1. **Investigating change using the Esri Landsat Lens**

Earlier, you examined the NASA Earth Observatory, which contains a great deal of Landsat data. The next tool that you will use, the Esri Landsat lens, is also based on Landsat data. Landsat is a series of satellites that have been operated by NASA and the US Geological Survey since 1972. As the name implies, these satellites' mission is to record images not of outer space but of the land—the Earth's surface. They do so in a series of specific bands in the electromagnetic spectrum, including visible and infrared. In an infrared image, healthy vegetation appears red. The infrared imagery also allows for changes to be detected easily on the landscape. As one preface to using the next tool – the Landsat Lens -- consider spending some time discussing the electromagnetic spectrum with this resource from NASA (https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html) as well as with others listed in the Explore Further section at the end of this component.

Access the Esri Landsat Lens: https://maps.esri.com/rc/landsat2/index.html

The initial view will look similar to the graphic shown here, with a satellite image "lens"—a small portion of a satellite image, tools to the upper right of the map, and a find places and zoom tools to the upper left of the map.
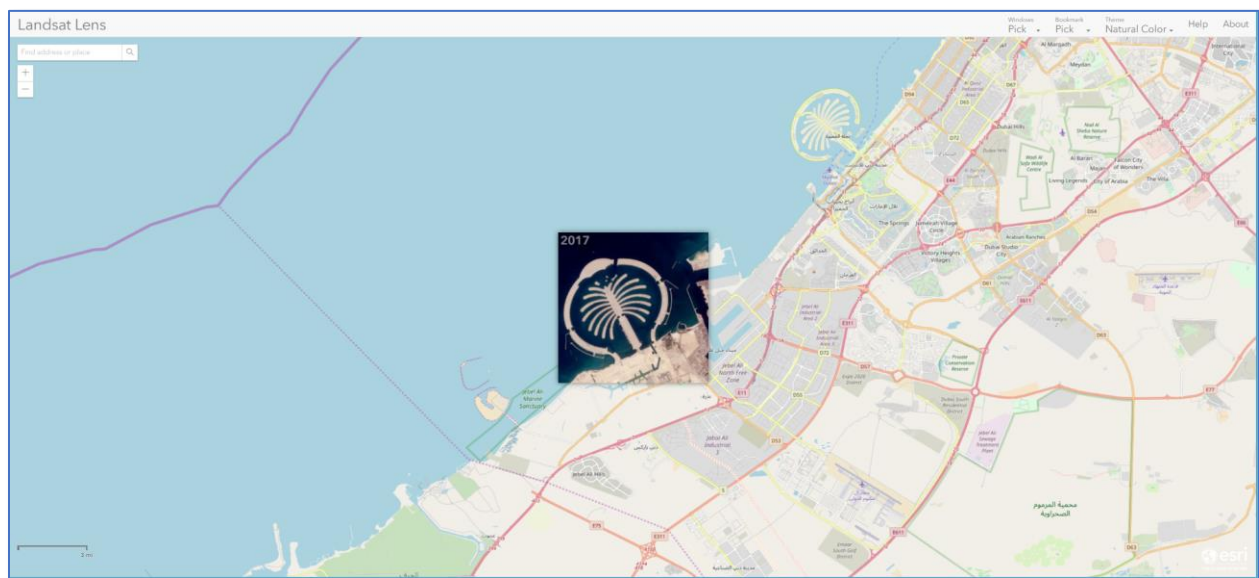

