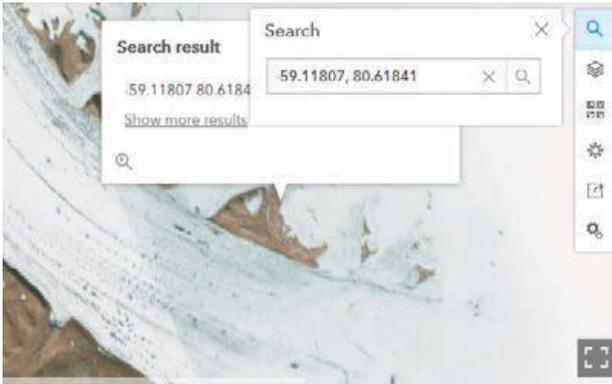
7. On the side navigation bar, change the basemap to Imagery with Labels.

Q1 Zooming in and out in the scene view identified where the scene has been Taken. What country it is?

Q2 Is it in the Arctic Circle?

Q3 What channel is it near?

2. Identify locations

1. On the right tab, go to Bookmarks and identify the scenes.
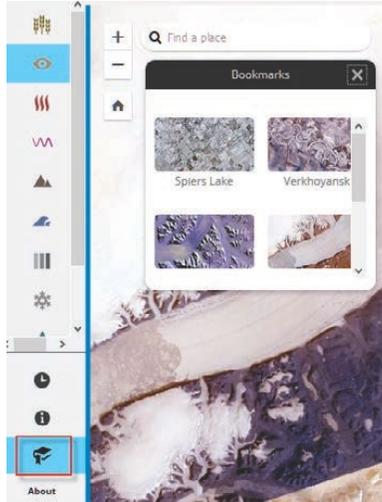
2. Following the procedure in section 1 of this activity, identify the bookmark in the Landsat Arctic app and the Scene app.
3. Use your investigative skills to write a brief description of each of the bookmarked scenes.
   The scenes are as follows:
   - Spiers Lake, Alberta, Canada
   - Verkhoyansk, Russia
   - Geikie Plateau, Greenland
   - Petermann Gletsched, Greenland
   - Watkins Range, Greenland

3. Additional activity

There are five more bookmarked scenes identified in the Landsat Arctic app. In this part of the activity, you will use the Landsat app, the Scene app, and your investigative abilities to visualize and write descriptions of the bookmarked scenes.

Exploring hurricane variables in the 3D scene viewer

ArcGIS Online Scene is an app that can symbolize 3D geospatial content that includes a multiscale basemap, a collection of 3D layers, styles, and configurations that allow you to visualize and analyze geographic information in an intuitive and interactive 3D environment. You can also create web apps with a scene by using a configurable app. Different configurable apps offer various bits of functionality.

You have been given the task of displaying hurricane track data by the two variables of wind speed and pressure. You are to show how atmospheric pressure and wind speed change along the path of the hurricane and show the relationship between the two. The hurricane data that you have been given is for Hurricane Katrina, which was one of the costliest natural disasters to ever hit the United States. It was active August 23–31 and was recorded as a Category 5 Hurricane. It impacted Florida, the Bahamas, and Cuba, but the most devastating damage was in New Orleans, Louisiana.

Build skills in these areas

➢ Adding layers to Scene in your organizational account
➢ Displaying hurricane track data in 3D by variables of speed and pressure
➢ Creating two web apps using configurable app template

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

1. Open Scene

1. Sign in to your ArcGIS organizational account.
2. Slick Scene on the upper ribbon.

Home   Gallery   Map   Scene   Groups   My Content   My Organization

3. In the upper-left corner of your screen are the navigation controls. Take a few minutes to familiarize yourself with the tools. Use all the tools.

Navigate your scene

In the upper left of your screen are the navigation controls.

* Click **Initial view** 🏠 to return to the initial camera position.
* Click + to zoom in.
* Click – to zoom out.
* You can also use your mouse and scroll wheel to zoom in and zoom out or press and hold the middle mouse button and move down or up to zoom in or out.
* Click **Pan** ✛ to pan. Click and hold the left mouse button and drag the scene in the direction you want to move it. You may also pan by using the arrow keys on the keyboard.
* Click **Rotate** to rotate. Click and hold the left mouse button and drag the scene in the direction you want to rotate and tilt it.

> **Tip:** The black triangle in the upper right of the tool indicates which tool is selected.

* If you have a two-button mouse, you can use the left mouse button for the primary navigation and the right mouse button for the secondary navigation. For example, if you click **Rotate** ✛, you can use the left mouse button to rotate and the right mouse button to pan.
* **Compass** gives you the orientation of the scene. Click **Compass** to set your scene to North orientation.

4. Pay attention to changing the basemaps.

🔍 Search and type a location into the search box

≋ View layers

▦ Choose a basemap

☀ Adjust daylight (This setting can be used to change how sunlight and shadows affect your scene different times of the day and year.)

✛ Share the scene

⚙ Change settings

2. Create scene of wind speed

1. Add an additional layer to the scene by clicking ADD LAYER.
2. Search for IGIMG_Katrina.
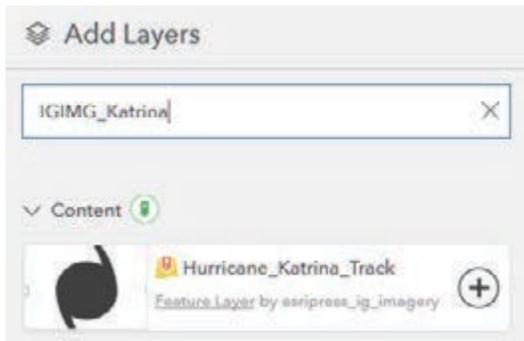
3. Click the plus sign (+) and add the layer to the scene.

   Notice that the point data for the hurricane track appears on the scene.

4. Click DONE.

   You will now style the layer to show wind speed. The menus involving styling the layer can be accessed from the tab on the side of the feature.

5. Click Rename and rename the layer Hurricane_Katrina_Wind_Speed.
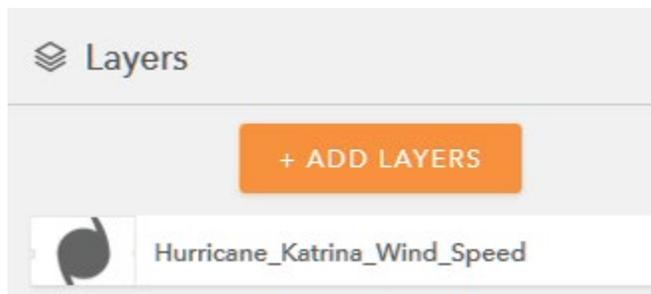
6. Click the tab again and select Layer Style

7. Choose the main attribute to visualize as Wind_MPH.
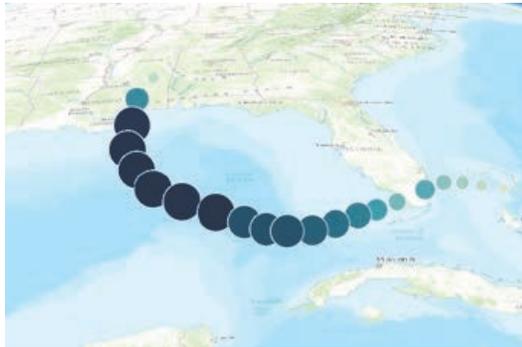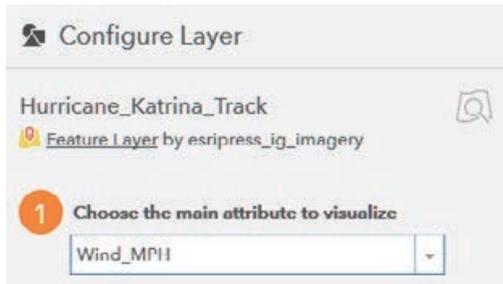
Notice that the wind speed is now represented on the map both as graduated symbols and using a color ramp. The symbols are spheres, and the larger the sphere, the stronger the wind. The wind speed is also shown as a graduated color ramp, with the darkest blue indicating the strongest wind.

You will next choose a drawing style. You want to choose the Counts & Amounts 3D>>OPTIONS.

8. Click OPTIONS.

9. Click Symbol and change to cone.
10. Change the color to the graduated red ramp.
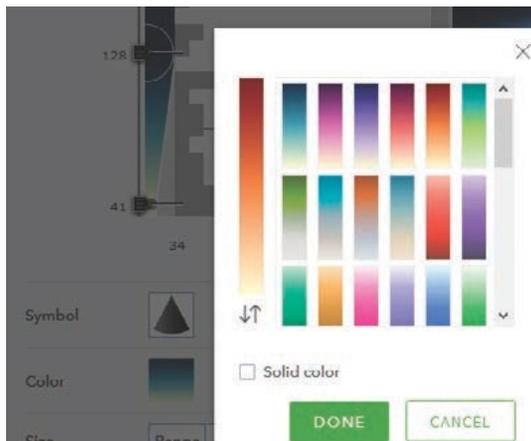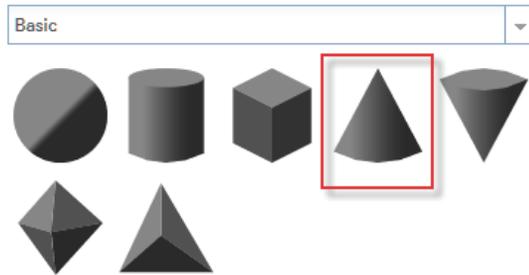
11. On the upper-right toolbar, change the basemap to Imagery with Labels to see the landscape better.
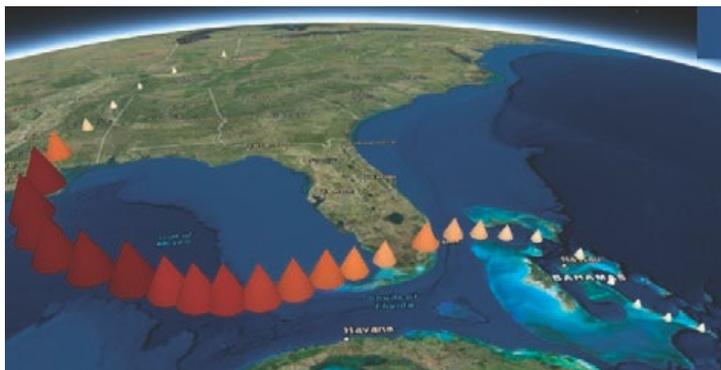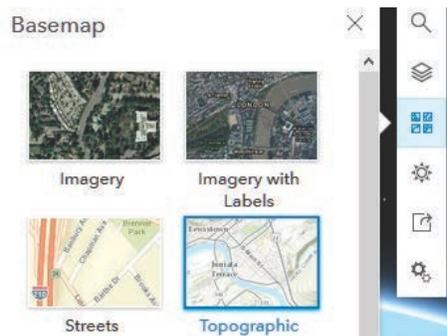
12. Before clicking DONE, use the Toggle to pan or rotate in 3D to see the cone shape.
13. Click DONE.
14. Click DONE again.
15. Click SAVE SCENE, and enter the following metadata:
    - Title is Hurricane Katrina Wind Speed (and your initials).
    - Summary: 3D Representation of Hurricane Katrina Wind Speed
    - Tags: individual tags
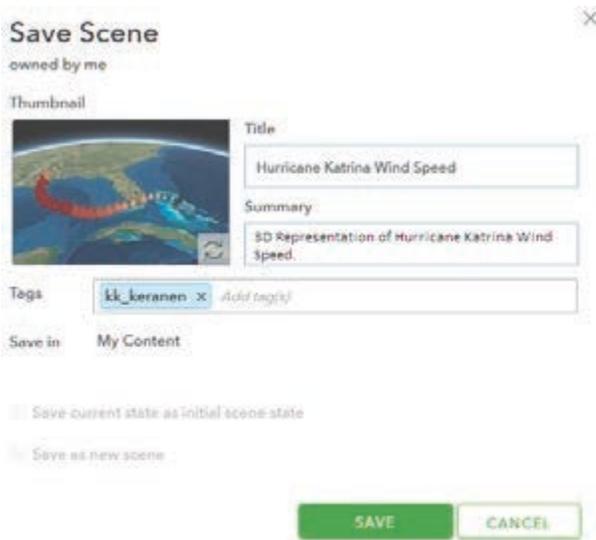
16. Click SAVE.

You have successfully made a 3D Scene showing Hurricane Katrina wind speed.

3. Create scene of barometric pressure

You will now make another map showing barometric pressure.

1. In the upper-right corner, click New Scene>>New Global Scene.

2. Repeat steps 1-16 from "Create scene of wind speed" to create the wind speed map with the following exceptions:
   - Rename the layer Hurricane_Katrina_Pressure.
   - For color, choose red.
   - For symbol, choose an inverted cone.
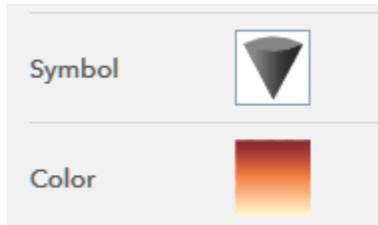
3. Click SAVE SCENE, and enter the following metadata:
   - Title: Hurricane Katrina Pressure (and your initials)
   - Summary: 3D representation of Hurricane Katrina barometri_pressure
   - Tags: individual tags
4. Click SAVE.

4. Configure a web app scene

Configuring a Web App Scene will let you view both 3D visualization. Wind speed and Pressure.

1. Go Home and choose My Content.

2. Click Hurricane Katrina Wind Speed and click Open.
3. Click Create Web App>>Using a Template.

4. Select Compare Scenes and click Open.
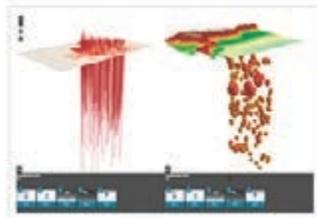
Compare Scenes

5. Click CREATE WEB APP, and enter the following metadata:
   - Title: Comparison of Wind Speed and Barometric Pressure
   - Summary: Using Hurricane Katrina to compare wind speed and barometric pressure
   - Tags: individualized tags
6. Click DONE.

   You can now select the two web scenes to be visualized in your app.

7. Click Select Web Scene(s).
8. Select Hurricane Katrina Pressure and Hurricane Katrina Wind Speed.
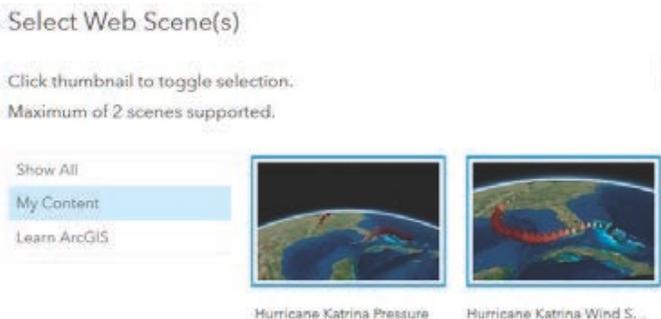
9. Click OK.
10. Click Options on the top ribbon.
- Be sure that Link Views is checked.
- Do not select Open info panels at start.
11. Click SAVE.
12. Click Launch.

When you launch the Comparison of Wind Speed and Barometric Pressure app, you will be able to visualize the
relationship between the two variables as well as compare the variables to their relationship of land and water.

5. Analysis

In this exercise, you have visualized how atmospheric pressure and wind speed change across the path of a hurricane.

Q1 Using the visualization, write an analysis listing all the variables and their relationships. Specifically include the relationship of wind speed to location on land versus water, wind speed to depth of water, and wind speed to atmospheric pressure.

Q2 Looking at the variables, where would the hurricane be the strongest?

6. Additional activity

Hurricane Matthew lasted from September 28 to October 20, 2016. It produced damage from Haiti to the southeastern United States and caused severe food damage. Use this hurricane track to solidify your ability to display the pressure and wind speed of a hurricane in 3D to show their inverse relationship.

1. Open a new scene.
2. Search for IGIMG_Matthew.
3. Use the Hurricane Matthew Track to produce and analyze another set of hurricane data.

Layering contemporary imagery with historical maps

Overlaying current satellite imagery with high-resolution historical map images (such as those in the David Rumsey Historical Map Collection) provides unique insights into the contemporary landscape. In the past decade, the proliferation of mobile devices and apps has given birth to a revolutionary new genre in the world of tourism—mobile map tours. Using only your smartphone, you can take a campus tour of virtually any college or university, a walking tour of an urban historic district, or a guided tour of an art museum. The possibilities are endless.

One of the largest arenas for mobile app development is tours of national, state, and local parks. You have been asked to work with an app tour developer to identify points of historic interest and importance in New York City's Central Park based on a map of New York City in 1836. Central Park did not exist at that time, but your company is creating a walking tour app that will highlight the park's history as well as its contemporary features. You will submit an ArcGIS Online map with selected 1836 historic locations noted so that a research team can develop appropriate text to go with them in the tour.

Build skills in these areas

- ➢ Opening and saving a new map
- ➢ Changing the basemap
- ➢ Creating and symbolizing an area map note
- ➢ Adding new map layers from ArcGIS Online
- ➢ Identifying latitude and longitude coordinates of specific locations
- ➢ Creating and symbolizing point map notes

What you need

- ➢ Account required
- ➢ Estimated time: 30 minutes – 1 hour

Identifying coordinates for historic locations in New York's Central Park

1. Sign into your ArcGIS Online organizational account and click Map to open a new map.
2. Change the basemap to imagery.
3. Save your map as Central Park Tour. Give the map appropriate tags and provide a summary.
4. Find Central Park by typing it in the Find box.
5. Create a map note (Add Content to Map>>Add Map Notes) called Central Park by digitizing Central Park's long rectangular shape from the Imagery basemap.

a. Using an Area tool, click three of the park's corners. Double click the fourth corner to finish.
b. Symbolize the area with a red outline and no fill.
c. Click Edit when you are done.

