Tectonic Hazards

This activity focuses on how to visualise global patterns of earthquakes, exploring magnitude and depth of individual events and accessing live earthquake data

🕐 30 – 45 mins

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Introduction

This activity will guide students through visualising global patterns of earthquakes, demonstrating that adding a location or spatial element to data can highlight patterns or relationships that were previously undiscovered.

The theory of plate tectonics was originally proposed as a hypothesis by Alfred Wegener in 1912 to offer a suggestion as to how landmasses could 'drift' across the planet in what he called 'continental drift'.

Wegner used several different pieces of evidence to support his theory, however not many people accepted his theory because one of the elements missing from the theory was the mechanism for how it works - why did the continents drift and what patterns did they follow?

Since then, observations show that the theory of plate tectonics can be used to provide a simplified explanation of the global distribution of earthquakes (source: British Geological Survey).

The Earth's crust is split into 7 major and 8 minor plates and the plate boundaries can be identified by looking at the spatial location of earthquakes. 90% of earthquakes occur at plate boundaries, while only 10% of earthquakes are classed as 'intra-plate' (source: The Geological Society). The most powerful earthquakes are associated with convergent or conservative boundaries (source: Edexcel A-Level Geography Revision).

Plate tectonic map of the world showing direction of movement (source: BGS)

Earth is an active place and earthquakes are always happening somewhere. In fact, there are around 12,000-14,000 earthquakes each year, although most of these are low magnitude events and aren't felt by people. On average there are about fifteen earthquakes every year with a magnitude of 7 or greater, with the potential to cause major damage (source: Incorporated Research Institutions for Seismology).

Learning Outcomes

In this practical, students will learn how to:

- Use free online maps
- Select different base maps
- Change the symbology to reflect different attributes
- Create a Heat Map to show the highest density of earthquakes
- Import live data into their maps to produce a constantly updating layer

This activity is aimed at KS4 – KS5 students, however students of all ages are welcome to complete the activity.

Contents

Section 1: Visualising Datasets

This section will introduce using an interactive map and how we can identify earthquake locations and plate boundaries.
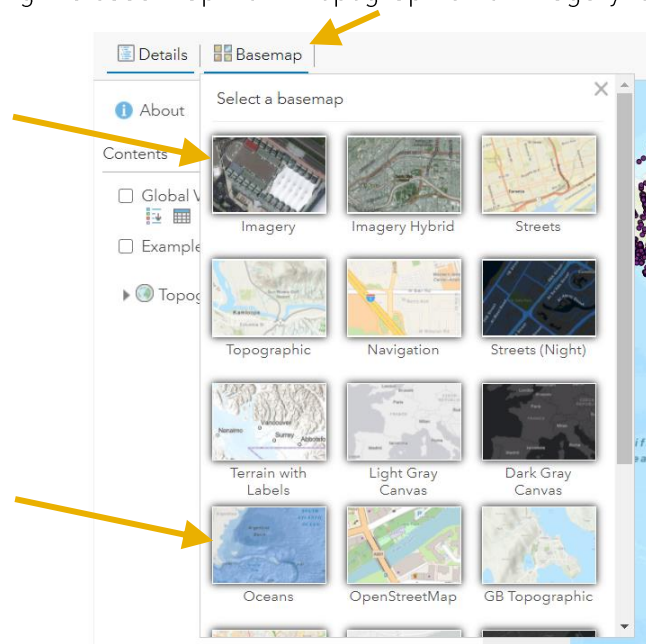
1.1. Accessing ArcGIS Online