1.1. Investigating Abu Dhabi. The Landsat Lens tool can be used to display imagery in different spectral bands, dates, and locations around the world. Start in Abu Dhabi by selecting the small satellite image that appears and moving it along the coast so you can examine the "palm frond" developments that extend out into the water. Pan and examine the urban area of Abu Dhabi and note the sand covering nearly all of the surrounding rural area. When working with Landsat Lens, be patient as the images load and changes scale as you zoom and pan. Next, use Windows Pick to select a 2002 image of the area. You will now see 2 images, one from 2002, and the other from 2017, that you can use to explore the development into the water and the urban growth of the city into the surrounding desert.
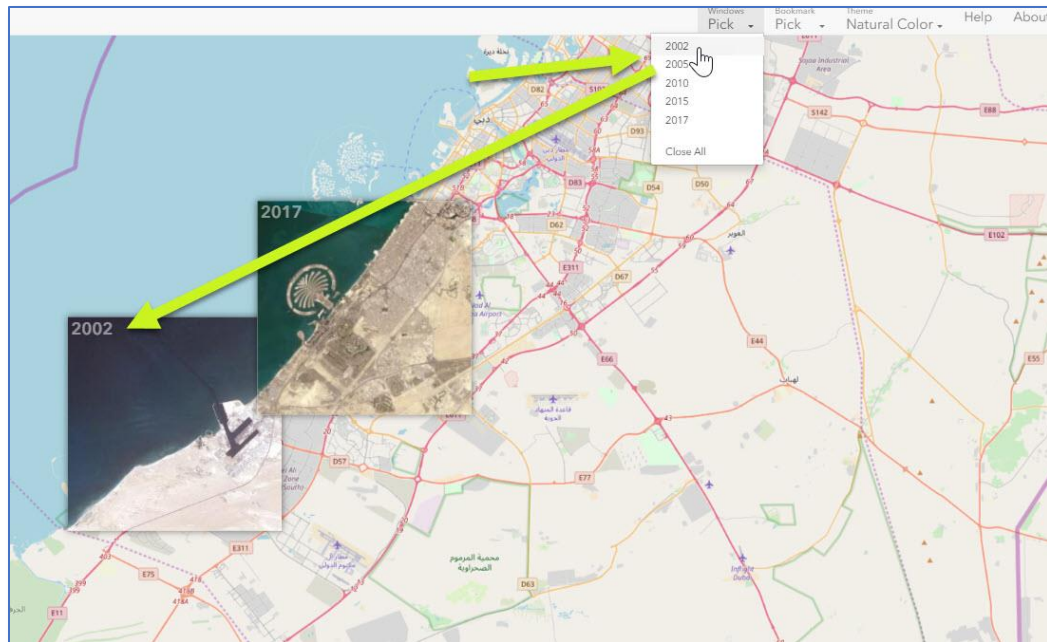
Use Bookmark Pick to select Mount Saint Helens. Use Windows Pick > Close All > then select 2002 and 2017. Change the Theme to Color Infrared so that healthy vegetation appears in bright red.

Using your newfound skills in the Landsat Lens tool, spatial thinking, and your content knowledge, and additional research if you need to, consider the following questions:

- What type of landform is Mt St Helens? How do you know?

- To what cardinal direction did the modern-day blast from this landform occur? Questions such as this help ensure that your students are using cardinal directions and other descriptive spatial terms.

- How would you characterize vegetation re-growth on the slopes of Mt St Helens between 2002 and 2017?
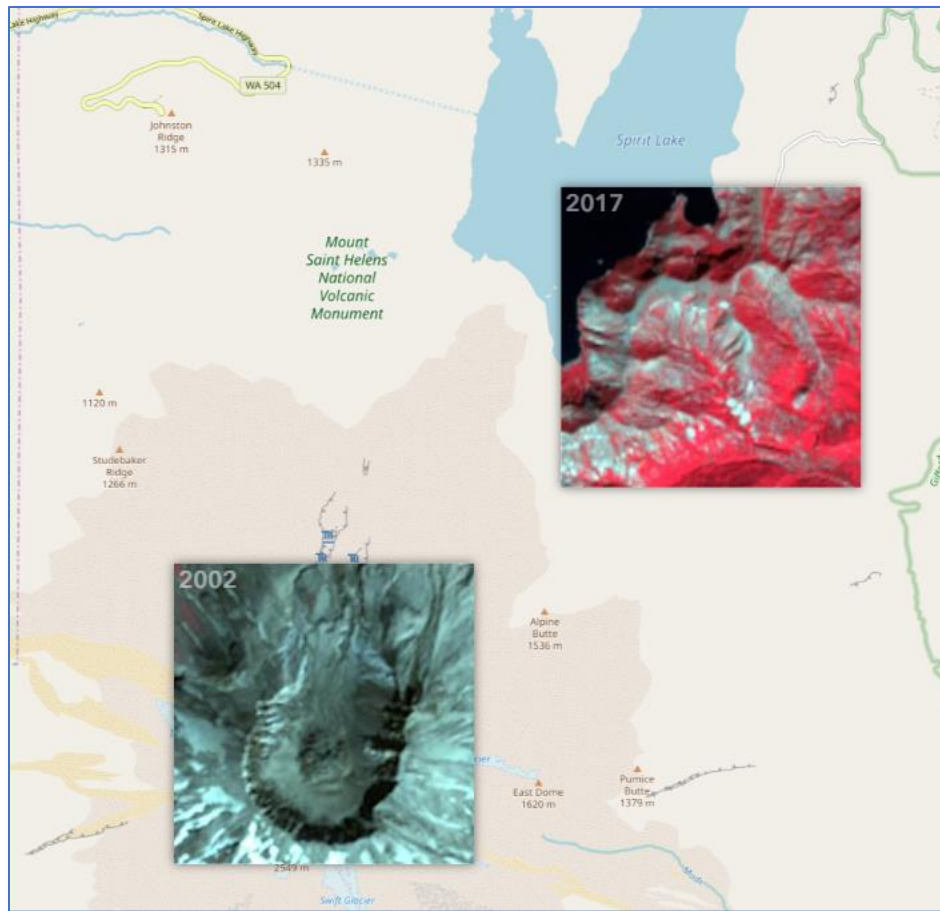
1.2. Investigating the Aral Sea. Use Bookmark Pick > Aral Sea > Windows Pick > Close All > Choose the 2005 and 2017 dates. Choose the Agriculture Theme.