6. Add New York City 1836 from the David Rumsey Historical Map Collection (Add Content to Map>>Search for layers). Search for New York City 1836 in ArcGIS Online. When you find the David Rumsey map, click Add.
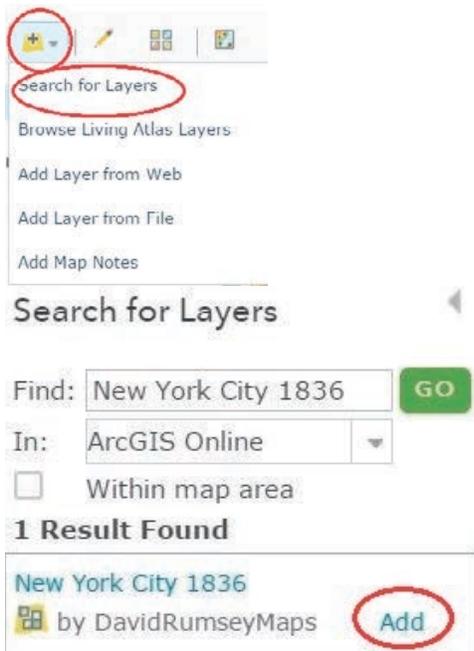
7. Turn on the 1836 map of New York City and move the Central Park map note above the historical map.

8. Zoom in to the map legend (Explanation) to learn what the map symbols represent.

9. Zoom in to the area of Central Park as delineated by your Central Park map note. Using the legend symbology, make a list of area features from 1836 that later became Central Park.

10. Use the Measure tool to determine the coordinates of each of the following locations in the Central Park area in 1836. Simply click the Measure tool, the Location tool, and the appropriate location on the map to find its latitude and longitude.
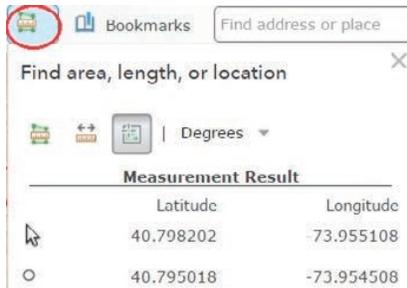
a. Powder House
b. Fort Clinton
c. Fort Fish
d. The Receiving Reservoir
e. Woods (one or more areas)
f. An orchard (one or more areas)
g. Marshland

11. Turn off the historical map layer, New York City 1836.
12. Create a map note for each of the locations in step 9. Use the following directions to create each map note:
   - In the Find box, enter the latitude and longitude coordinates for the Powder House. Note: enter the longitude (-73.97315), followed by a comma, and then the latitude (40.768908).
   - In the search results window, click Add to Map Notes.
   - Click the new blue Map Note symbol. Title it Powder House.
   - To change the Map Note symbol, in the Shapes symbol, select the red star and change the size to 25 px.
   - Click OK and click Close.
   - Repeat these steps for each of the remaining locations on the list above. Give each an appropriate title (e.g., Powder House, Fort Clinton, and so on).
13. In the map contents, change the Map Notes layer name to Historical Locations.
14. Save your map.

Your task is complete. You used an historical map to identify and locate historical features from 1836 in the area that is now Central Park. You summarized your findings by creating a map showing each of the historical locations.

Disappearing lake

The Aral Sea is in Central Asia between Northern Uzbekistan and the southern part of Kazakhstan. It used to be the fourth largest lake in the world but water diversions for irrigation and recent droughts have caused the lake to shrink. In 2014, the eastern lobe of the Southern Aral Sea completely disappeared.

Your geography teacher has given you an assignment of creating an online Story Map explaining with imagery and calculations the shrinkage of the Aral Sea.

Build skills in these areas

➢ Filtering a temporal database of Landsat satellites
➢ Digitizing and calculating area from imagery
➢ Creating layer files from graphics
➢ Calculating percentage change
➢ Building a story map series

What you need

➢ Account required

➢ Estimated time: over 1 hour

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1. Locate the Aral Sea

1. Sign into your ArcGIS organizational account.
2. Click Map.
3. Search for 60.00067,44.95809.
4. Click Add to Map Notes.
5. Click Basemap and select Imagery with Labels.
6. Save the map with proper metadata.

Save Map

Title:	Locational Aral Sea
Tags:	LearnResourceIMG × aral_sea × Add tag(s)
Summary:	Locational Aral Sea
Save in folder:	Aral Sea

SAVE MAP   CANCEL

2. Find temporal images of the Aral Sea

1. On the top ribbon click Save As and name the map Aral Sea 1975.
2. Click Add and select Browse Living Atlas layers.
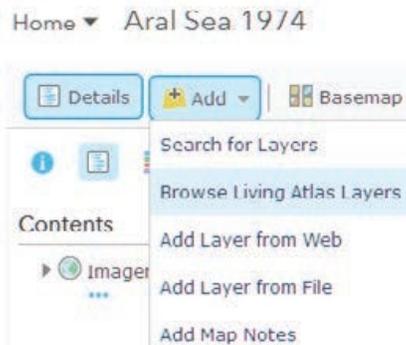
3. Choose Multispectral Landsat and Add layer to the map.

4. Click CLOSE.
5. Click Multispectral Landsat and select Rename.
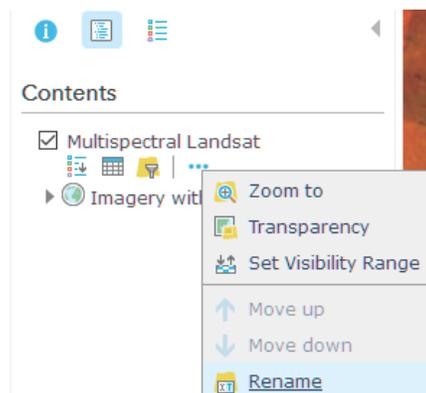
6. Rename Multispectral Landsat Image 1974.
7. Under Image 1974 choose Filter.
8. Create the expression: **Acquisition Data is on 12/31/1974**

9. Click APPLY FILTER. This will isolate the Landsat image.
10. Click Imager 1974 and select Image Display.
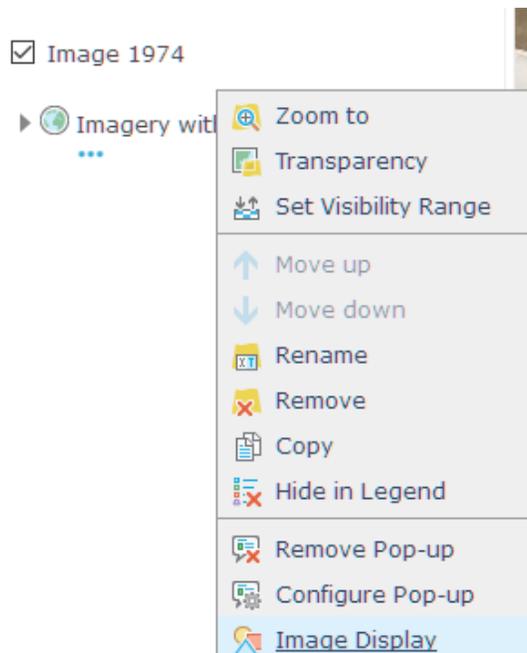
11. Select Color Infrared with DRA with a Stretch Type of Minimum and Maximum.

12. Click APPLY.
13. Click CLOSE.

3. Digitize and calculate the area of the Aral Sea for 1974

To find the area of the Aral Sea, you need to create a digitized polygon. Since two islands are within the sea, you need to create a water and a land polygon and then subtract the land from the water.

1. Click Add and select Add Map Notes.
   a. Name: Water 1974
   b. Template: Map Notes
2. Click CREATE.
3. Select the Freehand Area and draw around the water of the Aral Sea.
4. Double-click to end the polygon.
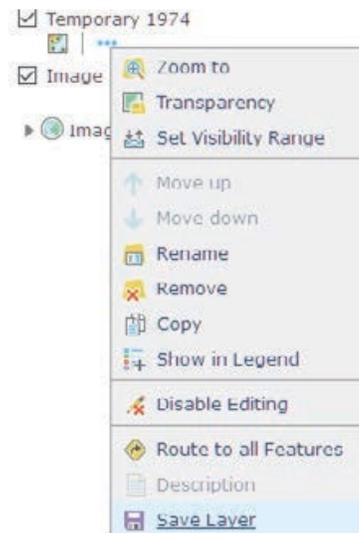
5. Click Close.
6. Click Details.
7. Click Water 1974 and Save layer.
8. Complete information.
9. Click CREATE ITEM.

10. Repeat steps 1-9 digitizing the two small islands shown within the Aral Sea and naming the Map Notes Land 1974.

Now you need to combine the water and land layers by erasing the land from the water layer. When you erase the land, area will be taken out of the total water layer.

11. Click Water 1974 and click Perform Analysis.
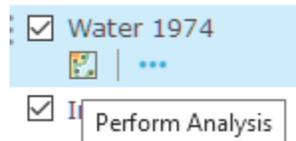
12. Click Manage Data.
13. Click Overlay Layers.
14. Use the following parameters:
    • Choose input layer is Water 1974 (areas)
    • Choose overlay layer is Land 1974 (Areas)
    • Choose overlay method of Erase.
    • Result layer name is Area 1974.
15. Uncheck Use current map extent.
16. Click RUN ANALYSIS.
17. Remove Water 1974 and remove Land 1974.
18. Click Area 1974 and Show Table. You can see that the area of the Aral Sea in 1974 has been recorded.
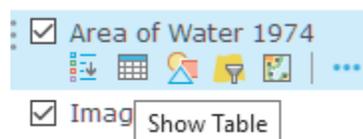
19. Use the table below to start recording your findings.
20. Click Save.

You need to follow the above steps 1-20 five more times. You will need to remove the Area of Water used in the previous map and rename the Image to match to year.

21. Save the Map as Aral Sea 1989.
22. Change the image name to Image 1989 and remove Area of Water 1974.
23. Use the Acquisition Date 12/31/1989.
24. Save the Map as Aral Sea 1999.
25. Change the Image name to Imager 1999 and remove Area of Water 1989.
26. Use the Acquisition Date 12/31/1999.
27. Save the Map as Aral Sea 2004.
28. Change the Image name to Image 2004 and remove Area of Water 1999.
29. Use the Acquisition Date 12/31/2004.
30. Save the Map as Aral Sea 2009.
31. Change the Image name to Image 2009 and remove Area of Water 2004.
32. Use the Acquisition Date 12/31/2009.
33. Save the Map as Aral Sea 2015.
34. Change the Image name to Image 2015 and remove Area of water 2009.
35. Use the Acquisition Date 07/06/2015.

4. Calculate change

Record your findings and calculations:

Year	Area of Water square miles	Change in square miles	% Change	Number of Years	% Change/Year
1974					
1989					
1999					
2004					
2009					
2015					

To calculate % change, user the following formula:
(change in square miles/area of water in square miles) X 100

To calculate change/year
divide the % Change by number of years

Calculate the percent change per year for the 41 – year period
(total change in square miles)/original area of water) X 100)/41 years

5. Combine area onto one map

1. Save Aral Sea 2015 as Final Area.
2. Remove Area 2015 and Image 2015.
3. Click the Add button on the top bar and Search for Layers.
4. Search for Area.
5. Add Area 1974, 1989, 1999, 2004, 2009, and 2015.
6. Click Change Style for each layer and make each a distinct color.
7. Click Save.
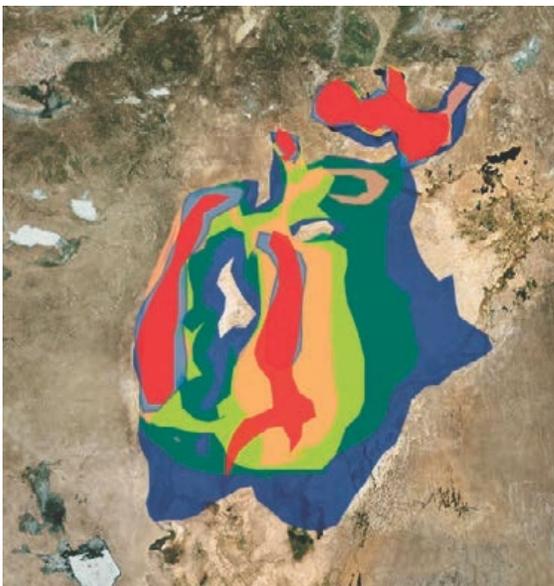
6. Create story map series

ArcGIS Online offers a suite of configurable apps that you can use to tell a story. Here are some things to keep in mind as you consider which configurable app to Use.

- Purpose – The most important consideration is the purpose of your app. Embedded within this goal is your intended audience. Who is going to use your app and what are the key points that you want them to take away from the experience?
- Functionality – What is the critical functionality needed to support that goal?
- Aesthetic – How does the app layout and color scheme support your brand or message?

In this story map, you should try to tell the story both qualitatively and quantitatively. Feel free to do research about the time areas shown and add pertinent data.

1. Open the Locational Aral Sea map.
2. On the upper ribbon click Share.
3. Click CREATE A WEB APP.
4. On the left panel choose Build a Story Map.
5. Click the Story Map Series.

6. Click CREATE WEB APP.

7. In Summary type: Temporal study of the Aral Sea using Landsat images.

8. Click DONE.
9. Choose the tab Map Series Builder.
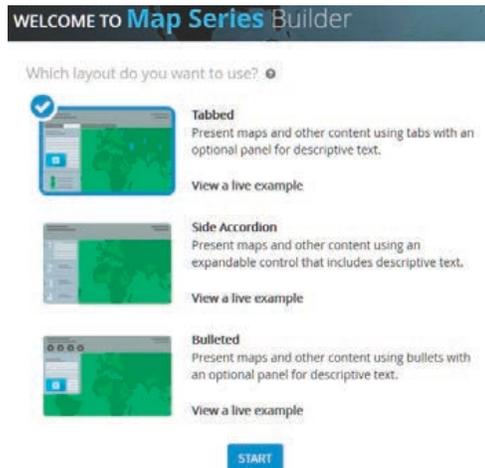
10. Click START.
11. Name the Tabbed Map Series: Temporal Study of the Aral Sea 1974-2015.

12. Click the Arrow to go to the next page.
13. For the Tab Title add Locational Aral Sea.
14. Select the Locational Aral Sea Map.
15. Click ADD.

You now have a box at the side that can contain text, images, or movies. Write a brief history of what is happening to the Aral Sea from 1974 to 2015.

16. Click Add.
17. Title the tab Aral Sea 1974.
18. Select the Aral Sea 1974 map.
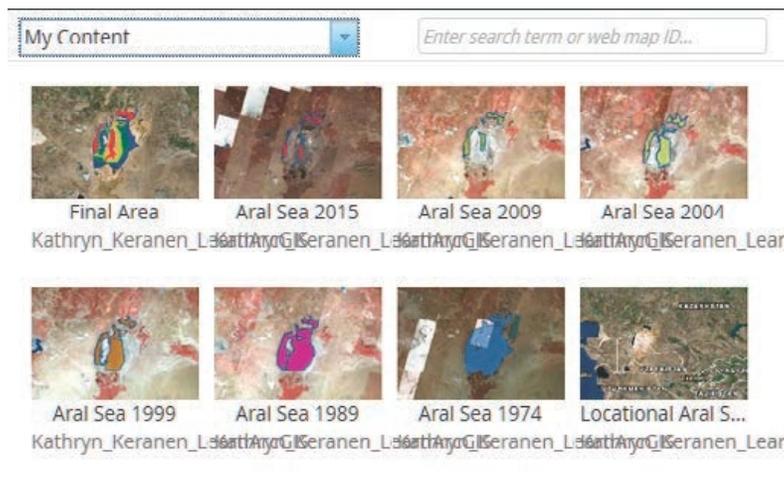
19. Repeat steps 16-18 for 1989, 1999, 2004, 2009, 2015, and Final.

For each map, add your maps and enter text and calculations.

Elevation

A raster is a grid of cells in a geographic space. The spaces with the grid are the cells. In the following lesson, you will take point data and turn it into a continuous surface raster. Surface interpolation tools create a continuous (or prediction) surface from sampled point values. The continuous surface representation of a raster dataset represents some measurement, such as elevation.

You have been given the task of making a continuous surface map from point data that has been collected in Oaxaca, Mexico.

Build skills in these areas

➢ Opening an existing online map
➢ Interpolating point data based on the variable elevation
➢ Using a feature as a mask
➢ Changing basemaps
➢ Setting transparency
➢ Using continuous surface maps to answer questions
➢ Saving and documenting online maps

What you need

➢ Account required
➢ Estimated time: under 30 minutes

1. Open the map

1. Open your ArcGIS organizational account.
2. Open the map Oaxaca.
3. Save the map to your organization with appropriate metadata.

2. Create a continuous surface map

1. Click Content.
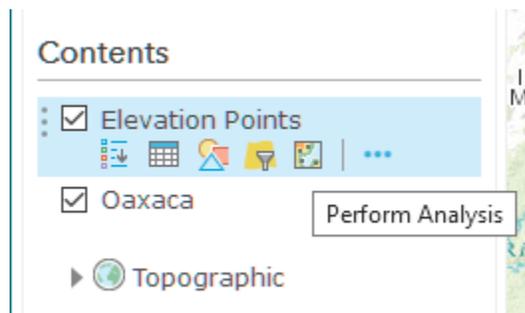
2. Click Elevation Points and select Perform Analysis.
3. Choose Analyze Patterns and select Interpolate Points.
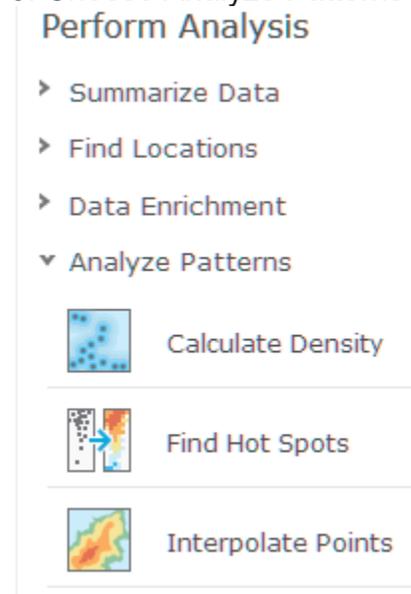
This tool allows you to predict values at new locations based on measurements found in a collection of points. The tool takes point data with values at each point and returns areas classified by predicted values.
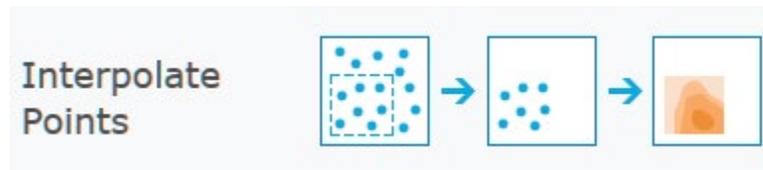
4. After activating the tools, use the following parameters:
   a. Choose point layer containing locations with known values of Elevation_Points
   b. Choose field to interpolate of Elev_meter
   c. Click Options
      o Clip output to Oaxaca
      o Classify by Equal Interval
      o Number of classes 10

   d. Result layer name is Continuous Elevation
   e. Uncheck Use current map Extent
   d. Click RUN ANALYSIS.

