Earth Imagery at Work MOOC

Exercise

Change Detection Over Time at Chernobyl with ArcGIS Online

Section 3 Exercise 1

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esri

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Change Detection Over Time at Chernobyl with ArcGIS Online

Instructions

Use this guide and ArcGIS Online to reproduce the results of the exercise on your own.

Note: ArcGIS Online is a dynamic mapping platform. The version of ArcGIS Online that you will be using for this course may be slightly different from the screenshots you see in the course materials.

Time to complete

Approximately 15-20 minutes.

Technical note

To take advantage of the web-based technologies available in ArcGIS Online, you need to use a fairly new version of a standard web browser, such as Google Chrome, Firefox, Safari, or Internet Explorer. Older web browsers may not display your maps correctly.

Note: For information on supported browsers for ArcGIS Online, visit http://doc.arcgis.com/en/arcgis-online/reference/browsers.htm.

Introduction

This exercise uses a web app built off of the Landsat archive to understand the development of the Chernobyl nuclear power plant in Ukraine and the effect it continues to have on the area today. You will see how the area transformed from forest, to farms, to an industrial city, and then vanished.

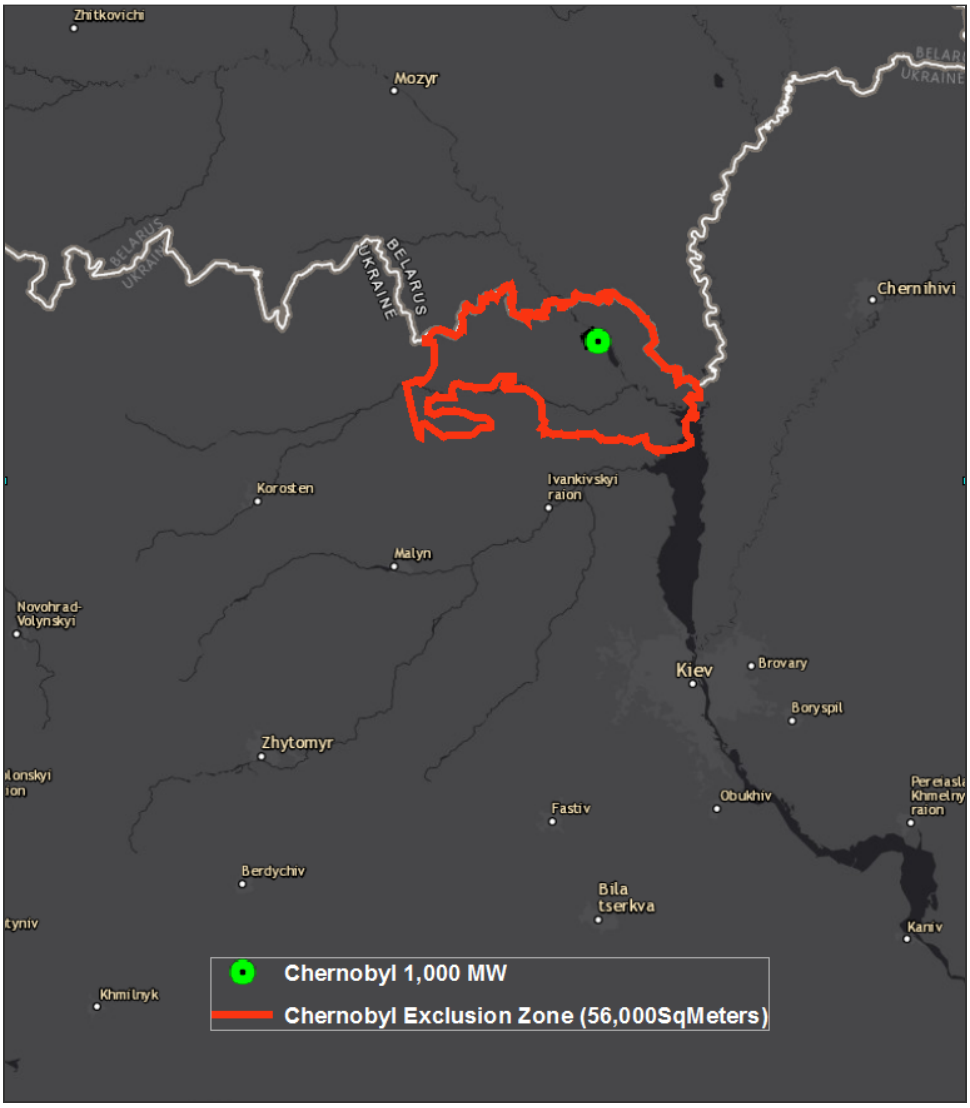
The purpose of this exercise is to show how you can use the historical archive of Landsat imagery to better understand how the world has changed over the past 40+ years.