The Aral Sea was once the fifth largest lake in the world. Describe 2 changes in the Aral Sea that have occurred over time. Think about our framework of what is there, why is it there, and why should we care: Why is the Aral Sea shrinking? Why should we care if the Aral Sea disappears?

Global attention on the Aral Sea over the past 20 years has increased. Change the dates analyzed to compare 2015 to 2017. According to this data set, with this imagery and this tool, would you say that the global attention has slowed the rate of the Aral Sea's disappearance?

This phrase, "according to this data set" is key when using Spatial Technology. Remember, all maps are imperfect—and some are very useful. All of your analysis depends on the data you are using, and thus, repeating this phrase with every new analysis will encourage your students to be critical of and mindful of the data. If time permits, analyze a few additional resources and compare them to whatever data you are analyzing using Spatial Technology. Often, though, time does not permit such additional investigation in class; so the task of "investigate this problem using at least 1 alternative source" could be a valuable homework assignment.

Pan to the region covering the Aral Sea. Speculate on the influence that the fact that the Aral Sea lies in two different countries might have on effectively managing it as a resource and to remediate the rate at which it is drying.

Consider asking your students to name one positive impact from human alteration of the Aral Sea, and one negative impact. Why? The Aral Sea's changes, like so many other issues in geography, is complex: Decisions were made on the landscape, with positive **and** negative impacts.