You now see a continuous surface elevation map created from point elevation data.
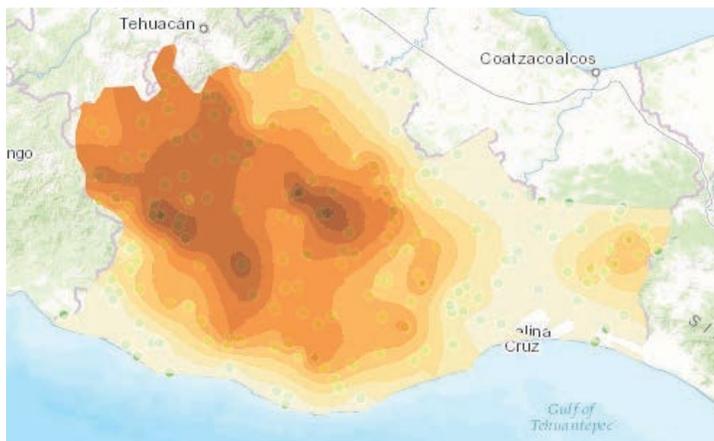
3. Symbolize the elevation map and set transparency

1. Uncheck Oaxaca and Elevation Points.
2. Click Continuous Elevation.

The legend shows you a range of elevation by colors.

3. Click Basemap and select Imagery.
4. Click Continuous Elevation and choose Transparency and set the Transparency at 50%.
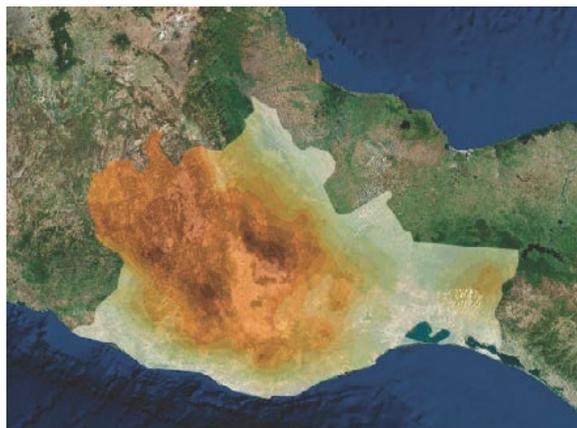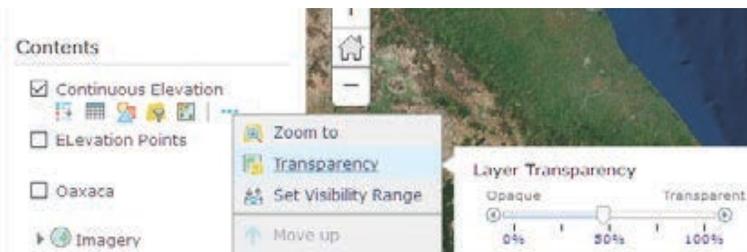
5. Write a description of the spatial distribution of Oaxaca. You might want to change the basemap to Imagery with Labels so you will know the names of some of the locational points such as the city of Oaxaca, Salina Cruz, Juchitan de Zaragoza, and Puerto Escondido.

In this exercise, you have created a continuous surface image by interpolating point data using the variable of elevation.
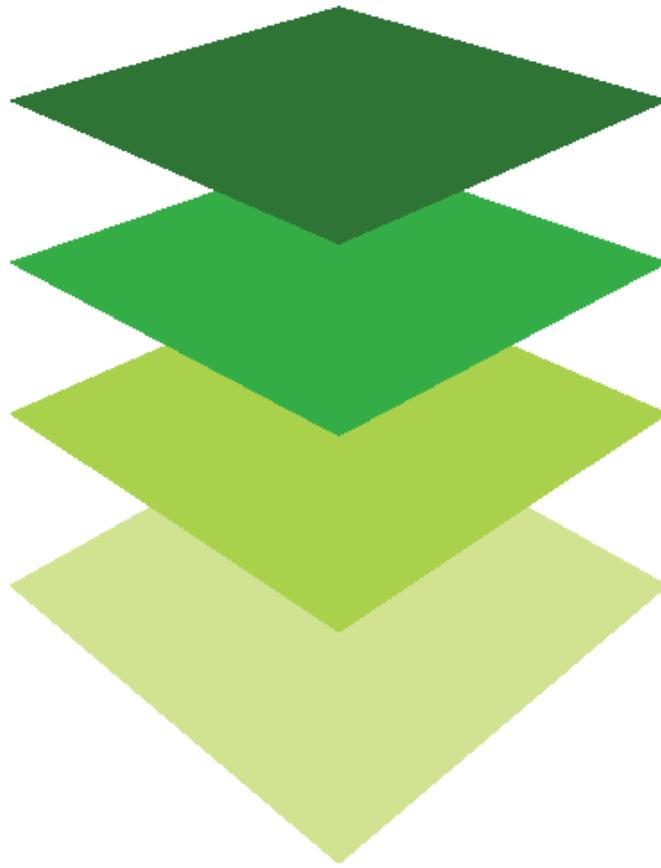
Measuring fires

For 50 years, the Landsat Program has been monitoring the Earth. Landsat imagery can be used to monitor and assess the extent and severity of wild fires and as a baseline to monitor vegetation recovery.

Your remote sensing company has been hired to create a series of lessons for a Massive Open Online Course (MOOC) being conducted for a global company. The group participating in the MOOC is global firefighters. The purpose of the lessons is to provide guidance about measuring burn areas from satellite imagery and displaying the burn scars most distinctly. You have chosen three fires for your exemplary study area:

- the Soberanes Fire in the Los Padres National Forest in Monterey County, California
- the Gibson Desert fire in Western Australia
- the fires on the Portuguese Island of Madeira

Build skills in these areas

➢ Filtering a temporal database of Landsat satellites
➢ Identifying before and after fire location
➢ Digitizing and calculating area from imagery
➢ Calculating and displaying the Normalized Burn Ratio (NBR) to define the severity of a burned area

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

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1. The Soberanes Fires in Monterey County

The Soberanes Fire started on July 22, 2016, from an illegal campfire and lasted until October 12, 2016 (82 days), burning approximately 132,127 acres. Normalized Burn Ratio (NBR) maps were used to map the spatial distribution of the fire's effects on the ground.

Locate the fire

1. Sign into your ArcGIS online organizational account.
2. Click Map on the upper ribbon.
3. Search for Los Padres National Forest.

4. Click Details and Show Contents of Map.
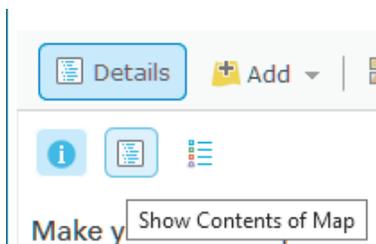
5. Click Add and Search for Layers.

6. Use the following parameters for the Search interface:
   a. Find: Soberanes_Perimeter
   b. In ArcGIS Online
   c. Uncheck Within map area

Home ▼ My Map

Details | Add ▼ | Basemap

Search for Layers

7. Click DONE ADDING LAYERS.

Search for Layers

Find: Soberanes Perimeter   GO
In: ArcGIS Online   ▼
☑   Within map area
2 Results Found

Soberanes Fire Impact Summary for Aug
by calema_gis   Add

Soberanes_Perimeter
by Kathryn_Keranen_LearnArcGIS Add
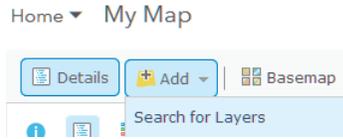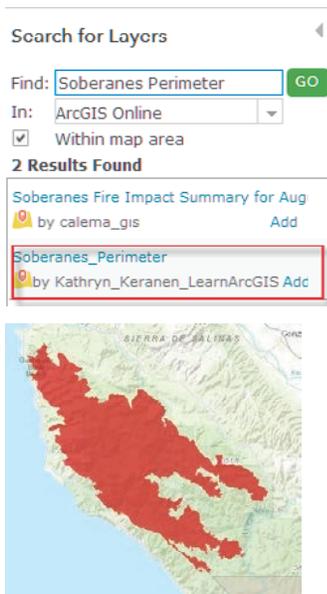
8. Click the Save As icon on the top ribbon and complete the metadata.

Save

Save As

Save Map

Title: Soberanes
Tags: LearnResourceIMG ✕ Add tag(s)
Summary: Soberanes Fires
Save in folder: Kathryn_Keranen_LearnArcGIS   ▼

SAVE MAP   CANCEL
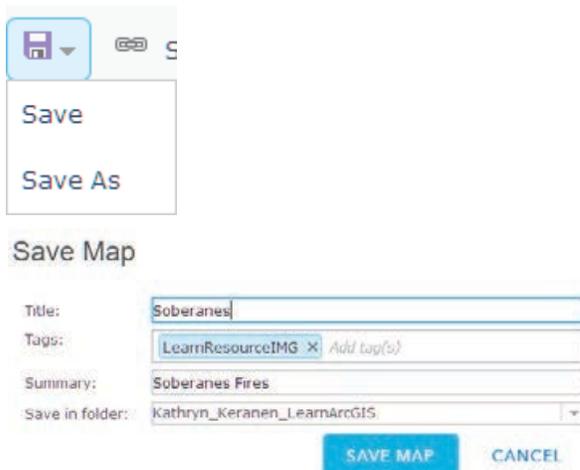
9. Click SAVE MAP.

Landsat Imagery before and after the fire

The Landsat satellite takes a picture of the same place on earth every 16 days. The Soberanes Fire started on July 22, 2016, around 8 a.m. and lasted until October 12, 2016. You will look at a Landsat image taken on June 20, 2016 or before the fire and one taken on August 30, 2016, after the fire started.

1. Click Add.
2. Click Search for Layers and enter the following:
   - Find: Landsat 8 Views
   - In: ArcGIS Online
   - Uncheck: Within map area
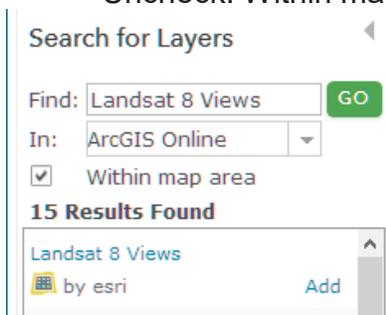
3. Add the Landsat 8 Views and clear the checkmark.
4. Click DONE ADDING LAYERS.

   You now need to filter to show a Landsat image before and after the fire.

5. Click Landsat 8 Views Filter.
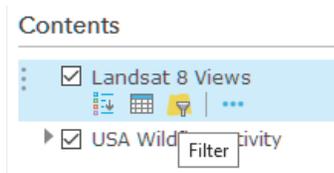
6. Click Edit and enter the following expression:
   Acquisition Date is on 06/20/2016.
7. Click APPLY Filter.
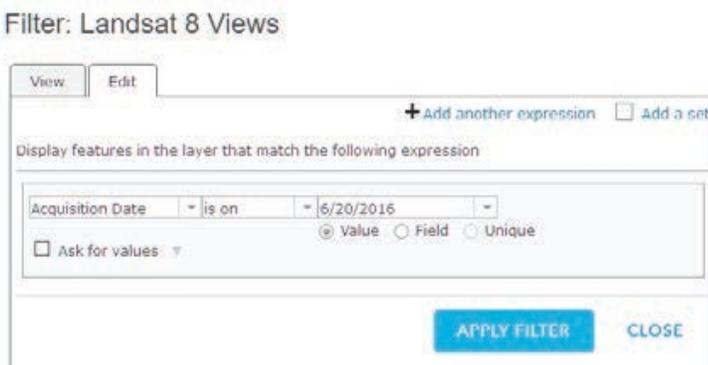
The default display for the Landsat is Agriculture with DRA that shows vigorous vegetation as bright green and stressed vegetation as dull green. Stressed vegetation is caused when factors reduce plant metabolism. As you can see, the vegetation is mostly bright green.

It is useful to look at the image using another display.

8. Right-click Landsat 8 View. Select More Options and go to Image Display.
9. Select Color Infrared with DRA.
10. Click APPLY.

Image Display ◀

Set image display for: Landsat 8 Views

Renderer

Color Infrared with DRA   ▼

In this display, healthy vegetation is bright red while stressed vegetation is dull red.

11. Click Image Display again and change back to Agriculture.
12. Click Landsat 8 Views and go to Rename
13. Rename the Landsat 8 View as Pre-Soberanes Fire.
14. Click Add.
15. Select Search for Layers.
16. Add Landsat 8 Views again.
17. Rename the Landsat 8 Views Post-Soberanes Fire.

18. Click Post-Soberanes Fire and go to Filter.
19. Click Edit.
20. Change date to 10/17/2016.
21. Click APPLY FILTER

You now have images showing pre and post Soberanes Fire.

22. If you change the Image Display to Color Infrared, the fire is even more visible than displayed as Agriculture.

Determine the fire area

You can use the map to determine the area of the fire.

1. Click Measure to display the Measure toolbar and select acres and the polygon tool.
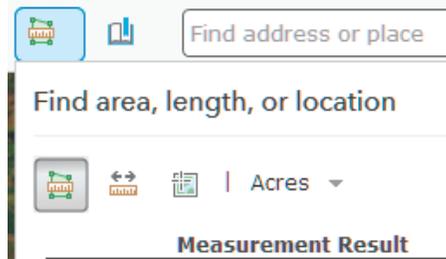
2. To measure the fire, click Area and click the map once for every vertex of the area you want to measure. Double-click to complete the area.
3. As mentioned, approximately 132.127 acres were burned. How does the area you obtained from digitizing the fire compare? Answers + or – 2% are acceptable.

Calculate burn index to show severity

The Normalized Burn Ratio (NBR) calculates and shows the severity of a burn. The NBR equation is calculated from reflectance with high numbers indicating high severity of burn and lower numbers signifying low- severity of burn.

1. Click the Post-Soberanes Fire and select Image Display.
2. Under Rendered select NBR Raw.
3. Click APPLY.
4. Click CLOSE.
The legend shows burn severity from low to high.

2. The Gibson Desert Fire in Western Australia

The Gibson Desert covers a large part of the dry portion of Western Australia. It is characterized by thin desert grass and red sand dunes. Fires that occur in the area burn the desert grass and the burn scars are recognized from satellite imagery. Landsat 8 acquired an image of a burn scar on November 19, 2015. Using the workflow, you followed to analyze the Soberanes Fire, analyze the Gibson Desert Fire.

Locate the fire

1. Click Create New Map.
2. Change the Basemap to Imagery with Labels.
3. Locate the fire by typing the longitude and latitude of the fire in the search box.
   Longitude: 127.859769
   Latitude: -23.284888
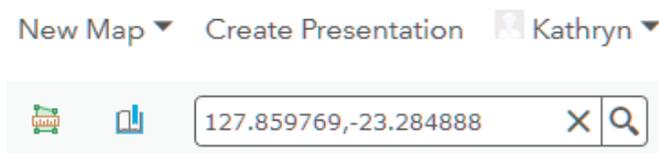
4. Click Add to Map Notes.
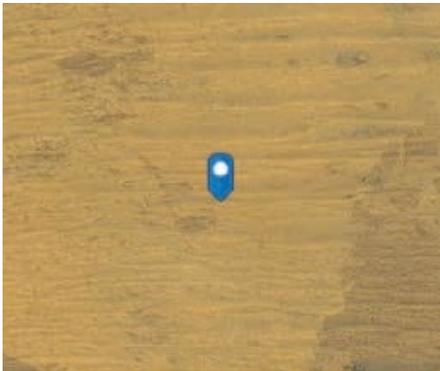
Landsat Imagery before and after the fire

1. Add Landsat 8 Views.
2. Filter the Landsat for the pre-fire to Acquisition Date 10/17/2015.
3. Name the feature service Pre-Gibson Fire.
4. Add Landsat 8 Views service again.
5. Filter the Landsat for the post-fire to Acquisition Date 09/01/2016.
6. Change the Image Display to Natural.
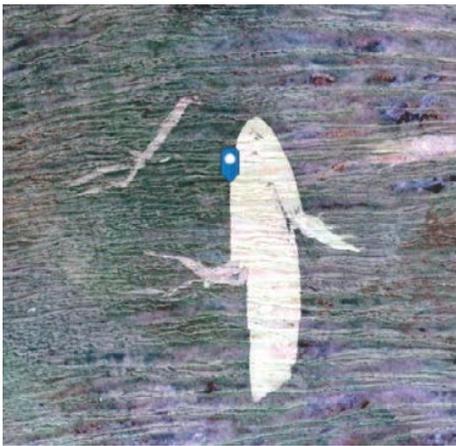
Determine the fire area

Us e the measure tool to draw a polygon and determine the area of the fire in acres.
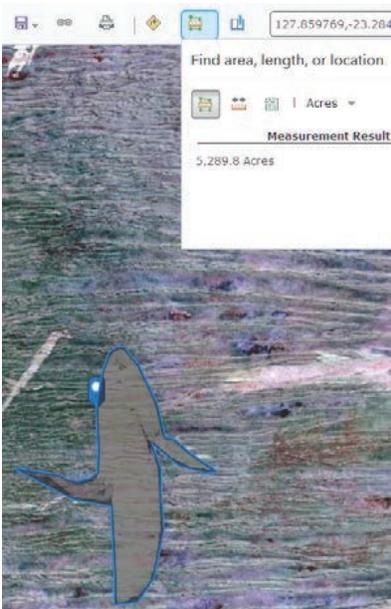
Calculate burn index to show severity

1. Change the Image Display to the Normalized Burn Index (NBR).
2. Add a Stretch Type to Standard Deviation. The stretch functions manipulates the digital values in an image to enhance the display.