Satellite imagery can be used for observing places that are hard and expensive to reach (like the middle of the Amazon to monitor deforestation), or for areas that are so big that it would be impossible to send a team of people out to. But it can also be used to go back in time and watch change happen. This is easily done with Landsat, which has an historical record that is more than 40 years long. Last year, Amazon Web Services began hosting the entire archive of available Landsat images, so you can go anywhere in the world and see how the planet has changed since the 1970s.

Exercise scenario

In this scenario, you are using the historical record of Landsat to better understand the impact of the worst nuclear energy accident in history. However, this approach is suitable to address any number of environmental questions that have developed over the last 40 years. Here, though, you are using Landsat to develop a baseline of what this area looked like before and after a major event.

On April 26, 1986, the Chernobyl nuclear power plant in the city of Pripyat in Ukraine (formerly the Ukrainian SSR) had the worst nuclear accident in history. Over half a million people responded to the accident. The disaster and cleanup cost billions of dollars. High levels of radiation were detected across Western Europe. Nearby cities and towns within 30 kilometers were evacuated as part of an exclusion zone. The exclusion zone is still in place and today is one of the most biologically diverse zones in the world.



Area near Chernobyl nuclear power plant in the city of Pripyat in Ukraine.

Earth Imagery at Work

Using ArcGIS Online and Imagery to Detect Change Over Time

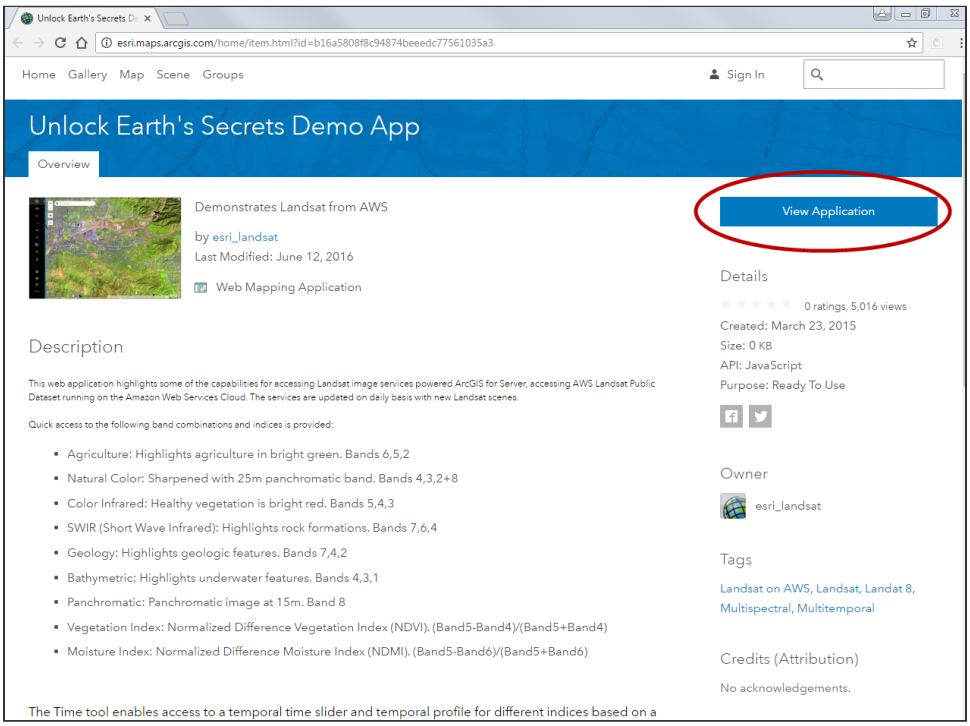
Using ArcGIS Online, you will examine a simple web app built using ArcGIS and Landsat earth observation satellites. Landsat is a collection of space-based, moderate-resolution, land remote-sensing data available from the USGS and includes imagery from the last 40 years. The imagery available from Landsat includes every location of earth's land surface. ArcGIS lets you use Landsat in your own apps.

Step 1: Open the web application

In this step, you will open a web application that highlights some of the capabilities for accessing Landsat image services using ArcGIS for Server.