a. Go to https://bit.ly/38RWTCg

   This should open an ArcGIS Online map which looks something like this:
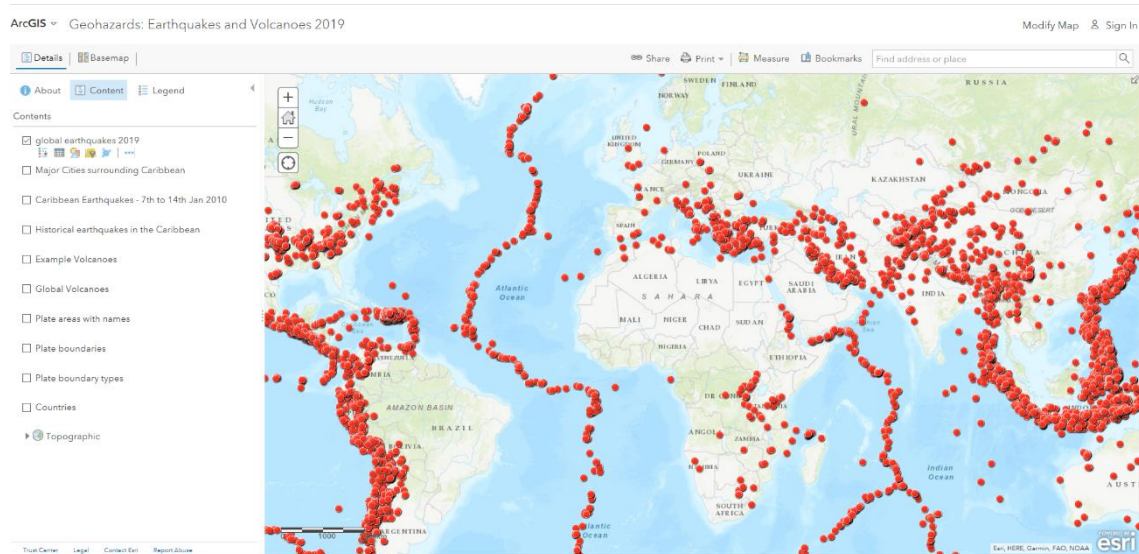
b. Spend a few minutes exploring the map and getting familiar with the controls.

c. Try changing the base map from 'Topographic' to 'Imagery' or 'Oceans'.

1.2. Locating Plate Boundaries Using Earthquakes

a. Now we must inspect what is shown on the map. Select the 'Contents' pane to the left-hand side. This shows you the 'layers' which are displayed on the map.
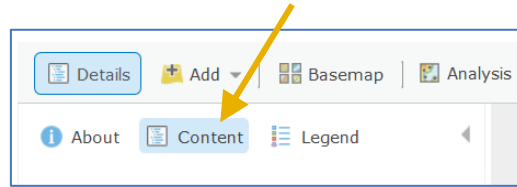
b. Turn 'on' the 'Global Earthquakes 2019' layer by ensuring the box is ticked.

c. Why do you think the earthquakes are located here? Is there something that could be causing this geospatial pattern?

d. Now turn 'on' the 'Plate Boundary Types' layer.

e. Explore the relationship between the location of the earthquakes and the plate boundaries.

Is there a relationship between the **type** of boundary and the location of the earthquakes?

Section 2: Changing Symbology

Most datasets have more than one piece of information attached to them, known as an 'attribute'. You can change what information or attribute you want to display which can tell a different story.

2.1. Displaying Earthquake Magnitude

a. You can find out more about the earthquakes by changing the symbology to display different information.

    Click the symbology button on the 'Global Earthquakes 2019' layer. This will appear as 'Change Style' when you hover the mouse over it.
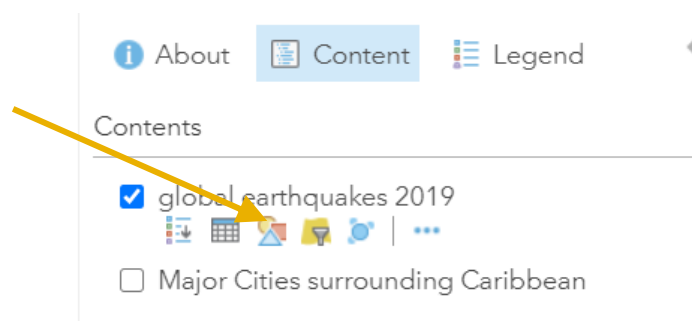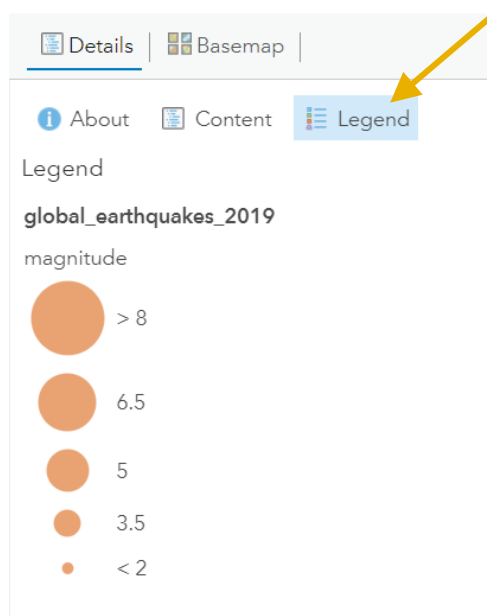
b. Change the attribute to 'Magnitude' from the drop-down menu. Ensure that 'Counts and Amounts (Size) is clicked. Then click 'Done' to save the changes.