3. The fires on the Island of Madere, Madeira, Portugal

Locate the fire

In August 2016, deadly wildfires raged on the Portuguese Island of Madeira. The blaze reached the island's largest city of Funchal, killing three people. Using the workflow, you followed to analyze the Soberanes Fire and Gibson Desert Fire, analyze the fires in Portugal.

1. Create New Map.
2. Change the Basemap to Imagery with Labels.
3. Locate Madere, Madeira, Portugal using the search box.

Landsat Imagery before and after the fire

1. Add Landsat 8 Views.
2. Filter the Landsat for the pre-fire to Acquisition Date is 06/08/2016.
3. Name the feature service Pre- Madere.
4. Add Landsat 8 Views service again.
5. Filter the Landsat for the post-fire to Acquisition Date 08/11/2016.
6. Change the Image Display to Natural Color with DRA.
7. Change the Image Display to Color Infrared with DRA.

D etermine the fire area

Calculate burn index to show severity

1. Change the Image Display for 08/11/2016 to the Normalized Burn Index (NBR).
2. Add a Stretch Type of Standard Deviation.
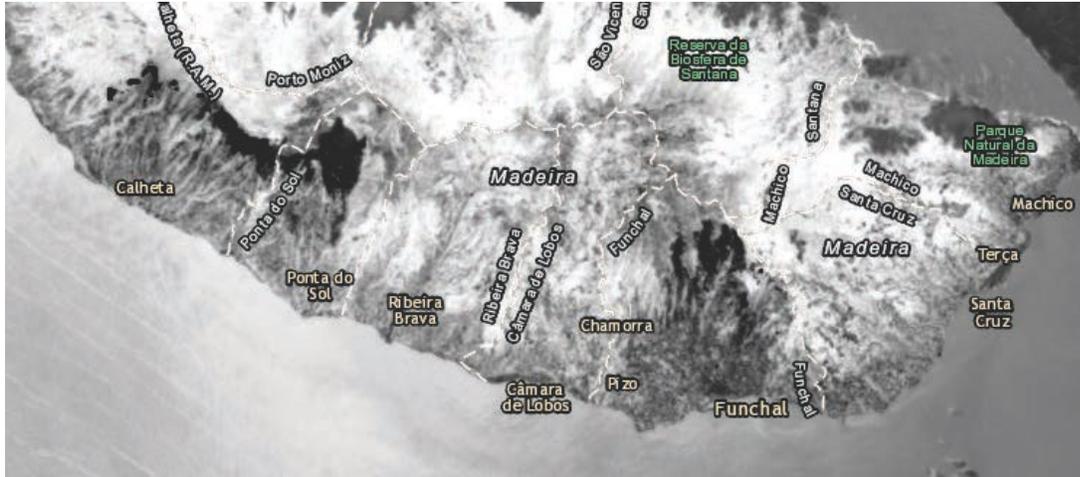
In this lesson, you have identified and displayed Landsat 8 images before and after a fire. You have calculated the area of the fire and shown the image as a burn index to indicate burn severity.

Zaatari refugee camp

The United Nations High Commissioner for Refugees is looking for information about the Zaatari camp. They would like to determine information about the area of habitation for the refugees starting from 2012 when it opened to the present.

In the following activity, you will find the Zaatari refugee camp, identify features, and calculate the area of the camp.

Build skills in these areas

- ➢ Use various types of imagery
- ➢ Calculate area from imagery
- ➢ Determine the average camp size per person in square meters

What you need

- ➢ Account not required
- ➢ Estimated time: under 30 minutes

Although refugee camps are defined as temporary settlements built to accommodate displaced people, the United Nations has had a refugee agency called the United Nations High Commissioner for Refugees (UNHCR) for 66 years. The purpose of this organization is to protect the rights of refugees. It was created in 1950 to help millions of European refugees. Since then, the organization has tried to set standards for planned settlements or refugee camps. The UNHCR has set standards to determine the adequacy of refugee camps.

One of the standards is indicated by the average camp area per person in square meters. A range of 45 to 35 square meters is acceptable, 34 to 30 square meters is unacceptable, and 29 square meters or less is critical. In the following activity, you will investigate the Zaatari refugee camp in Jordan, which was first opened in July 2012. It is a holding place for Syrian refugees and has had an up-and-down population from 2012 to today. Below is a table recording the number of yearly inhabitants in the Zaatari camp since 2012.

Date	Refugees
2012	15,000
2013	76,000
2014	79,000
2015	84,000
2016	80,000
2017	78.425

These figures were taken from Syria Regional Refugee Response Inter-agency Information Sharing Portal.

1. Locate Zaatari refugee camp

1. Go to ArcGIS.com
2. On the upper ribbon, click Map.
3. In the upper-right corner, click Modify Map.
4. Under Details, click Show Contents of Map.
5. On the top ribbon click Basemap and select Imagery with Labels.

2
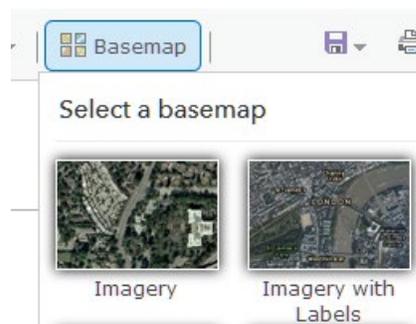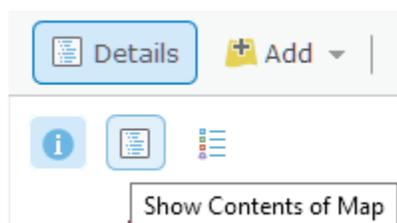
6. In the upper-right search box, search for Jordan.
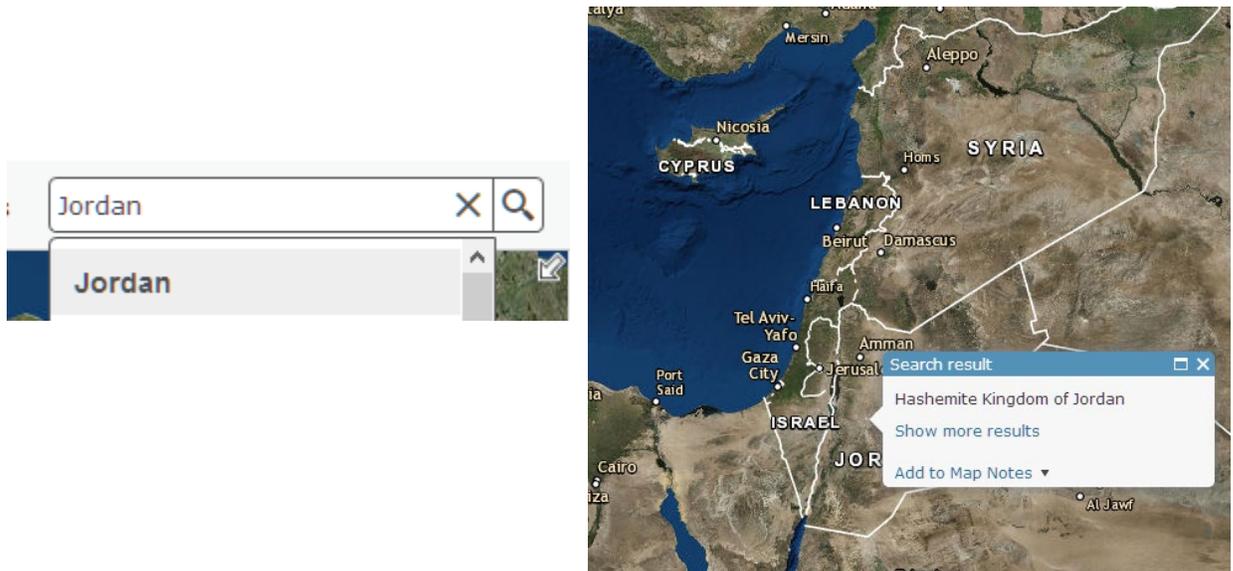
7. Once again in the search box, search for Mafraq. Mafraq is the capitol city of the Mafraq Govermorate in Jordan.

In this image you can see an airstrip and the city of Mafraq. You can also see the Zaatari refugee camp.

2. Measure area of Zaatari refugee camp

You are now ready to tackle the initial problem of deciding if the refugee camp meets the standards of occupation set by the UNHCR. As a reminder below are the standards set for occupation:

- 45-35 square meters is acceptable

- 34-30 square meters is unacceptable

- 29 or less square meters is critical

1. Zoom in so the refugee camp is visible.
2. Click Measure to display the Measure toolbar and select Sq. Meters and the polygon tool.
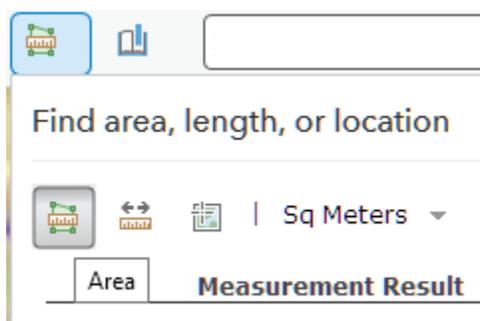
3. To measure the camp, click Area and click the map once for every vertex of the area you want to measure. Double click to complete the area.
4. Record the area in square meters in the table below.

You are now ready to compile your information. To calculate the number of refugees per square meters use the following formula:

Square meters/Refugees = Square meters per Refugee

Referring to the UNHCR guidelines above rate the condition of the camp in the table below.

Date	Refugees	Square Meters/Refugee	Condition
2012	15,000		
2013	76,000		
2014	79,000		
2015	84,000		
2016	80,000		
2017	78,425		

3. Use Landsat 8 Imagery

Another source or imagery that can be used is the Landsat 8 satellite images. The Landsat 8 satellite images the entire Earth every 16 days. For more information on Landsat 8 visit the website below.

Landsat 8

1. On the top ribbon click Add and Search for layers.
2. Search for Landsat 8.
3. Add Landsat 8 Views to the map.
4. Click DONE ADDING LAYERS.
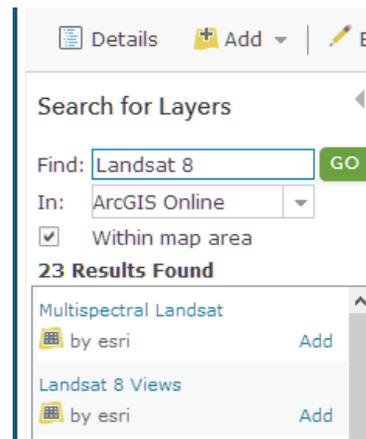
You can change the image display by using a predefined template or setting the band combination and stretch parameters. The band combination allows you to specify which band are displayed using the red, green, and blue color composite scheme. The different color combinations display your imagery with various color effects. You can display your data in natural color which displays the layer as you would normally see it, or you can use color combinations that highlight vegetation, urban areas, water, and other features.

5. Click on Landsat 8 Views and go to Image Display.
6. Under the Rendered Tab select the various displays to view.
7. Click APPLY after each selection.
8. Click on the Landsat image to see the Date of Acquisition.

5
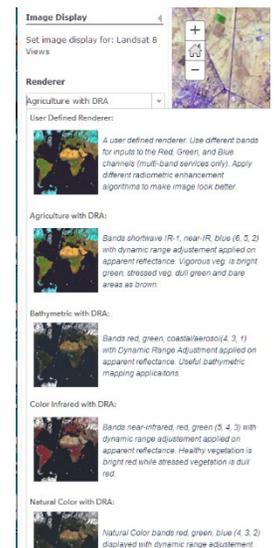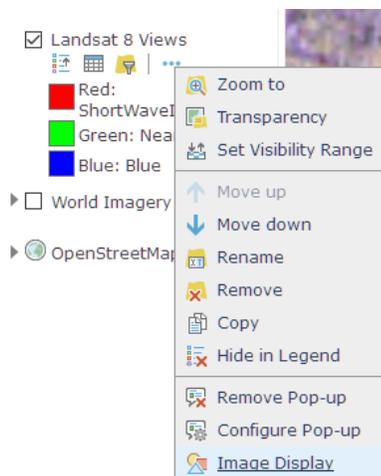
4. Use OpenStreetMap basemap

There are other basemaps that can be used to help you visualize. The OpenStreetMap is a free, editable map produced by an open collaborative project. Volunteers gather location data using GPS, local knowledge, and other free sources of information and upload it. For more information visit OpenStreetMap.

1. Click Basemap on the top ribbon and choose the OpenStreetMap.
2. Click Add and search for Zaatari in ArcGIS online.
3. Add the following:
   - Zaatari Shops Facilities – facilities
   - Zaatari Shops Facilities – businesses
   - Zaatari Shops
   - Zaatari Hospitals and Clinics
   - Zaatari Community Spaces
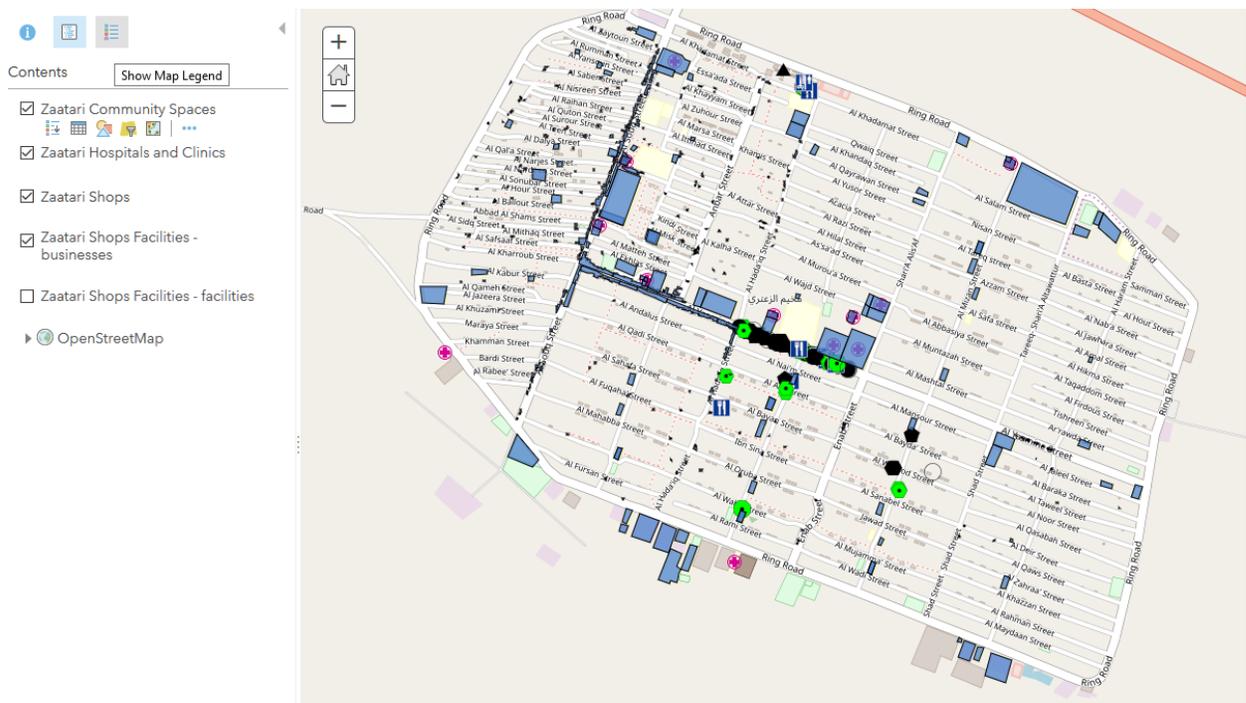
In this lesson you have used imagery to obtain quantitative data for analysis to support decisions.

Learn more

How to Measure in ArcGIS Online

7

Mid Term Elections 2018

Elections require long and costly preparation. Because of this, extensive planning is required to designate where to geographically campaign based on variables of voter interest. Results from previous elections can be used to analyze geographical areas for intense campaigning. Elections are held for national, state and local areas.

Your GIS team has been selected to use historical data to analyze voting patterns and predict where the political parties need to concentrate their money and time to the best advantage for the 2018 elections.

You have been contracted by both the Democrats and the Republicans, so you must analyze the data objectively.

You need to present a series of analytical political maps that show both historical trends and predictions of future campaigns. Each map must be accompanied by an explanation, and other media is allowed. The maps must be presented in a story map format.

Build skills in these areas

- ➢ Use predominant mapping
- ➢ Filter and use map notes
- ➢ Create a tabbed story map

What you need

- ➢ Account required
- ➢ Estimated time: over 1 hour
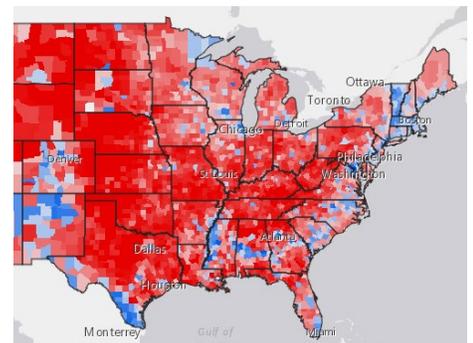
1. USA Level Map 01

The purpose of this map is to show which states changed voting affiliation between 2012 and 2016.

1. Open Mid-Term Election 2018 and save into your organization. Save as **01 Election 2016 Swing States_your initials**. Add appropriate metadata. Remove the existing tags and add individualized tags.
2. Click Details and Content to show the layers in the content pane.
3. Check the USA States 2012 Election.
4. Click the Change Style icon under USA States 2012 Election. Choose the attribute F2012_elec.
5. Click OPTIONS and right click on the red square beside Obama and change to blue. Click the blue square beside Romney and change to red. Click OK and DONE.
6. Next Click the States 2016 Election and change the style using the attribute Win2016S. Click Done.