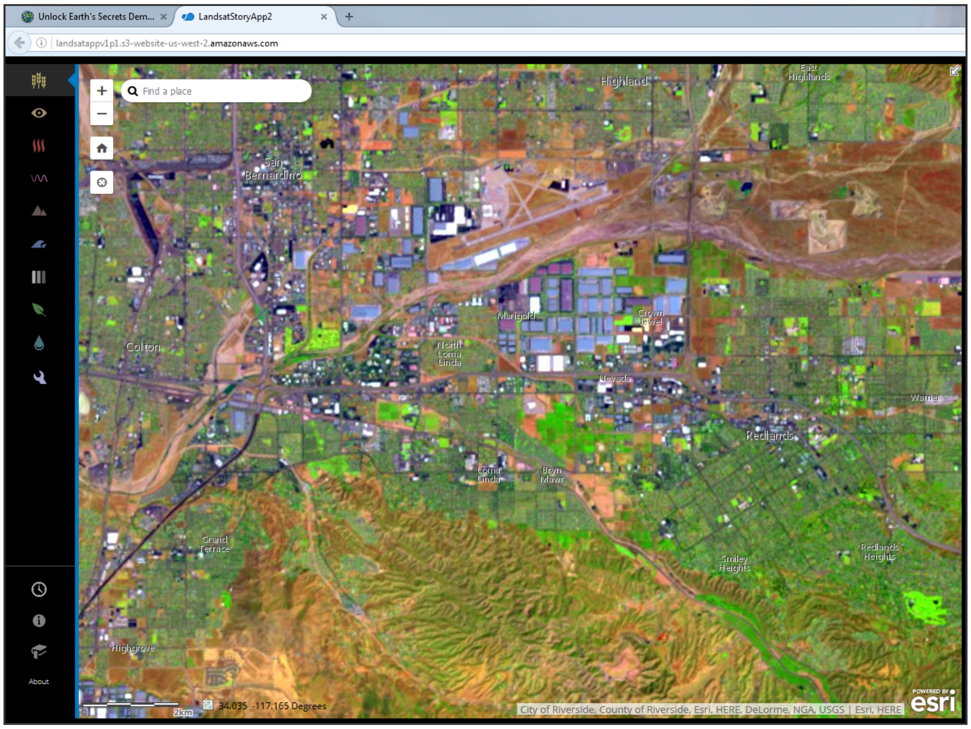
a. Open a new Internet browser tab or window.

b. Open the Unlock Earth's Secrets Demo App via this URL: http://esri.maps.arcgis.com/home/item.html?id=b16a5808f8c94874beeedc77561035a3.



c. Click View Application.

The web application opens in a new browser tab.



Area near Redlands, California.

When the app opens, you should see the area around Redlands, a small city in Southern California in the United States. The band combination that you are looking at is designed to highlight agricultural areas, which are bright green. It also picks up golf courses, which you can see in the southeastern corner of the image near Yucaipa.

Hint: You may need to pan the map east to see the golf courses.

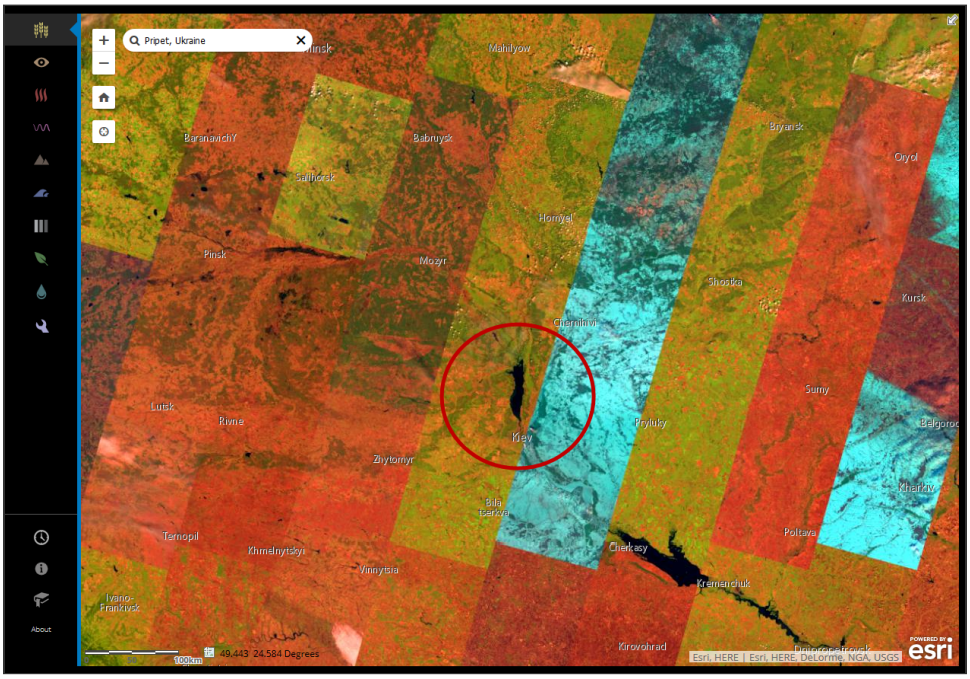
Sometimes you can identify features based on their color (also known as spectral characteristics), but their shape is also very important.