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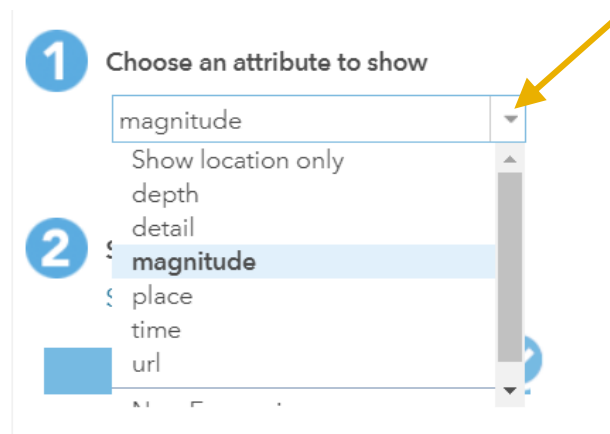
The map of magnitude will look like this:
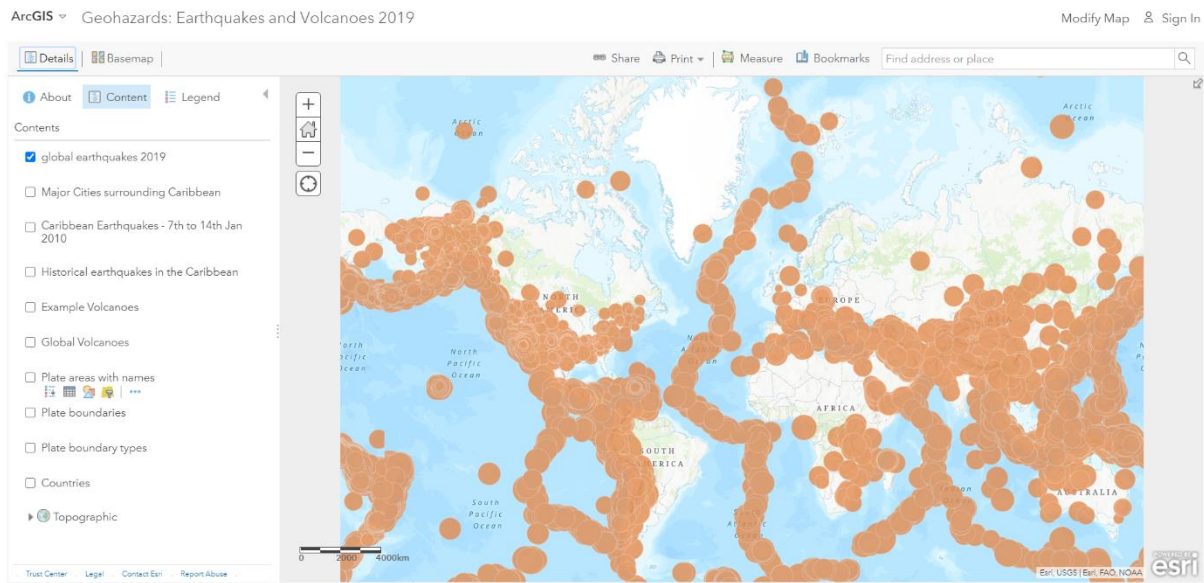
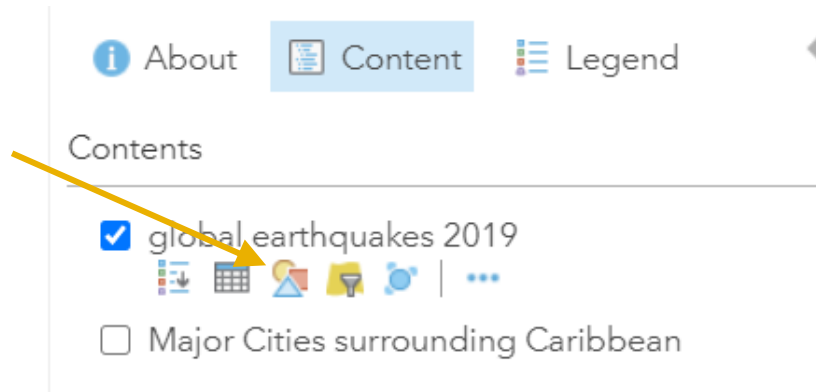c. Click on the 'Legend' button to see what the sizes of circles indicate.