    The color of the states that changed from blue to red can be seen on the map. To make the states that changed move visible add to map notes.

7. In the upper right search tab search for each name of the six states that have changed and add a map note.
8. Save.
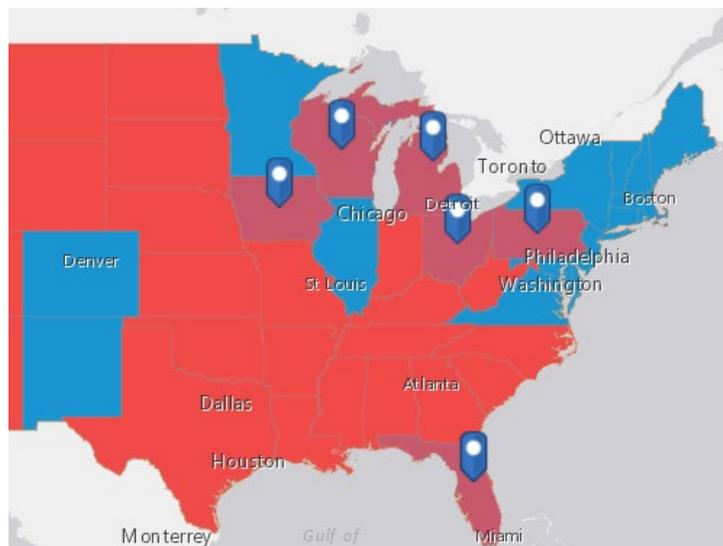
Q1. Do some quick research and explain the reason that was given for these changes. Write the explanation in the description of your map so it will be easily

accessible.

2. USA Level Map 02

In this section the spatial variation of voting in the 2016 election using county level data is shown. Use predominant mapping to display the data. Predominant mapping compares attributes that share a common subject and unit of measurement to see which has the highest value. Color shows the predominant category, and transparency shows the strength of the attribute.

1. Open Mid_Term Election 2018 and save into your organization as **02 USA Counties Election 2018_your initials**. Add appropriate metadata. Remove the existing tags and add individualized tags.
2. Turn on Counties 2016 Election.
3. Click the style icon under Counties 2016 Election.
4. Choose an attribute: %GOP.
5. Add attribute and choose %DEM.
6. Choose Predominant Category>>SELECT.
7. Click OPTIONS.
8. Click the square color box by %GOP and change to red.
9. Click the square color box by %DEM and change to blue.
10. Click OK and DONE.
11. Click on USA States (Generalized) and move the layer above Counties 2016 Election.
12. Click the change style icon under USA States Generalized and choose OPTIONS.
13. Click Symbols and change FILL to be no color and OUTLINE to be black.
14. SAVE.
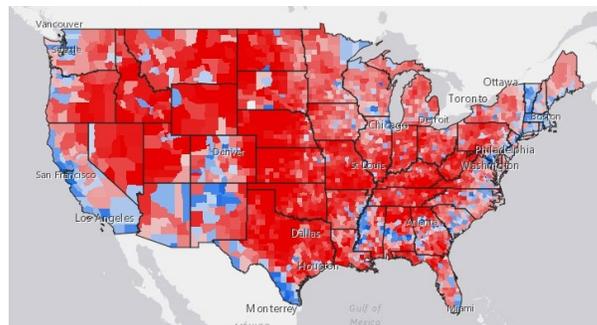
Q2 Write an analysis of the voting trends of the USA. Within this analysis name some states that would be beneficial for a Republican to campaign, a Democrat.

3. State Level Map 03

In the following section analysis will be done at a state level. The state of Virginia is to be used as an example. After completing the example state other states can be selected to analyze.

1. Save the **02 USA Counties Election 2016_your initials** as **03 Virginia_your initials**. Add appropriate metadata. Remove tags and add individualized tags.
2. Click the filter icon under Counties 2016 Election and create the expression:

    State is Virginia
3. APPLY FILTER.
4. Zoom to the state of Virginia.
5. Save.

Q3 Write an analysis of the voting trends in Virginia by counties. Within this analysis name some counties that would be beneficial for a Republican to campaign, a Democrat.

4. State Level Map 04

A congressional district is a geographic designation that elects a single member of a congress. There are 435 congressional districts in the United States House of Representatives. Districts are often drawn and redrawn by state governments. When districting becomes politicized, gerrymandering enters the picture. Gerrymandering is defined as the manipulation of boundaries to favor one party or class. It is the way that one political group tries to change a voting district to create a result that helps them or hurts the group who is against them. Two layers have been provided to show how congressional districts have changed: USA 114 Congressional Districts and USA 115 Congressional Districts.

1. Save **03 Virginia_yourinitials** as **04Virginia Districts_yourinitials**. Add appropriate metadata. Remove tags and add individualized tags.
2. Under USA 114th Congressional Districts filter for:

    State is VA
3. APPLY FILTER.
4. Under USA 115 Congressional Districts filter for:

    STATEFP is 51
5. APPLY FILTER.

Using various techniques of styling and filtering identify the five districts that have changed.

6. Save.

Q4 List the Congressional Districts that have changed.
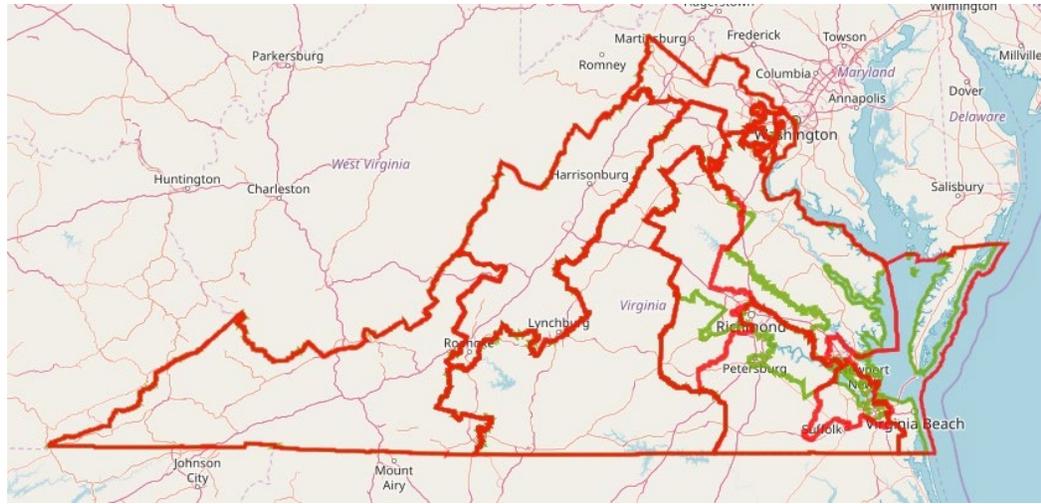
5. State Level Map 05

Use predominant mapping to show how Congressional Districts voted in the past.

1. Save **04 Virginia Districts_yourinitials** as **05 VA Districts Voting_your initials**. Add appropriate metadata. Remove tags and add individualized tags.
2. Click change style under USA 115 Congressional Districts. Choose the attribute: Clinton 2016.
3. Add attribute and choose Trump 2016.
4. Choose Predominant Category>>SELECT.
5. Click OPTIONS.
6. Click the square color box by Trump 2016 and change to red.
7. Click the square color box by Clinton 2016 and change to blue.
8. Click OK and DONE.

9. Save.

Q5 Write an analysis of the voting trends in Virginia by congressional districts.
Q6. What districts would you have the most success campaigning to switch to Democrat? To Republican?
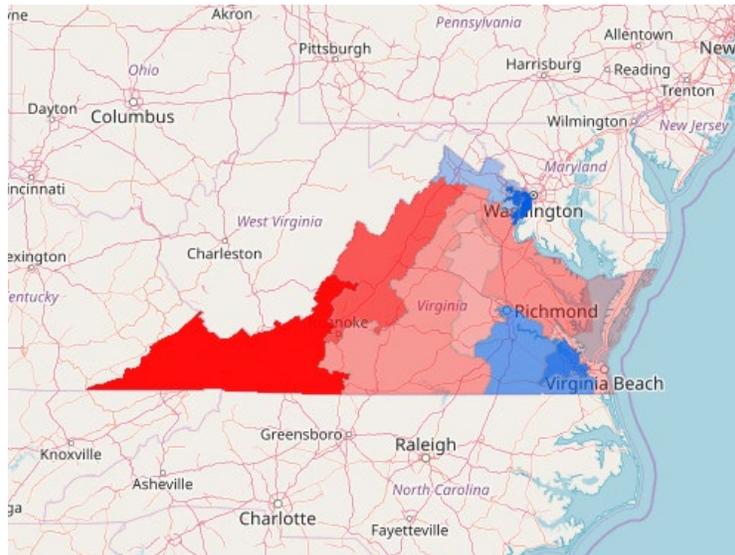
6. Local Precincts and Voting Polls Map 06

A precinct is generally the lowest-level governmentally related division in the United States, and in that context is also known in some places as an election district. The US Census uses the term voting district. A polling place is where voters cast their ballots in elections. Placement of polling stations can have an influence on voter turnout. The geographic location of precincts and voting places have been recognized as major factors in voter turnout.

The following exercise deals with polling precincts and voting places in Fairfax County, VA. This exercise can be duplicated to your individual state precincts and polling places.

1. Open Mid Term Election 2018 Fairfax and save into your organization. Save as **06 Fairfax Precincts and Polling Places_yourinitials**. Add appropriate metadata. Remove the existing tags and add individualized tags.

   It would be interesting to find out how many of the polling places were within a 3-minute drive-time radius of the polling place.

2. Under Polling Places click the icon Perform Analysis.
3. Choose Proximity>>Create Drive-Time Areas.
4. The point layer is Polling Places and the driving time is 3 Minutes.
5. Uncheck Use current map extent.
6. RUN ANALYSIS.
7. Done.
8. Click the Change Style icon under Voting Precincts.
9. Click OPTIONS>>Symbols.
10. Select No Color for Fill and make the Outline Black 2 pt.
11. Change the Basemap to OpenStreetMap.

Q7 Identify any geographic areas of Fairfax County that need more polling places.
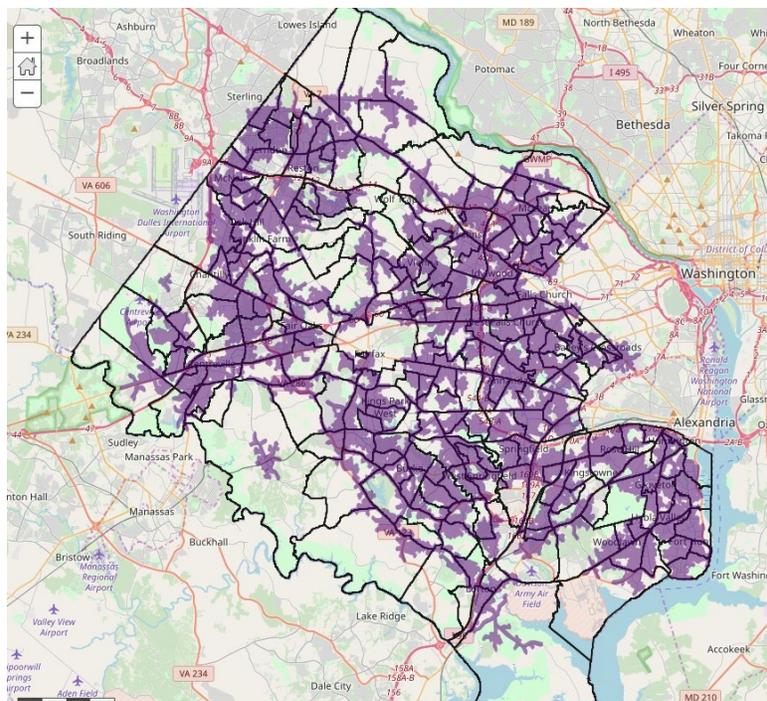
7. Story 07 Web Map Application

Esri Story Maps let users combine maps with text, images, and multimedia content. This following section creates a story map from the six maps that have been made to investigate national, state, and local politics.

1. Go to Content and click **01Election 2016 Swing States_yourinitials** and open the map.
2. On the top ribbon click Share>>CREATE A WEB APP.
3. Click Build A Story Map>>Story Map Series.
4. Click CREATE WEB APP.
5. Title: 2018 Mid Term Election Analysis.
6. Remote the tags and add individualized tags.
7. DONE.
8. Select Tabbed and START.
9. Click the blue arrow to advance.
10. Tab title should be: Swing States in the 2016 Election.
11. Select the 01 Election Swing States Map.
12. ADD.
13. Add descriptive text on the left side panel. Also add any appropriate media.
14. Click Add to continue the map series. Continue adding maps and explanatory text until all seven maps have been added to the story map.
15. SAVE.
16. Launch.

In this exercise political data at a national, state, and local level has been analyzed. The results have been displayed as a Story Map.

Breaching the Swine Lagoons

Hurricane Florence and the North Carolina Hog Industry

Hurricane Florence made landfall just south of Wrightsville Beach, North Carolina on September 14, 2018. It landed as a category 1 storm, but its slow movement created torrential rain and flooding. The NC streams flooded for days and caused the worst damage to NC hog farms in nearly two decades, with more than 5,000 animals dying and several dozen waste lagoons releasing pollutants into waterways. FEMA is under pressure to identify and map hog farm lagoons that could be breached after historic flooding. They have asked your GIS department to create maps showing total lagoons by county and lagoons located within a 1-mile buffer of NC rivers.
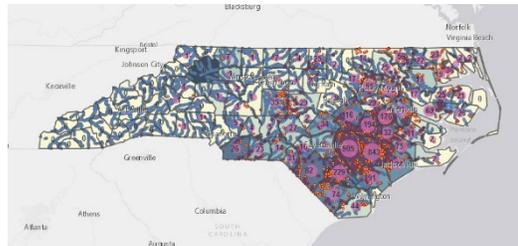
Build skills in these areas

➢ Style by natural break
➢ Create buffers
➢ Intersect layers
➢ Summarize within
➢ Create heat maps

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hour

Teacher Resources

➢ North Carolina Pig Farms Video Essay

Publication Date: Feb 2019

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1. North Carolina and Contained Feeding Operations

A CAFO is defined as a concentrated animal feeding operation that confines animals for more than 45 days in an area that does not produce vegetation.

1. Sign into your ArcGIS online account.
2. Click NC Hog Farming.
3. Save in your organizational with appropriate metadata.
4. Click Change Style under CAFOs NC.
5. Choose CAFOs as the attribute.
6. Click DONE.
7. Save.

Q1 Where are the most CAFOs located within the state of NC?

2. Summarize Swine Lagoons by County

An anaerobic lagoon or manure lagoon is a man-made outdoor earthen basin filled with animal waste that undergoes anaerobic respiration as part of a system designed to manage and treat refuse created by concentrated animal feeding operations (CAFOs). Anaerobic lagoons are created from a manure slurry, which is washed out from underneath the animal pens and then piped into the lagoon. Sometimes the slurry is placed in an intermediary holding tank under or next to the barns before it is deposited in a lagoon. During floods the lagoons are extremely vulnerable to overtopping which happens when the water goes over the top releasing the animal waste into the environment. FEMA has asked for a map with the number of lagoons totaled for each county.

1. Check NC Swine Lagoons.
2. Click the perform analysis button under NC Swine Lagoons.
3. Click Summarize Data>>Summarize Within.
4. Choose CAFOs NC as the polygon layer.
5. Choose NC Swine Lagoons as the layer to summarize.
6. For Result layer name: Number of Lagoons in Each County_yourinitials.
7. Uncheck Use current map extent.

8. RUN ANALYSIS.
9. Right click the Number of Lagoons in Each County_your_yourinitials, and select Create Labels.
10. Label features by Count of Points.
11. OK
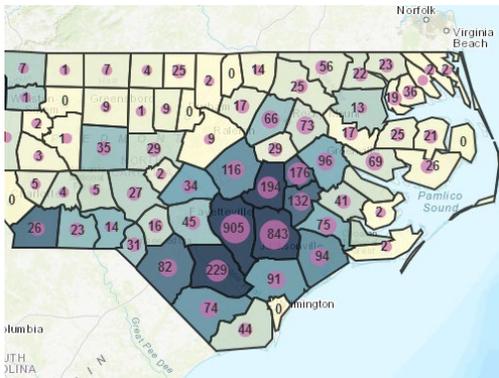
3. Buffer Streams and Rivers 1 Mile

There was a mandatory evacuation for all residents within one mile of the banks of the Cape Fear River. In the following exercise a 1-mile buffer around all the streams in NC will be created.

1.Under USA River and Streams click on Perform Analysis.
2. Use Proximity>>Create Buffers.
3. USA Rivers and Streams is the layer to buffer.
4. Buffer size is 1 mile.
5. Click Options>>Dissolve.
6. Result name should be: Buffer 1 mile_your initials.
7. Uncheck Use current map extent.
8. RUN ANALYSIS.
9. DONE.

4. Intersect Swine Lagoons with Buffers

FEMA is only interested in the swine lagoons that are within the 1-mile flooded area. In order to isolate those lagoons, intersect the buffered layer with the swine lagoons. This will produce a layer that only has features that overlap each other.

1. Click perform analysis under Buffer of USA Rivers and Streams.
2. Manage Data>>Overlay Layers.
3. Choose Swine Lagoons for the input layer.
4. Choose Buffer of USA_Rivers_and_Streams for the overlay layer.
5. Choose Intersect for the overlay method.
6. Output: Points.
7. Name the resulting layer: Endangered Lagoons_yourinitials.
8. Uncheck Use current map extent.
9. RUN ANALYSIS.

In this lesson you have analyzed swine lagoons in North Carolina by proximity to streams and rivers.

China in Layers

Your company is introducing online GIS into its suite of tools that beginning employees must know to compete in today's workplace. They have asked you to create an online lesson that introduces their employees to GIS. The main focuses of the lesson should be to investigate different types of data, use analytical functions and explore basemaps.