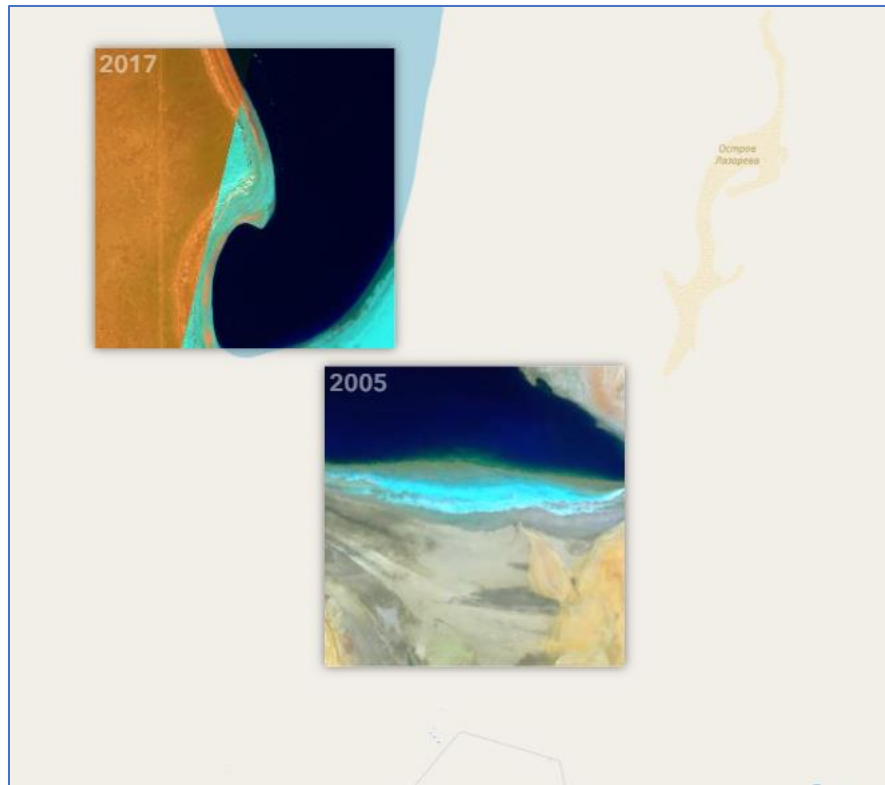
1.3. Explore Melbourne with the Landsat Lens. Landsat data covers the entire planet.   The bookmarks only contain a few places to explore. But you can use the search tool to the upper left of the map to explore other places, such as Melbourne. Using a variety of dates and themes, you could examine deforestation and reforestation, urban growth, coastal processes (particularly in the 12 Apostles area southwest of Melbourne), and much more. Below is an example using Color Infrared imagery.
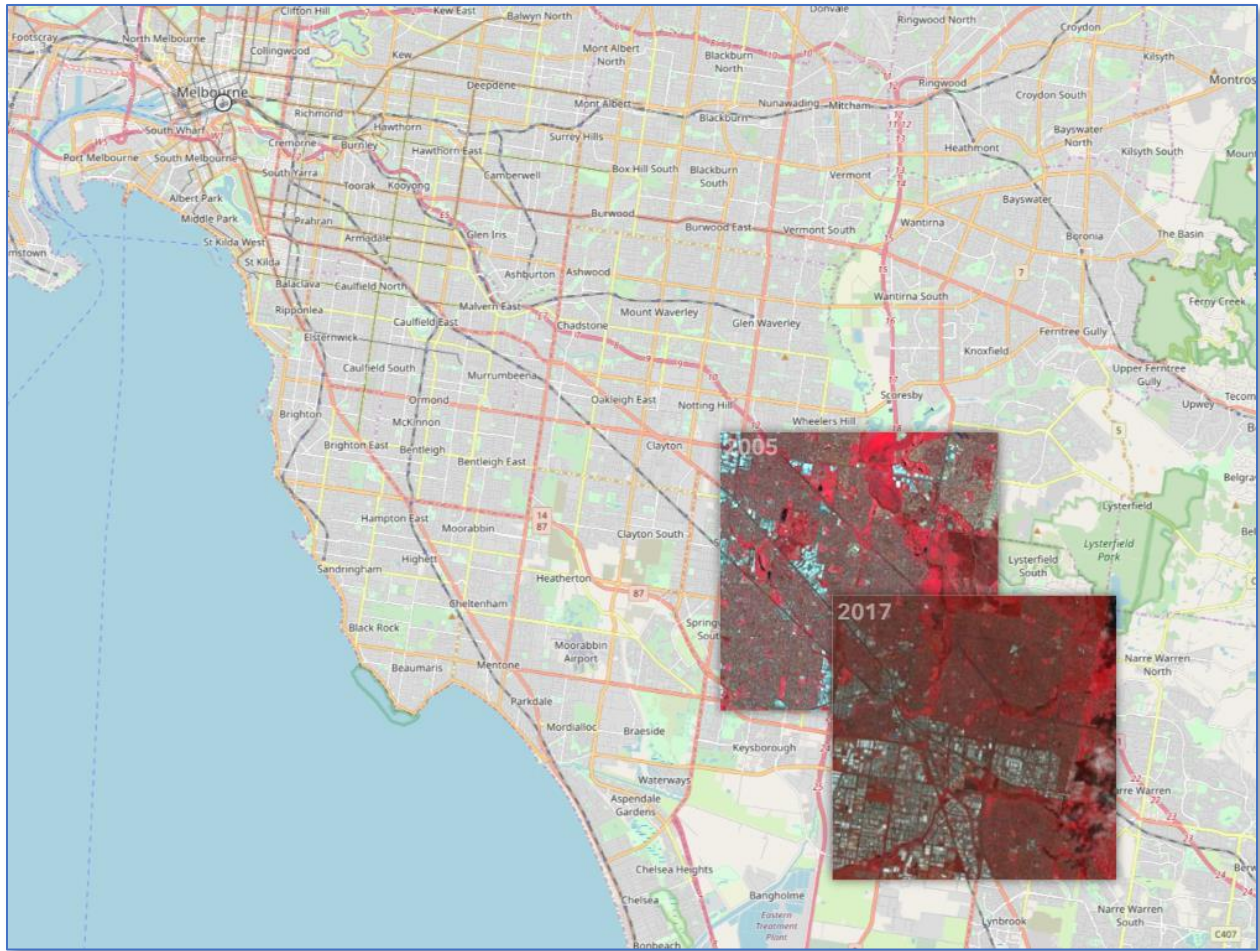
1.4. Explore further using the Landsat Lens. You can use the tool to examine other places around the world, such as Lake Chad on the Chad-Nigeria-Cameroon border, Las Vegas Nevada USA, development along the Gold Coast of Australia, China's Three Gorges Dam, and elsewhere. As with other Spatial Technologies, the advantage to the Landsat Lens is that you can investigate a wide variety of issues, themes, and places—all with the same tool.

A "swipe" map is another way to compare satellite imagery over time. A swipe map provides an interactive "squeegee-like" bar that you can drag across a map, revealing different content on the left and right sides, or different dates, for any given area. An example of the swipe technique is visible on the Changing Planet tab on the following space images story map: https://dalspatial.maps.arcgis.com/apps/MapSeries/index.html?appid=de978631f3fe4bc98095a8d8191 f4966. The places available to compare with the swipe map include New Orleans, Lake MacKay Australia, Cyprus, and more.

-