d. Where do the biggest earthquakes occur? Where do the smallest earthquakes occur?

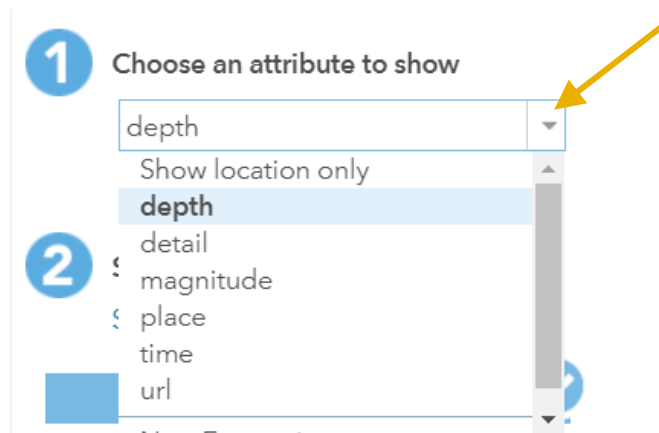e. Does this change the apparent relationship? Is there anything else which we can now see which we couldn't before?

2.2. Displaying Earthquake Depth

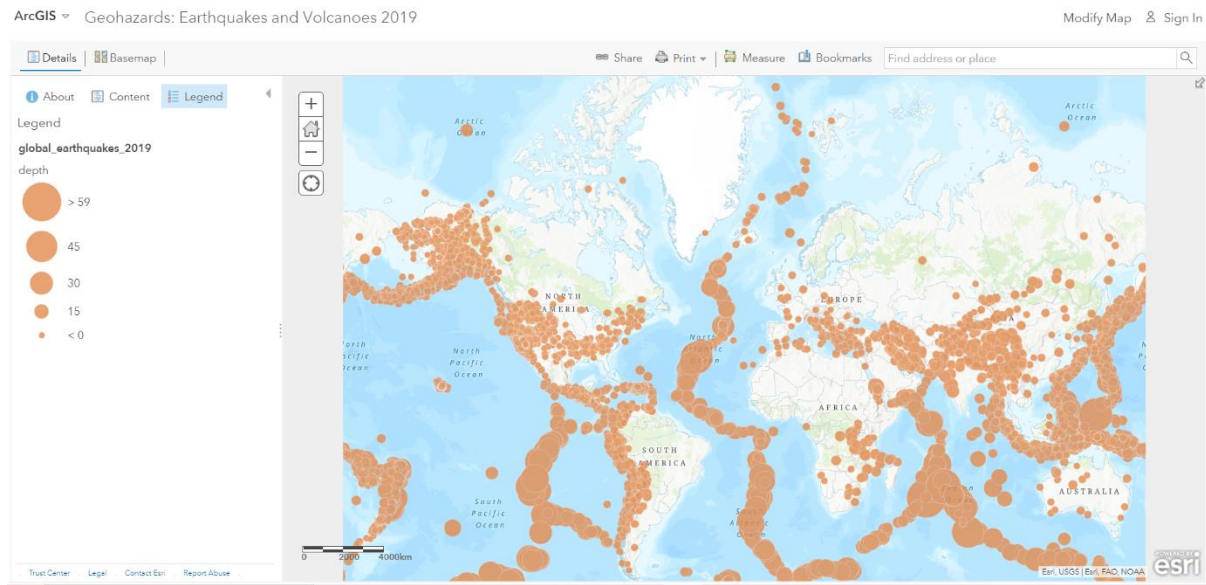a. You can find out the depth that earthquakes occurred at using the same method as Section 2.1.