Build skills in these areas

- Opening, saving, and navigating an existing online map
- Interpreting legends
- Filtering and classifying data
- Locational data: geocoding, and x,y (longitude, latitude) data
- Using map notes
- Using basemaps

What you need

- Account required
- Estimated time: 30 minutes to 1 hour

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1. Opening, saving, investigating

Opening and saving

1. Sign into your ArcGIS online account.
2. Click China Layers.
3. Click the Save As icon on the top ribbon.

4. Enter the following metadata:
    *   Title: China Layers_yourinitials
    *   Tags: your school name, your last name

5. SAVE MAP.
6. Practice moving around the map: zoom in, zoom out, pan.
7. Click Content to show all the layers in the Content Pane.

2. Filtering and Classifying

Filtering

Our study is about China. Select and filter out China so the study area is defined. A filter presents a focused view of a feature layer in a map. Only the features that meet the filter criteria appear on the map.

1. Select the filter icon under World Countries.
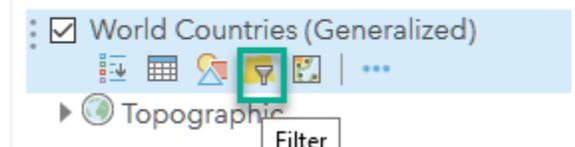
2. Construct the following expression:

Country is China (Choose Unique)
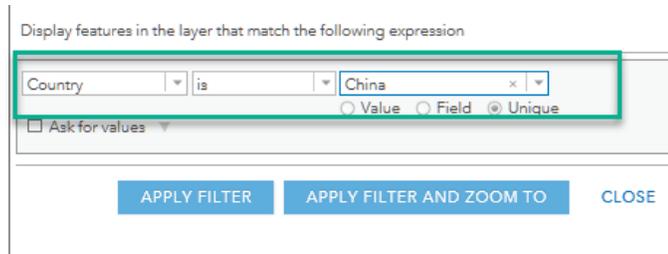
3. APPLY FILTER.

For this lesson's purpose, it would be best if China was represented by just an outline.

4. Click the Change Style icon under World Countries (Generalized).
5. Click OPTIONS.
6. Click Symbols
7. Fill is selected. Change the color to No Color.
8. Click Outline and change color to dark Purple with a size of 2.
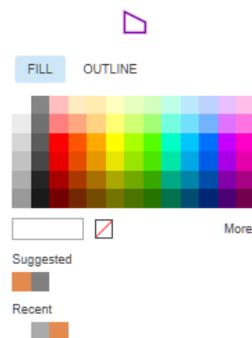
9. Click OK.
10. Click DONE.

Styling/Classifying

1. Turn on China rivers by checking the box.
2. Click Change style under China rivers.
3. Click OPTIONS>>Symbols.
4. Change color to Dark blue.
5. Click OK.
6. Click DONE.
7. Turn on China roads by checking the box.
8. Click Change style under China roads.
9. Click OPTIONS>>Symbols.
10. Change color to black.
11. Click OK.
12. Click DONE.
13. Turn on China admin. by checking the box.
14. Click Change style under China admin.
15. Under Choose an attribute to show, select Name.
16. Click OPTIONS.
17. Click the double tree icon to change all the administrative symbols.
18. Click OK.
19. Click DONE.
20. Click Save.
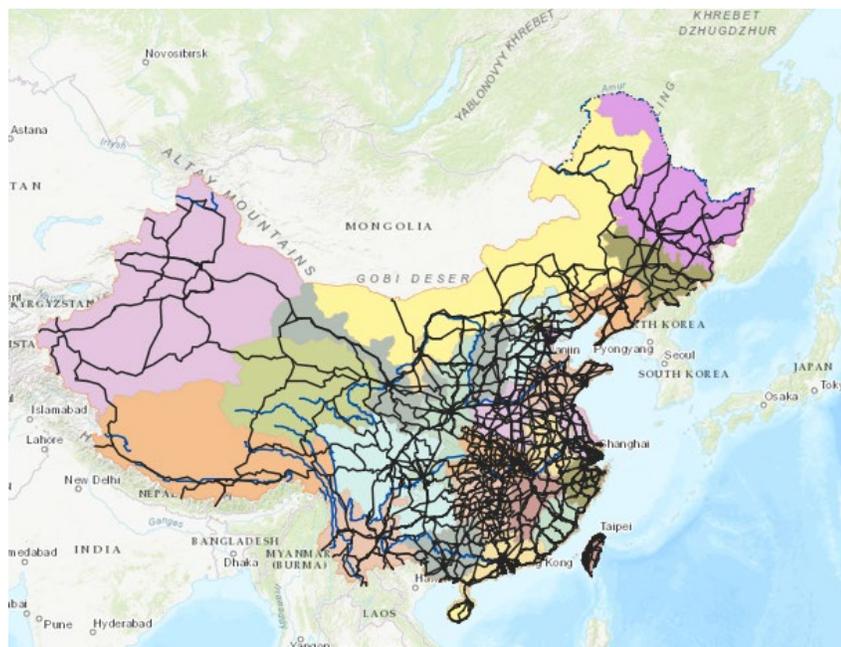
21. Turn on World Cities.
22. Select the Filter icon under the World Cities layer.
23. Construct the following expression.

              Country is China.

24. Click Change Style under the World Cities layer.
25. Choose Population as the attribute to show.
    This represents your numerical or ranked data. The larger the symbol, the bigger the data value.
26. Click DONE.
27. Click Save.
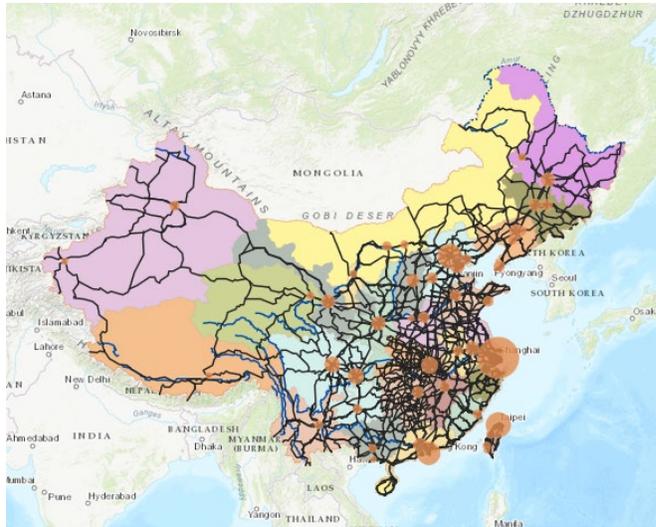
3. Location

This lesson focuses on the location of different features on the Earth's surface, as the unifying link in geospatial technologies. You do not have to rely on prepared or existing layers to enter data into your GIS system. You can add point data to your GIS map in different ways.

Using Locator Tab to Geocode

The ArcGIS software has a built-in World geocoder which allows you to type in an address and identify a location on the map. Beijing is the capital of China and Shanghai is the most populated city in China, as well as the world. Locate these cities using the Locator tab and the World geocoder.

1. Type Beijing, China in the Locator tab.
2. Click Add to Map Notes.
3. On the Top ribbon choose Bookmarks.
4. Add bookmark.
5. Title the bookmark Beijing.
6. In the locator tab type Shanghai, China.

7. Add to map notes.
8. On the Top ribbon choose Bookmarks.
9. Add bookmark.
10. Title the bookmark Shanghai.
11. Click Save.

x,y (longitude, latitude) data

Another way to add point data is to add specific longitude and latitude coordinates to identify a location. The Great Wall of China is one of the best known locations in China.

1. In the locator tab type 40.68,117.230003. This is the longitude and latitude of a point on the Great Wall of China.
2. Add to map notes.
3. Following the directions above, add a bookmark and name it Great Wall of China.
4. Click Save.

4. Basemaps

A basemap provides a background of geographical context for the content you want to display in a map. When you create a new map, you can choose which basemap you want to use. You can change the basemap of the current map at any time using the basemap gallery or specifying your own layer as the basemap.

1. On the upper ribbon select and experiment with different basemaps.
2. Use Imagery and Imagery with labels.
3. Use OpenStreeMap.
4. For each basemap, use the bookmarks you have made
to zoom to Beijing, Shanghai, and the Great Wall of China.
5. Click Save.
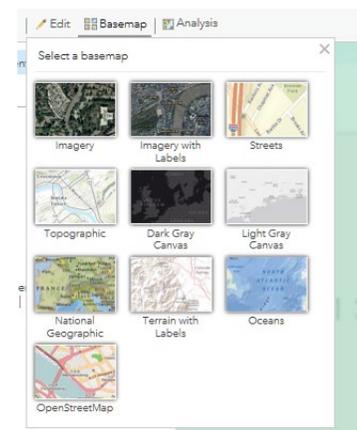
5. Skill Assessment and Map

Here are different ways to assess your work.

1. On screen assessment: students have their map shown on the screen for teacher evaluation.
2. Maps shared with organization: students share map with their organization for teacher to evaluate.
3. List of skills: students compile list of skills and explanation of skills to be handed into instructor. For example:
   zoom, pan, basemaps, filter, classification, map notes, x,y data, locator, bookmark, etc.

Learn more

Continue your GIS exploration.
- Select your administrative boundary.
- Locate your address.
- Locate your school.
- Change basemaps.
- Save as a unique map with appropriate metadata.
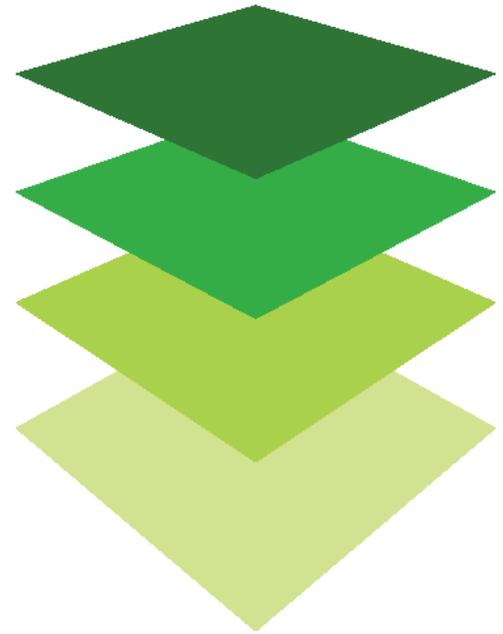
Hurricane Michael

Before and After Images of Destruction

It landed as a Category 4 hurricane which made it the first ever category 4 hurricane to land in that region. It was also the strongest storm of the season.

National Oceanic and Atmospheric Administration has provided imagery of the destruction of Mexico Beach, FL. Your office has been tasked to quickly create a storymap application that can compare the pre and post imagery.

Build skills in these areas

➢ Add a WNTS Service

➢ Make pre and post imagery maps

➢ Create a Swipe Map to compare

What you need

➢ Account required

➢ Estimated time: 30 minutes – 1 hr

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1. Obtaining the WMTS service from NOAA

A Web Map Tile Service (WMTS) delivers pregenerated georeferenced map images. The WMTS to be used in this exercise was acquired by the NOAA Remote Sensing Division to support NOAA homeland security and emergency response requirements.

1. Click on NOAA Emergency Response Imagery.
2. Click Hurricane Michael (2018).
3. Click About.
4. Click Web Services.
5. Copy the URL for the WMTS Service.
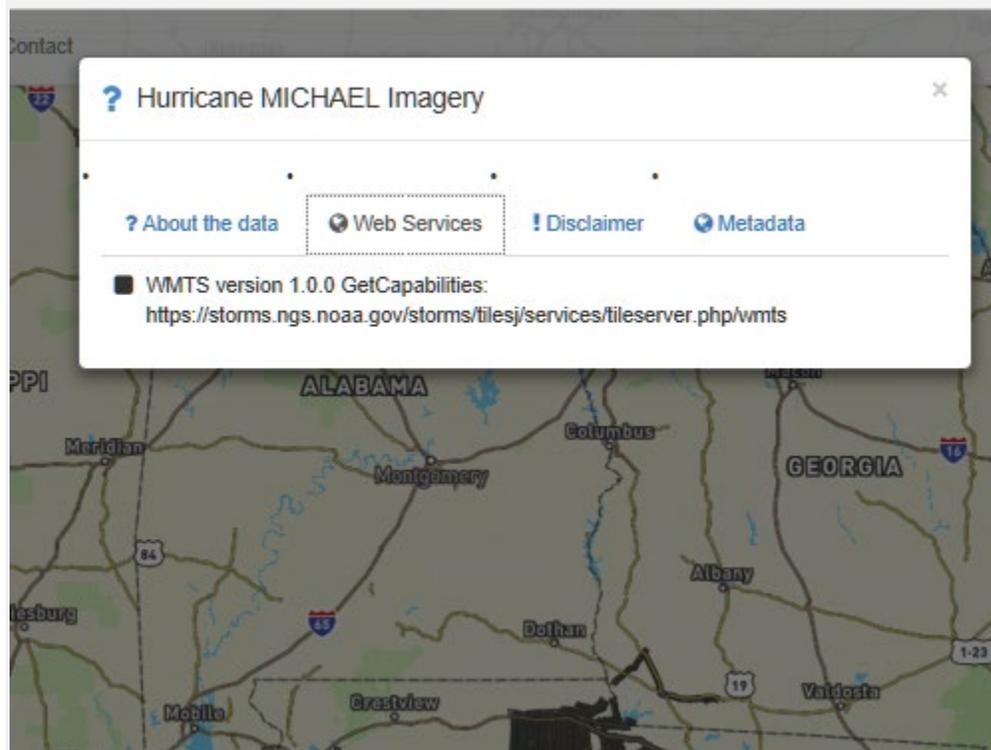
2. Preparing Pre-Hurricane Michael Imagery Map

Using Basemap imagery to prepare Pre Hurricane Michael Imagery Map.

1. Go to ArcGIS Online and sign into your organizational account.
2. Click Map.
3. In the locational box in the upper right corner search for Mexico Beach, FL
4. Add to Map Notes.
5. Change the Basemap to Imagery.
6. On the top ribbon save the map as Pre-Hurricane Michael_your initials. Add Appropriate tags and summary.

.
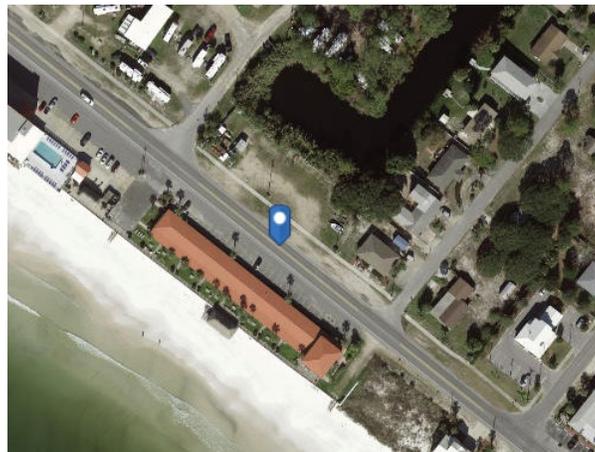
Q1 Write a paragraph describing the landscape of Mexico Beach before Hurricane Michael.

3. Preparing Post Hurricane Michael Imagery Map

Add the WMTS from NOAA to show Mexico Beach after Hurricane Michael came to shore.

1. On the top menu ribbon select Add.
2. Select Add Layer from the Web.
3. Select A WMTS OGC Web Service as the type of data referenced.
4. Copy and paste the WMTS URL obtained from NOAA in the first section of the exercise.
5. Click GET LAYERS.
6. Click Choose a Layer and select 20181011a_RGB.
7. ADD LAYER.

8. Save the map as Post Hurricane Michael_your initials.

4. Constructing a Swipe Map to Compare and Contrast

The Esri Story Map Swipe and Spyglass app template enables users to interact with two web maps. This is a perfect application for observing pre and post changes.

1. On the upper left go to Home and select Content.
2. Click and open Pre-Hurricane Michael.
3. Click Create Web App Using a Template.
4. Click Build a Story Map and select Story Map Swipe and Spyglass.
5. CREATE WEB APP.
6. Title: Pre and Post Imagery of Mexico Beach after Hurricane Michael.
7. Done.
8. Select Vertical bar layout and click Next.
9. Select Two web maps.
10. Click the magnifying glass and select the Post Hurricane Michael Map.
11. Click Next and Next again.
12. Type Pre Michael for the Left Map Header Title and Post Michel for the Right Map Header Title.
13. Click Open the app.
14. In the Tab on the left type information about Hurricane Michael.
15. SAVE.

Q2 Write a paragraph describing the landscape of Mexico Beach before and after Hurricane Michael. Be specific with details about structures that have been destroyed.

In this lesson you have used a Web Map Tile Service of post hurricane imagery to compare the damage done to Mexico Beach by Hurricane Michael.
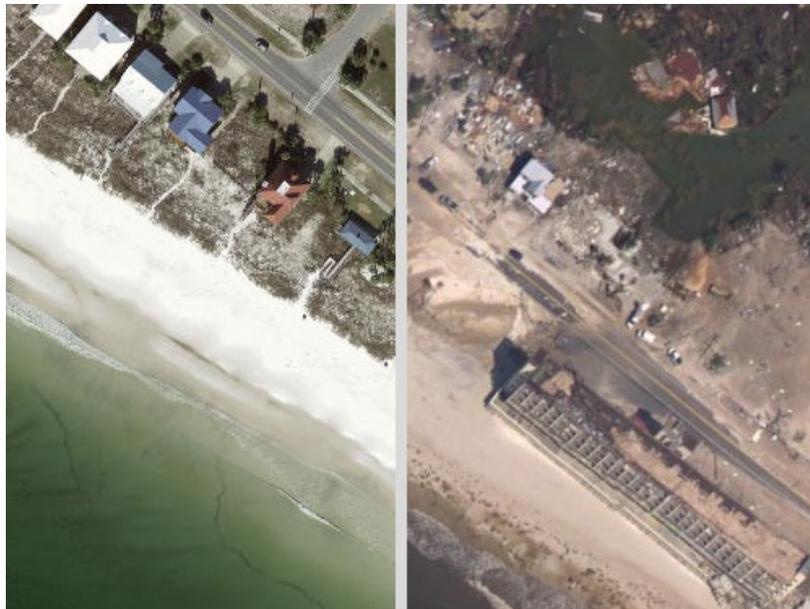
Learn more

Choose another event and create a swipe map.