Step 2: Explore features using Landsat band combinations

Next, you will use Landsat band combinations to explore the area of the world where the Chernobyl nuclear power plant is located so that you can better understand the impact of the accident on that area.

a. At the top left, in the Find A Place field, type **Pripet, Ukraine** and press Enter.

Note: You will also see Pripyat identified as Pripet, Ukraine. This web application uses the Pripet spelling.



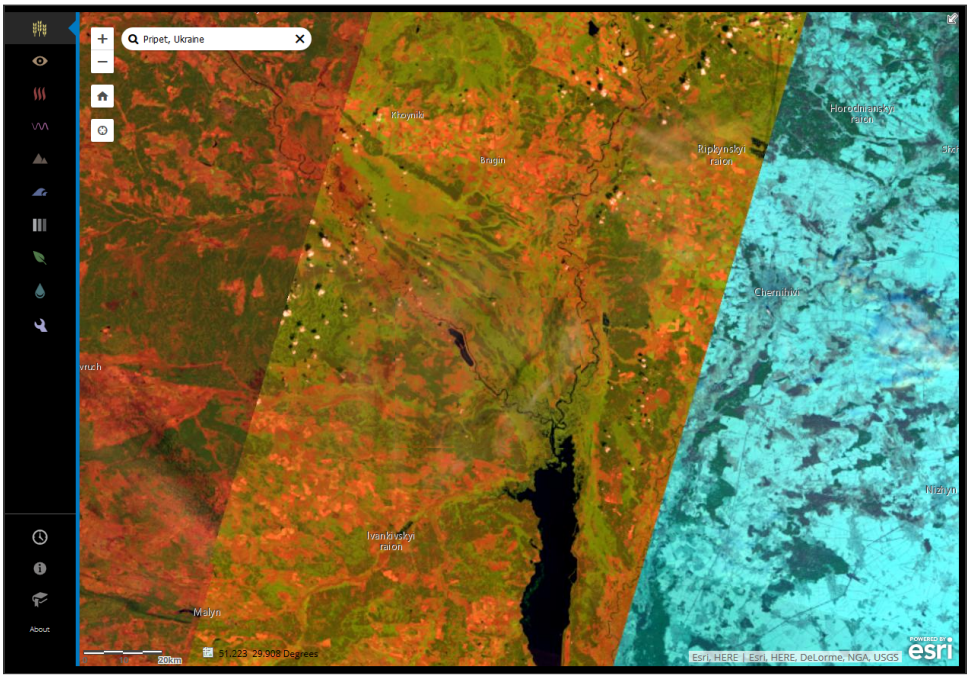
Reservoir near Pripet, Ukraine at a zoom level of 100km.

You will notice that the imagery here is quilted together and does not look as smooth as the imagery in Southern California. In many parts of the world, it is hard to collect imagery because of cloud cover. Esri uses an algorithm to select the best imagery based on cloud cover and the most recent imagery, but it is sometimes impossible to avoid clouds. Each strip is about 180 kilometers wide and is collected once every eight days. There are currently two Landsat satellites in orbit, and it takes each one 16 days to capture the entire earth. If you are in an area with lots of clouds, it might take weeks before you obtain a clear image. The blue stripes are examples of cloudy images.

In the center of the screen is a long, narrow reservoir.

b. Zoom in to the reservoir.

   Note: You can use the Zoom In button or double-click the map to zoom in.



Reservoir near Pripet, Ukraine at a zoom level of 20km. A smaller reservoir is visible to the northwest.

To the north of the reservoir is another smaller reservoir.

c Zoom in to the smaller reservoir.