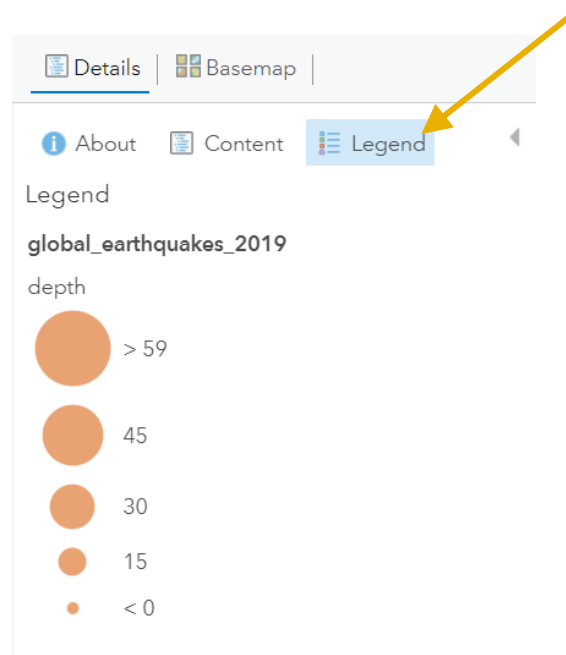Click the symbology button on the 'Global Earthquakes 2019' layer.

b. Change the attribute to 'Depth' from the drop-down menu. Ensure that 'Counts and Amounts (Size) is clicked. Then click 'Done' to save the changes.

The map of depth will look like this:

c. Click on the 'Legend' button to see what the sizes of circles indicate.


d. Where do the deepest earthquakes occur? Where do the shallowest earthquakes occur?

e. Does this change the apparent relationship? Is there anything else which we can now see which we couldn't before?

2.3. Plotting a Heat Map

a. To get a better view of where earthquakes are most likely to occur, we can also plot a heat map of earthquakes based on their density over an area.

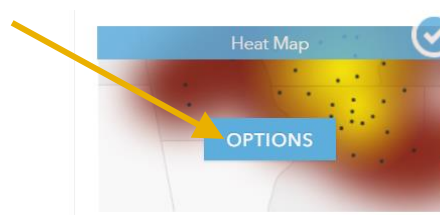   Explore this by changing the symbology, ensuring that the attribute is changed to 'Show Location Only'.

b. Then click on the 'Heat Map' option instead of 'Counts and Amounts (Size). Click 'Done' to save your changes.
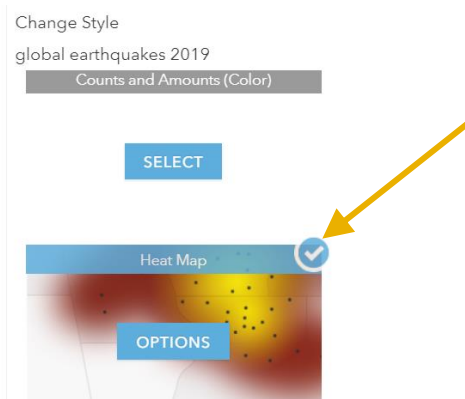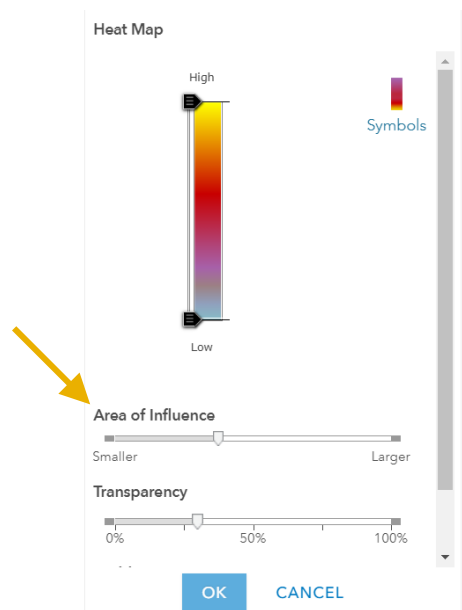