Thailand's Rescue Cave Miracle
A race against time

On June 23, 2018 twelve boys between 11 and 17 years of age and their coach entered the Tham Luang cave to explore. The team was trapped in the cave by continuous rainfall. They were found and rescued by an international team that involved 100 divers and many countries. They were found on July 2 and were finally all rescued on July 11, 2018.
The International Community needs maps to describe the location of the caves and the rescue to inform the public. They have hired you to construct the maps.

Build skills in these areas

➢ Select by attribute
➢ Create bookmarks
➢ Configure pop-ups
➢ Search for data
➢ Filter

What you need

➢ Account required
➢ Estimated time: 30 minutes – 1 hr

Teacher Resources

➢ Youtube Video: Thailand Cave Rescue: ABC New (Australia)
➢ Hand on Lab: Sinkholes in a Cup
➢ National Speleological Society

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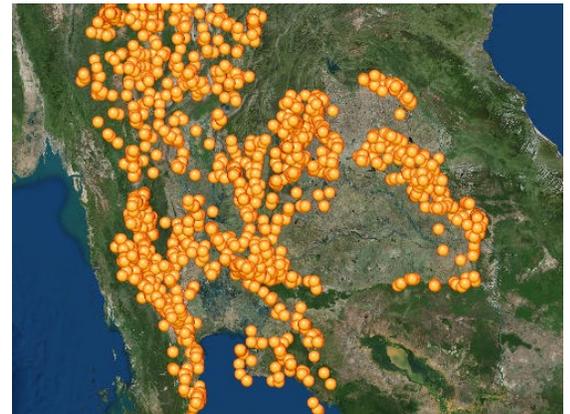
1.   Make a map: Identify Thailand

1. Go to ArcGIS Online and sign into your Organizational Account.
2. Click Map on the top ribbon.
3. Click content under Details.
4. Go to Add >> Browse Living Atlas Layers and search for World Countries (Generalized).
5. Click the plus in the lower right corner to add the layer to the map.
6. Click the back arrow to return to the contents pane.
7. Click the three dots at the end of the World Countries and Zoom to layer.
8. In the upper right corner type Thailand and hit return.
9. Click Add to Map Notes.
10. In the Content Pane click on the three dots at the end of Map Notes.
11. Name the Map Notes: Thailand and click OK.
12. On the top ribbon click Save As.
13. Add the appropriate metadata to the map:
      Title: Thailand Rescue_your initials
      Tags: your individualized tags
      Summary: A spatial presentation of the Thailand Cave Rescue.
14. SAVE MAP.

2. Identify International Help

The following countries helped in the rescue: Australia, China, Japan, Laos, Myanmar, United Kingdom, and the United States. Your job is to make a map showing the location of these countries.

1. Click Filter under World Countries.
2. Create the expression: country is Australia
3. Add expression.
4. Create the expression: Country is China.
5. Continue adding expressions until all seven countries have been selected.
6. Select the tab that says: "Display features in the layer that match any of the following expressions".

7. Click APPLY FILTER.
8. Click the three dots at the end of World Countries and rename the layer: "International Help".
9. On the top ribbon to the left of the search tab, click on the Bookmark Tab.
10. Add a bookmark and name it "International Help".
11. Click Save on the top ribbon.

Filter: World Countries
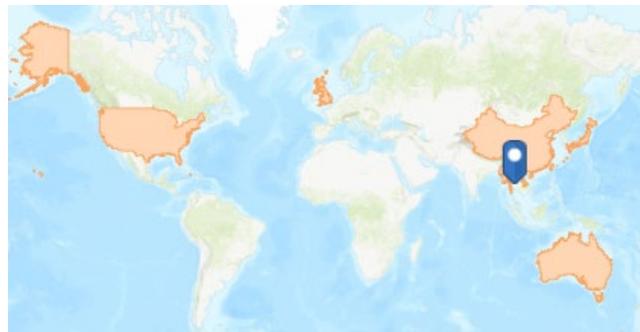
3. Make a map: Identify Thailand

Karst is defined as a type of landscape formed by the dissolving of soluble rock such as limestone, dolomite, and gypsum. The karst layer used in this exercise shows the percent of each ecoregion that contains karst. Karst area generally reflects the distribution of karst cave systems. The data set was derived by the Nature Conservancy.

1. Go to Add >> Browse Living Atlas Layers.
2. Search for Karst.
3. Add Percent Karst Area. Click on the layer to expose the legend.

Notice that the karst layer is categorized by different colors to show the percentages of land that is karst.

4. Click the back arrow to return to the Contents Pane.

5. Click Filter under Percent Karst Area.
6. Filter the karst layer for the most percentage which is 97.1467%.
   Expression should be: Karst_pct is 97.1467
7. Apply Filter
8.   Zoom to the area that has the most karst % in the world.

   Q1: What boundary has the most karst % in the world?

9. Change the basemap from topographic to imagery.

   *Q2. What features do you see in the imagery that would be an
      indication of karst?*

10. Change the basemap back to topographic.
11. Filter the karst layer that greater than 41.028 (this means that more
    of the area contains karst).
12. Expression should be: Karst_pct is greater than 41.028.

 The map is now showing areas that have a karst % of more than 41.028.

 A province is an administrative division of a country. It is the same thing
 as a state. The province where the cave is located is CHIANG RAI.

13. Go to Add >> Search for Layers >> ArcGIS Online and search for
    "thailand_provinces" ownder: Kathryn_Karanen_LearnArcGIS.
14. Click the + to Add to the map.
15. Click the back arrow to return to the Content Pane.
16. Click Filter under the Thailand Province layer and use the expression:
              Name is Chiang Rai

17. Apply Filter.

   This isolates the Chiang Rai province.

Q3: Is the province of Chiang Rai located in a high karst percentage area?

17. Go to the top ribbon and bookmark this view. Name the bookmark Chiang Rai province.

4. Identify the cave

1. Go to Add>>Search for Layers>>ArcGIS Online>>"thailand_caves" owner:Kathryn_Keranen_LearnArcGIS
2. Add thailand_caves.

Q4. Is there any correlation between the karst and the number of caves?

3. Click Change Style under thailand_caves.
 4. SELECT HeatMap.

Heat maps are used to map the location of point features. They are useful when many points on the map are close together or overlapping. In ArcGIS Online this heat map produced is scalable.

 5. Uncheck the Percent Karst Area.
 6. Change the basemap to imagery with labels.

>   *Q5. Name some locations that have high concentrations of caves.*
>
>   *Q6. What is a scalable map?*
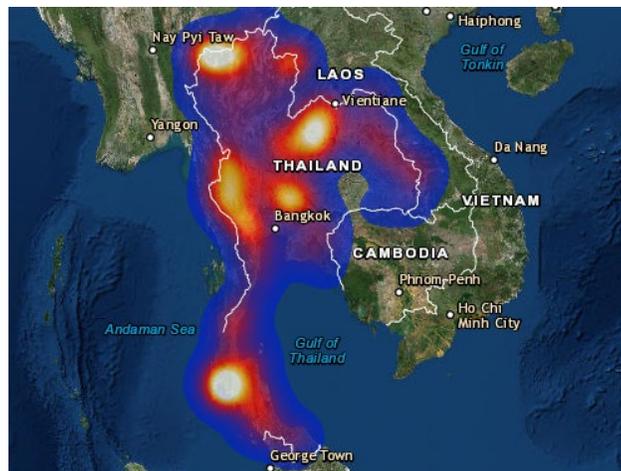
7. Change the thailand caves style back to Location (Single Symbol).
8. Filter the caves using the expression: Name **starts with** CR0003.
    The name of the cave is Tham Luang.
9. Apply Filter.
10. Click Change Style under Caves.
11. Click Options.
12. Click Symbols and pick a symbol of your choice and make it larger.
13. Click OK.
14. Zoom to the cave.
15. Uncheck International Help, Percent Karst Area, and Thailand
     Provinces

16. Change the basemap to imagery.
17. Create a bookmark called Cave.

Q7. Describe the landscape around the cave.

5. Different Symbolization of Thailand Caves

Thailand Cave Symbolization

Above is a story map that shows four different types of symbolization. Locations show the caves as stationary points.
A heat map is a scalable map that takes into consideration if points are on top of each other.
Clustering is used with a large number of points to extract information from your data. It is applied at multiple scales which means as you zoom out, more points are aggregated into fewer groups, while zooming in creates more cluster groups.
Hex bins are used to summarize point data into equal sized connected hexagons. By using hexagon, you can make the actual x, y location of the point private which is good for sensitive material such as the actual cave locations.

Q8. Click on each of the tabs and investigate the different types of classification. You have already constructed a locational map and a heat map
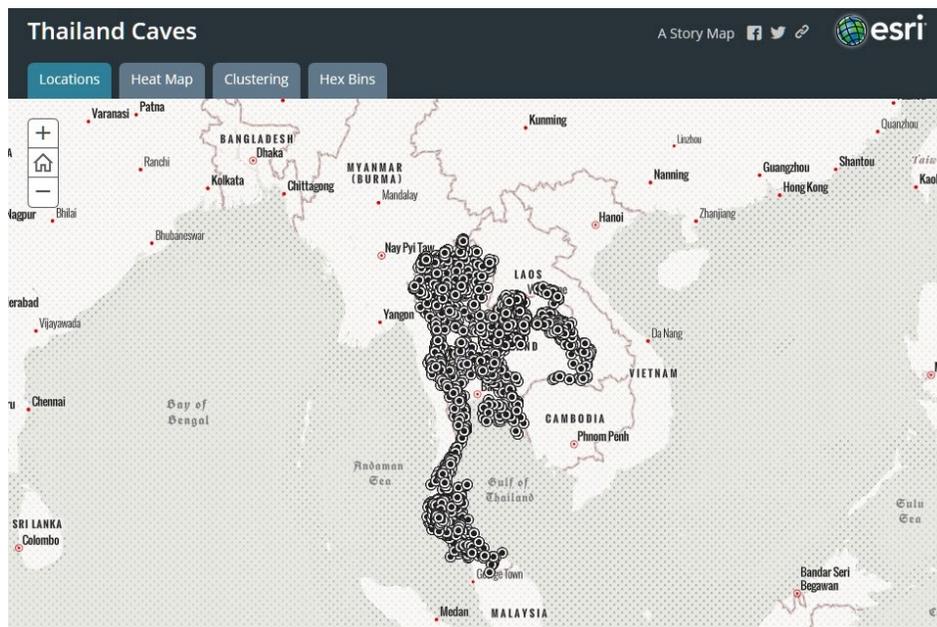
6. Add the underground cave line and identify locations within the cave

1. Go to Add >> Search for Layers >> ArcGIS Online.
2. Search for learn_thailand.
3. Add cave_line to the map.
4. Click the back arrow to return to the content pane.

   Notice the entrance of the cave.

5. In the locate tab type: 99.8578044,20.3780681
6. Add a Map Note.
7. Name the Map Note: Pattaya Beach and change the symbol.

   This is where the rescue crew hoped to find the boys.

8. In the locate tab type: 99.8575364,20.3767639
9. Name the Map Note: BOYS and change the symbol.

   The boys and their coach were found on a ledge.

10. Make a bookmark and name it: Inside the Cave.
11. Save.

In this lesson you have created a series of world, regional, and local maps to show the location of the Tham Luang Cave.

Building a GIS Portfolio

How to build a GIS Portfolio of maps and web applications that can be viewed online, printed, or saved as a PDF.

Build skills in these areas

➢ Build a Map Journal, incorporating Web Maps and Story Maps

➢ Print a Map Journal to paper or Save as a PDF

What you need

➢ Account required

➢ Existing Web Maps and/or Story Maps

➢ Estimated time: Over 1 hour

Publication Date: Dec 2018

1. Create a Portfolio using a Story Map Journal

GIS projects come in many forms, from the basic Web Map to the complex Web Apps, including Story Maps and Web AppBuilder. For the GIS student, showcasing one's work in a portfolio can make for a handsome resume item. Furthermore, the ability to save a printed or PDF copy of this portfolio provides a means of keeping this resume item even after a course ends or an online account is closed. The Map Journal template provides an effective way to build a portfolio with print capabilities.

Assuming you already have existing Web Maps, Story Maps, etc. saved to your account, proceed to the steps below to begin building your portfolio in a Map Journal:

- **Beginning Steps**: Create a simple cover page map and begin the Map Journal template. [10 minutes]

- **Add Web Maps**: Add existing Web Maps to the Map Journal. [5 minutes per Web Map]

- **Add Web Apps**: Add existing Web Apps to the Map Journal [5 minutes per Web App]

- **Table of Contents**: Link each entry to your Table of Contents [5 minutes]

Create a simple Cover Page map

A cover page map serves as a personalized opener to your portfolio. The options are limitless – it can be as simple or complex a map as you please. For this tutorial, we will create a simple map to act as your cover page.

1. Start a new map.
2. Use the "Find address or place" search box in the upper-right corner to zoom to a location that represents you (a school, favorite location, etc.)
3. Select an attractive Basemap. It could be one of your organization's default basemaps or one from the Living Atlas.
4. Save the map as "Portfolio Cover Page".

Create a Story Map Journal

The *Story Map Journal* template will house the cover page map and any Web Maps and Web Apps you want to include in your portfolio. A new Map Journal can be created through the Share button on an open Web Map. However, we will create it from your account's Content page to demonstrate how to start it from scratch.

1. Go to your account's *Content* page.
2. Click Create and choose an *App Using a Template*.
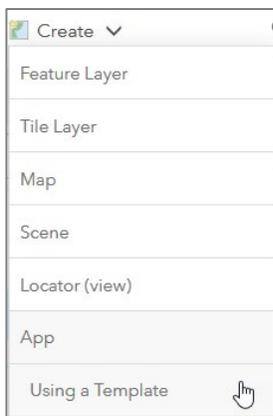
3. From the Build a Story Map category, choose *Story Map Journal*.
4. Click *Create Web App* and add an appropriate title, tag, and summary.
5. Choose the Side Panel layout. Confirm a displayed tile.
6. **Add Home Section to the Main Stage:** From the 4 content choice bullets, choose Map. Select the Portfolio Cover Page map you created earlier.
7. Leave all Map settings (Location, Content, etc.) as default and click Next.
8. **Add text to the Side Panel:** Type the text "Table of Contents". We will add items to this later. Save.
9. Your cover page map has been added to the Main Stage and your text has been added to the Side Panel.

10. Before proceeding, click Settings on the top ribbon and choose Layout Options. The default is to have the Side Panel take up 40% of the screen. To give your maps more room, choose Small (30%). Apply.
11. Your Map Journal has been started. Save your work (top-right corner).
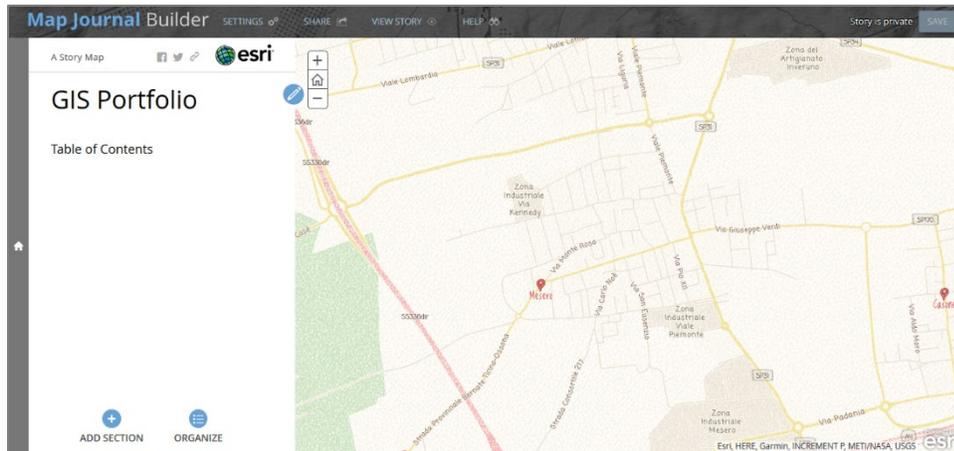
2. Add Content to your Portfolio

The simplest GIS projects, Web Maps, can be added to your Map Journal in the same way we added the Cover Page map. Each Web Map will be added to its own Section of the Map Journal.

Adding a Web Map to a new Section in the Map Journal

1. Click +Add Section at the bottom of your Side Panel.
2. Give your new section a title that represents the Web Map you will choose.
3. Under Content, the Map bullet is already selected. From the Map selector, choose a map you want to showcase.
4. Assuming your map already is saved with a desired Location (zoom extent), Content (visible layers), and other settings, choose Next.
   Tip: You can edit these settings later, including displaying a Legend, adding alt text for screen readers, etc.
5. Add a description about the map. Consider the topic, any analysis performed, the intended audience, or other details you wish to document. Click Add when finished.

Additional Web Maps can be added to your Map Journal following the steps above.

Adding a Web Application to a new Section in the Map Journal

Existing Web Applications, including Story Maps and apps created with Web AppBuilder, can be added to your Map Journal. The process is different than selecting a simple Web Map. Instead of choosing one from a selector screen, Web Apps can be added to a Map Journal using each app's shareable URL (web link). These can be obtained in three ways:

1. By opening the app in another web browser tab and copying the full URL displayed in your browser's address bar.
2. Opening that app's description page from your Content page and copying the short URL located at the bottom-right.
3. Clicking the Share button (if available) in your app and copying the short URL.

Assuming you have the URL of a completed Web Application copied, follow the steps below to bring the app into a new section of your Map Journal.

1. Add a new Section to your Map Journal and give it a title.
2. From the 4 content choice bullets, choose Web page.
3. Paste the URL of a Web App in the box labeled Web page link. Click Configure.
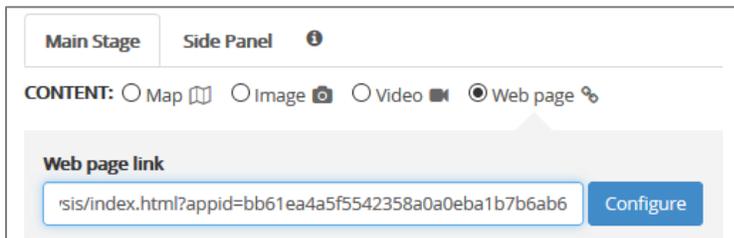
4. Uncheck the *Unload when reader navigates away* option. This will prevent the web app from automatically reloading if a reader leaves and returns to this section of your Map Journal. Click Next.
5. Add a description and click Add.