The map will look like this:
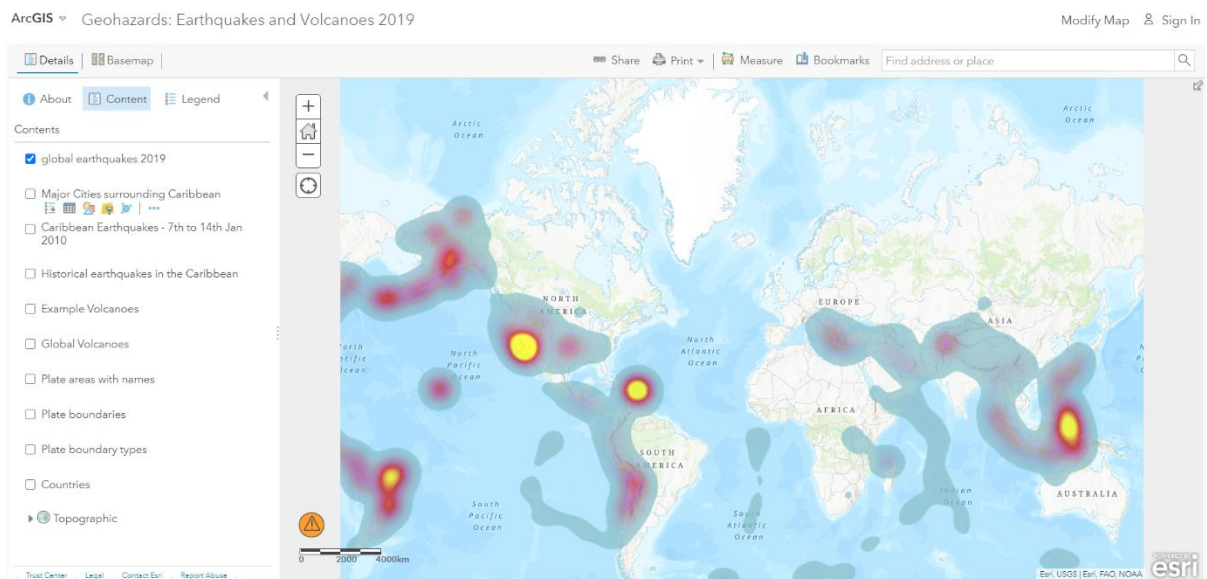
c. The symbology of data can affect how we interpret it. On the Heat Map, click on 'Options'.

Then change the settings, such as 'Area of Influence'.

d. This will affect how the occurrence and concentrations of earthquake events appear on the map compared to the default settings.

Section 3: Recent Earthquakes

So far, we have only used data from 2019 however as this is not very recent, we can use data feeds from websites to import data to our map to give us up-to-date information about current or recent earthquake events.

3.1. Adding Live Data to Maps

a. Turn 'off' all layers apart from 'Plate Boundaries'.

Go to the United States Geological Survey (USGS) website: https://goo.gl/nHEjgP
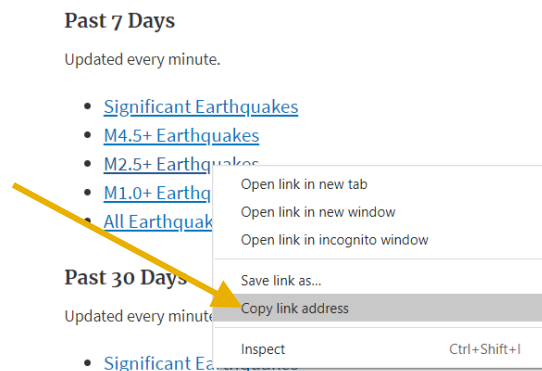
The USGS website will look like this:
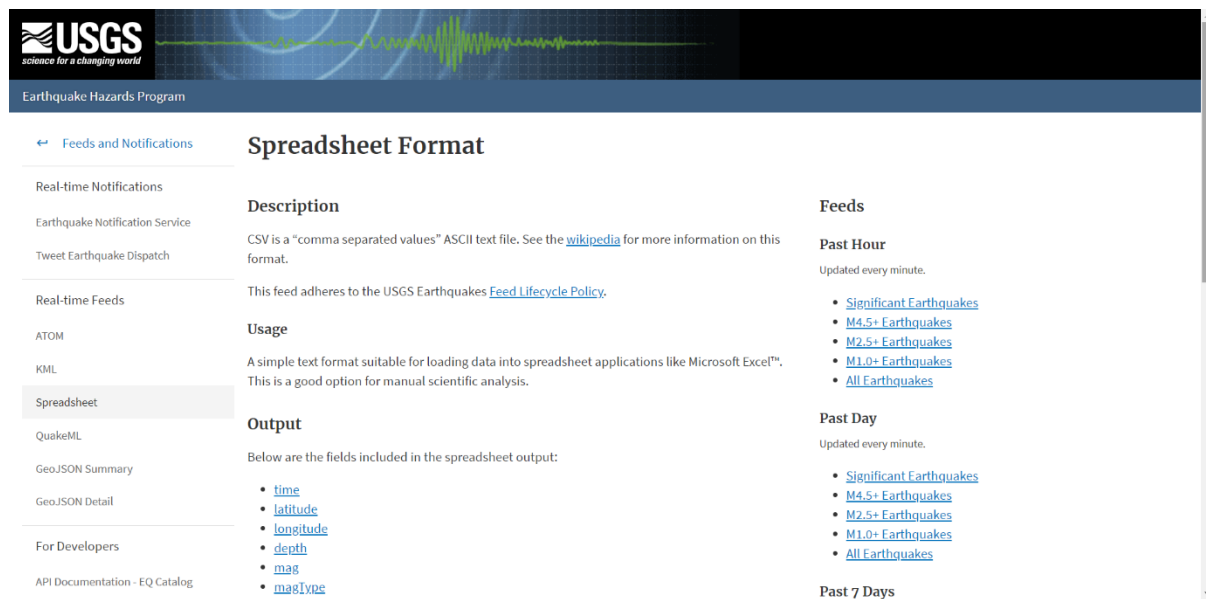
b. Scroll down the page to the 'Past 7 Days' section on the right-hand side and right click on the 'M2.5+ Earthquakes' text. This will give you all the information for the earthquakes which occurred within the last 7 days.
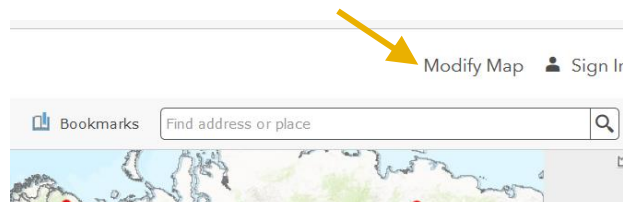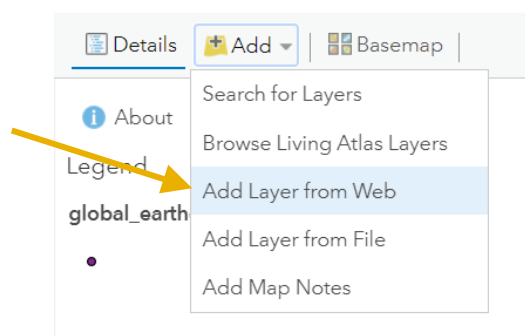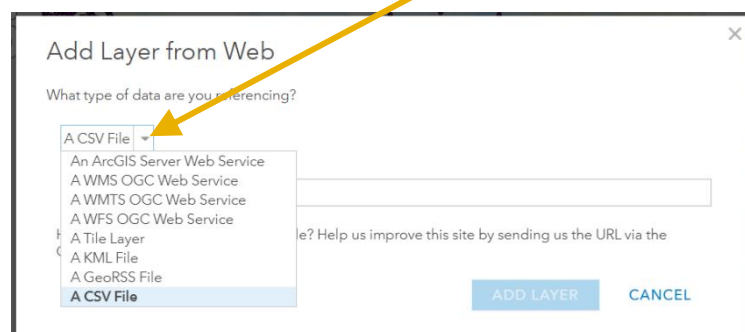
c.   Select 'Copy Link Address'.