Additional Web Applications can be added to your Map Journal following the steps above.

Adding a Table of Contents Using Story Actions

After adding all desired Web Maps and Web Apps to your Portfolio, we can list these items in our Table of Contents in the Home Section and use Story Actions to make your TOC interactive.

1. Scroll up to your Home Section and click the Edit icon.

2. In the text description box, list the names of your sections. Consider formatting options such as bold, italics, a bulleted or numbered list, etc.
3. Highlight the name of your first entry.
4. In the Story Actions toolbar, click the Navigate to Another Section button.
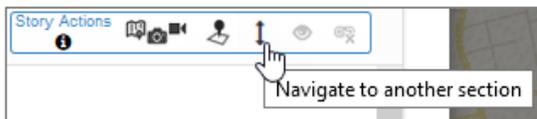
5. Choose the section in your Map Journal that corresponds to the entry name you highlighted.
6. Repeat for any additional entries in your Table of Contents. Save the description.

3. Printing Your Map Journal

Having the ability to print your GIS Portfolio to paper or to save it as a PDF is valuable, particularly for those who may have temporary ArcGIS Online accounts (students). Even the professional may wish to have a paper copy available. Assuming your Map Journal is complete, follow the steps below to:

1. Print the Portfolio to paper.
2. Save a PDF copy of a printable Portfolio.

Printing or Saving a PDF of Your Map Journal

1. Click the Share button in the top ribbon and choose Public.
   Note: Some maps or apps associated with this Map Journal may also be shared publicly by choosing this option.
2. Close the Share window and click View Story in the top ribbon.
3. While viewing the completed Map Journal, click the Share button located in the header of your Side Panel.

   🔗

4. Click the Print button and give the printable Map Journal time to load all pages. Note the formatting options available to you.
5. Scroll through the printable Map Journal and ensure all sections have completely loaded.
6. Click the blue Print button and:
   a. Choose a printer to send this document to.
   b. Choose a PDF generator, if available, to save as a PDF.
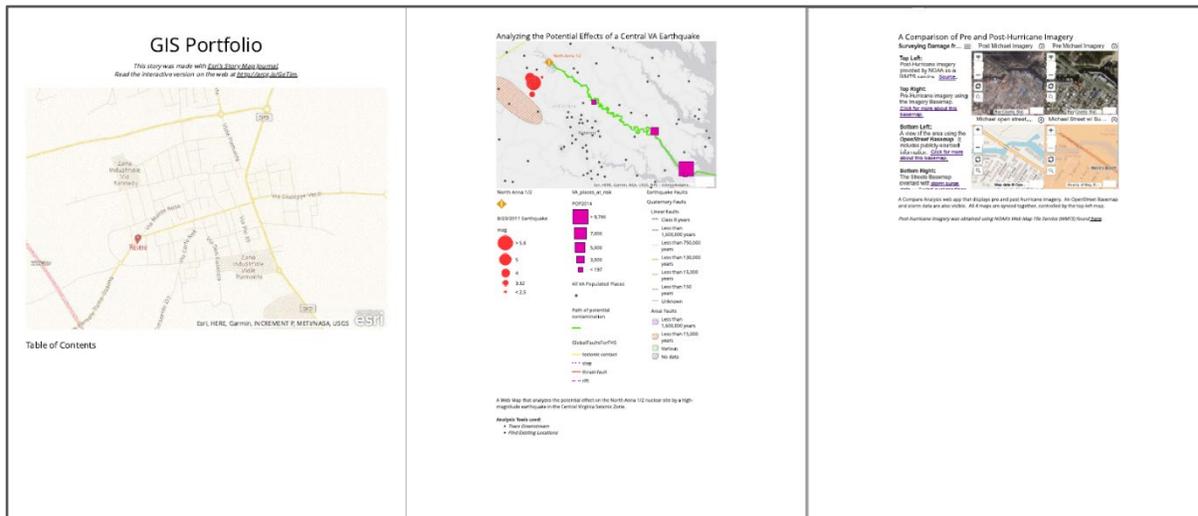
Credit usage

Credit consumption will occur when creating Web Maps and Web Apps. The steps to create a GIS Portfolio using the Map Journal template require no additional credits other than storage credits.

Questions and comprehension

How do I create a Story Map or other Web Application?

The following link will help you create a Web Application:

Choosing a Configurable App

Visualizing an E.Coli Outbreak

How to import a spreadsheet of data into a map and connect these data points to an origin point.

Build skills in these areas

- Build a spreadsheet in the CSV (Comma Separated Values) format and import it into a map.

- Mark a location using a Map Note.

- Use a proximity tool to generate lines (as a visual) to connect data points to an origin point.

What you need

- Account required

- Spreadsheet software (Microsoft Excel, Google Sheets)

- Estimated time: 30 minutes to 1 hour

Publication Date: Jan 2019

esri | THE SCIENCE OF WHERE™

1. Collect data about the Fall 2018 romaine lettuce recall and associated E.coli-related illnesses.

On November 20, 2018, the CDC and FDA announced they were investigating cases of food-borne illnesses reported in multiple states related to the presence of E. coli bacteria in romaine lettuce. All romaine lettuce was pulled from grocery shelves and consumers were urged to dispose of any they had purchased. It was later determined the tainted romaine originated from a farm in Santa Maria, California.

This lesson assumes you have basic knowledge in adding data to a map and symbolizing it. A basic working knowledge of Microsoft Excel or Google Sheets is helpful, but not required.

You will visualize the reported illnesses associated with the E.coli outbreak, which prompted the recall of romaine lettuce, by:

- **CSV:** Building a spreadsheet in the CSV (Comma Separated Values) format and importing it into a map. [15 minutes]

- **Map Note**: Locating the origin of the tainted romaine lettuce using a Map Note [5 minutes]

- **Connecting Lines**: Generating lines to connect the states with reported illness to the romaine lettuce's origin point. [10 minutes]

- *OPTIONAL - **Updating Your Map**: Edit data and re-run the tool [15 minutes]*

Build a spreadsheet in the CSV (Comma-Separated Values) format.

One way to turn tabular data into GIS point data is using a spreadsheet saved in the CSV file format. CSV stands for Comma-Separated Values. A text file of data contains commas that, when brought into a spreadsheet, create columns for the data. We will skip the use of a text file and enter our data directly into a spreadsheet of columns and rows.

The most current list of E. coli cases by state can be found on the CDC's website. For this lesson, we will use a list as current as the publication of this lesson, shown below:

State	Ill People
California	12
Connecticut	1
District of Columbia	1
Florida	1
Illinois	2
Louisiana	1
Massachusetts	1
Maryland	1
Michigan	7
New Hampshire	6
New Jersey	12
New York	7
Ohio	1
Pennsylvania	4
Rhode Island	1
Wisconsin	1

1. Using spreadsheet software like Microsoft Excel or Google Sheets, list all the affected states in one column and number of cases per state in another column. Include headers (*State* and *Illness Cases*) in the first row. The order of the states does not matter, but correct spelling does.
2. When saving the spreadsheet to your computer, change the file type to CSV (Comma Delimited). See steps 2a and 2b for software-specific examples:

a. **In MS Excel:** select File>Save As and choose a location and a name for the spreadsheet. Change the filetype dropdown from Excel Workbook (*.xlsx) to CSV (Comma delimited) (*.csv).

File name:	Lettuce_EColi_Cases.csv	⌄
Save as type:	CSV (Comma delimited) (*.csv)	⌄

b. **In Google Sheets:** select File>Download as>Comma-separated values (.csv) and save it to a folder on your computer where you can find it later.

Download as ►	Microsoft Excel (.xlsx)
Email as attachment...	OpenDocument format (.ods)
Version history ►	PDF document (.pdf)
	Web page (.html, zipped)
Rename...	Comma-separated values (.csv, current sheet)
■ Move to...	
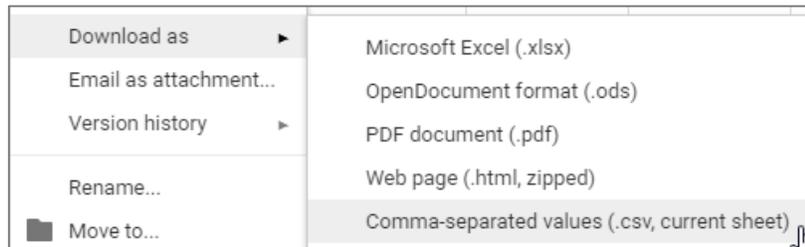
Import the CSV file into a new map

The CSV file that contains your illness data can be imported directly into your map. Note that the data will not be published to your organizational account but will instead be saved only in this one map. Deleting this map will also delete the imported data, requiring you to re-import the CSV file next time you want to use the data.

1. In a new map, click the *Add* button and choose *Add Layer from File*.
2. Click *Choose File* to browse for the CSV file. Select the file and click *Import Layer*.

A small screen may appear with a section for you to review the fields (headers) that will be used to locate your entries. The Address or Places option should be selected since we used state names in our spreadsheet rather than coordinates. Your State field (left column) should be matched with the State location field in the right column. The field for the number of ill people should not be used in identifying the geographic location of the entries, so it should say Not used in the right column.
Note: Field names in the left column may differ if you used different headers in your spreadsheet.

Add CSV Layer

Locate features by:
○ Coordinates ● Addresses or Places ○ None, add as table

In: United States

Review the location fields. Click on a cell to change it.

Field Name	Location Fields
State	State
Ill_People	Not used

ADD LAYER CANCEL

3. Click *Add Layer* to complete the import process.
4. Your new layer of points has been added to your map. They may automatically be symbolized according to the number of ill people. You can edit this to your liking.
5. Click *Done* to close the symbology menu.

Locate the presumed origin of the tainted romaine lettuce using a Map Note

A Map Note is not traditional GIS point data. Rather, think of it as a sticky note that you can use to mark or draw with, complete with a symbol and a description. We will use a Map Note to quickly mark the origin of the tainted romaine lettuce which caused the E.coli outbreak.

1. According to recent reports, the farm where the tainted romaine lettuce came from is located at 2101 Sinton Rd. Santa Maria, CA 93458. Type this address in the "Find address or place" search box in the top-right corner of the screen.

2101 Sinton Rd. Santa Maria, CA 93458   ✕ 🔍

2. The map will zoom to the located you searched for. A search result box confirms the location and marks it with a blue pointer. To save this location, click the the black triangle ▼ next to *Add to Map Notes* to open the dropdown, and choose *New Map Notes Layer*.
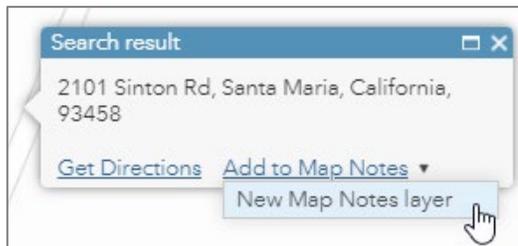
3. This Map Note now appears in your Table of Contents. Click the *More Options* button ···, choose *Rename*, and name it *Lettuce Source*.

2. Visualize the paths of the lettuce farm to the states reporting illnesses using an Analysis Tool.

Our map now contains all our data points: Points on each state symbolized by the number of reported illnesses, and an origin point marking the source of the tainted romaine lettuce using a Map Note. Next, we will run an analysis tool called *Connect Origins to Destinations* that will visualize the paths of the lettuce from the farm to the various states where illnesses have been reported.

Running the *Connect Origins to Destinations* analysis tool

The *Connect Origins to Destinations* tool can calculate routes based on time or distance according to walking, driving, or trucking. However, we will use another option, Line Distance, to ignore actual routes and simply draw lines that will act as a visual, connecting the source farm to the affected states with straight lines.

1. In the top ribbon, click Analysis [Analysis], open the *Use Proximity* category, and choose the *Connect Origins to Destinations* tool.
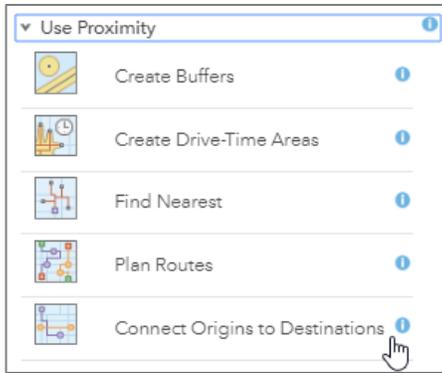
2. **Choose point layer representing the origin locations:** choose your Map Note layer which marks the originating farm.
3. **Route to destinations in:** choose your layer containing the illness points from your CSV file.
4. **Measure:** choose *Line distance*.
5. **Result layer name:** Provide a new name for the resulting layer, uncheck the "Include route layers" box, uncheck the "Use current map extent" box, and click *Run Analysis*.

The result of running the tool is a layer containing connecting paths for each point. These lines can be symbolized by an attribute (like the number of ill people, which may be redundant), by distance, or left as a Single Symbol using one color scheme.

Further embellishments can be made to this map, including adding labels, changing the basemap, adjusting symbology and transparency, and customizing the pop-ups. Remember to save your map along the way!
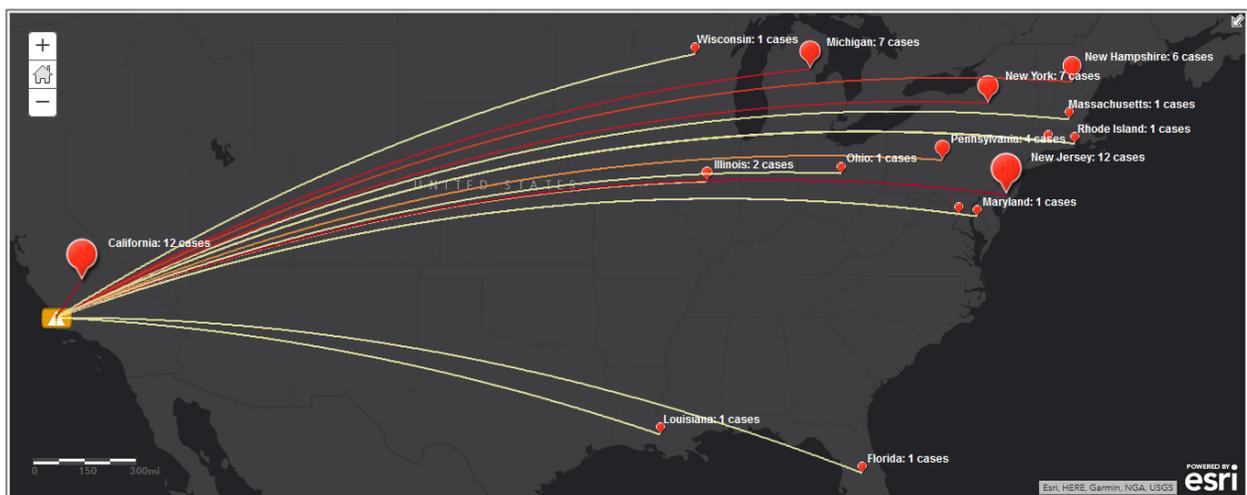
OPTIONAL:
Updating the illness information and re-running the tool

When mapping the spread of E.coli or other illness scenarios, it is important to keep in mind that additional cases may be reported after your map is published. There are many ways to update your data. Below is one method which involves using the Edit button to add or edit features, and then using the Rerun button to duplicate the analysis.

1. When you are authorized to edit a layer, most commonly because it is something you created, an *Edit* button appears in the top ribbon. Clicking this button will allow you to edit layers that you are authorized to edit: in this case, Map Notes and your illness CSV layer.
2. **Edit an existing illness point:** Click *Edit*, then click the point that exists in one of your states. A pop-up opens with editable fields.
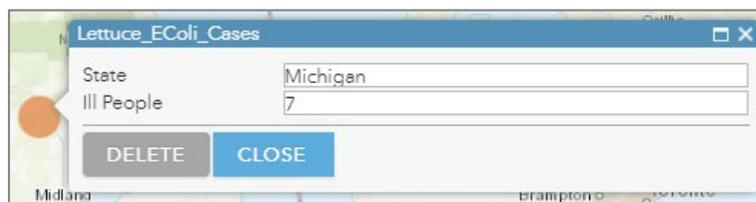
3. Change the illness count to reflect updated information from the CDC.

   Alternative Method: Without clicking Edit, open the Attribute Table ⊞ of the illness layer. The fields in the table are editable since you are authorized to edit this layer.

4. **Add a new illness point to another state:** Click *Edit* and find the illness layer listed in the left-hand Add Features menu. Click *New Feature*, and then click on your map where the new point feature should go. A pop-up opens with editable fields for you to complete.

When your illness layer has been updated, you will have to <u>rerun</u> the *Connect Origins to Destinations* analysis to include the newest data. Located in the toolbar of the line layer that resulted from your original analysis is a button called Rerun ⤾. Click *Rerun* to return to the analysis tool you used. All the entries (Step 1-4) remain as you originally set them. Simply scroll down, change the resulting layer's name, and click *Run Analysis*. When finished, turn off the original resulting layer in favor of the new one.

Next Steps?

1. Map other recent outbreaks using data from the CDC website.
2. Add to a web app, like a Story Map, or a Dashboard using Web AppBuilder

Questions and comprehension

Where can I learn more about CSV files?

The following link explains CSV files in greater detail: CSV, TXT, and GPX files

For more practice using CSV files, try this lesson: Add a layer from a CSV file

Besides CSV, what other file types can be published to my ArcGIS Online account?

The following link explains publishing hosted feature layers: Publishing hosted feature layers

What is a Map Note?

The following link explains Map Notes: Map Notes

How does the Connect Origins to Destinations tool work?

The following link explains how the analysis tool works: Connect Origins to Destinations

How do I create a Story Map or other Web Application?

The following link will help you create a Web Application: Choosing a Configurable App

How are credits used?

The following link will help you understand credit usage: Understanding credits

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