d.   On your map in ArcMaps Online, click the 'Modify Map' button in the top right-hand corner of the screen.
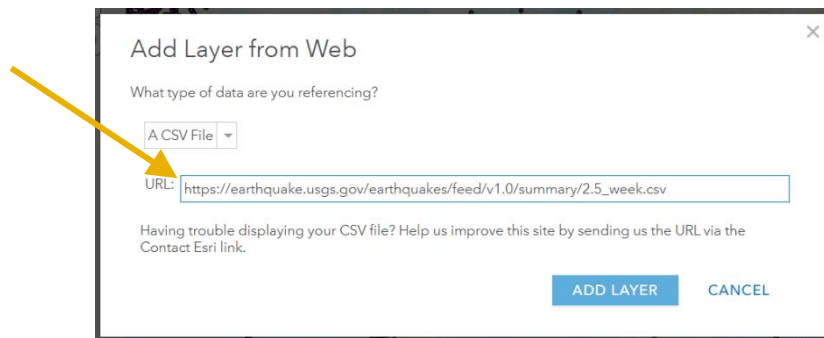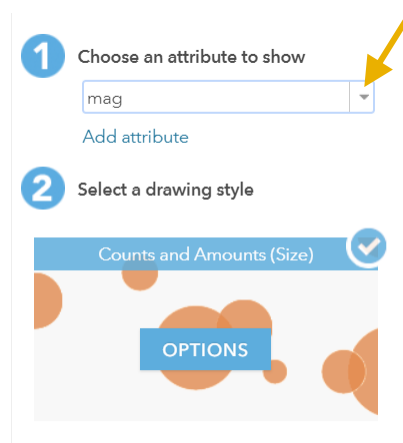

e.   Then click 'Add' and select 'Add Layer from Web'.

f.   In the window that appears, change the first drop down box to 'A CSV File'.

g. Then right-click in the 'URL' box and paste the copied link. Click the 'Add Layer' button.

h. When loaded, change the attribute to 'mag'. Ensure that 'Counts and Amounts (Size) is ticked. Then click 'Done' to save your changes.

i. This will give you all the information from recent earthquakes in the last 7 days.

j. You can rename the layer to a more suitable name, for example, 'Last 7 Days' by clicking on the 3 dots to the right, then 'Rename'.
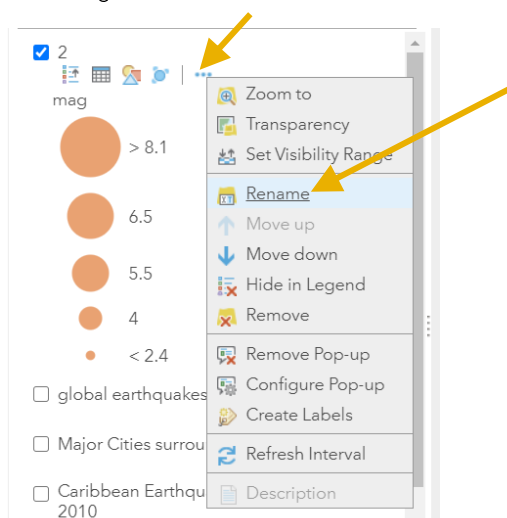
k. You can now see how the range of earthquakes which have occurred in the past seven days, and this will be automatically updated as the file we have linked to is updated.

Section 4: Summary

This activity demonstrates how adding a location or spatial element to data can highlight patterns or relationships that were previously undiscovered. For example, we can map the plate boundaries by look at the location of the earthquakes. By changing the symbology of a particular dataset, we can also uncover more information such as the magnitude or depth of an earthquake. This activity also emphasises the vast amount of free data available on the internet, which can be used to create current or live maps, which can be used for independent research.

If you want to investigate further, repeat Section 2 with the last 7 days dataset from USGS.

This concludes the exercise.

Geospatial UK

This activity was created by Newcastle University on behalf of Geospatial UK.

For more resources or activities, visit

www.geospatialuk.org

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