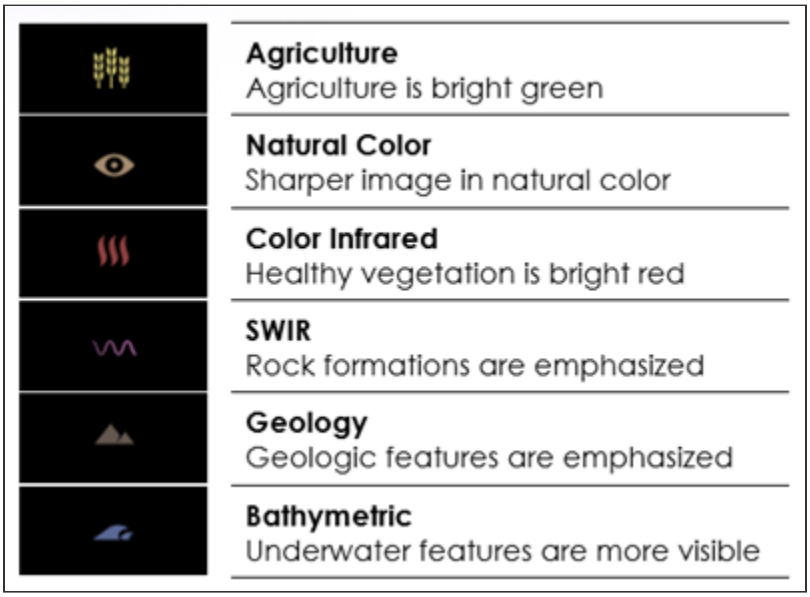
Smaller reservoir near Pripet, Ukraine at a zoom level of 2km.

From the patterns and shapes, what can you say about the agriculture in this region? What can you tell about the history of the river? Where there are fields, they are fallow. The river

appears to have been channelized at some point. You can see dried-up oxbow lakes to the east of the river. In this band combination, buildings appear lavender or white.

You can use the vertical menu on the left side of the map to view the location using different band combinations.

The first six options on the vertical menu are different band combinations designed to highlight various features on the earth. These bands capture energy in different parts of the electromagnetic (EM) spectrum.



Human eyes are also remote-sensing instruments. They are able to understand energy in the red, green, and blue portions of the electromagnetic spectrum, as well as energy in the near infrared, shortwave infrared, and even thermal bands. A sensor like Landsat also has the ability to do this.

d Click the Natural Color button to see what this area looks like from space.

Next, examine the area using the shortwave band.

e Click the SWIR button.

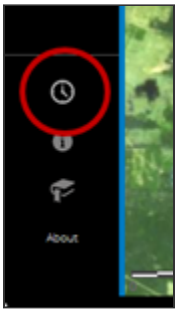
Notice that the haze lessens when you go from natural color to shortwave (SWIR).

This is because haze is highly reflective in the blue portion of the EM spectrum. Shortwave energy can pass through these atmospheric particles without disruption.

The area where the Chernobyl nuclear power plant is located, near Pripet, Ukraine.

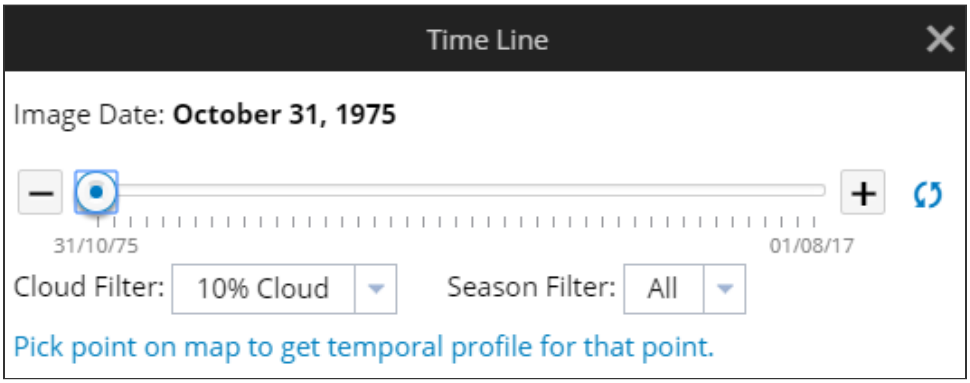
Step 3: Examine the temporal profile for a location

The historical images collected for the area near Chernobyl provide insight into the changes that have occurred there.



a. At the bottom of the vertical menu, click the Time button.

   Note: Click and drag the Time Line pop-up to move it to another location so you can see the reservoir.



The Time Line allows you to view the entire collection of historical images, or temporal profile, for an area. Temporal data is data that represents a state in time.

Note: Clicking an area on the map will retrieve a temporal profile for that location.

b. Click the Color Infrared symbol button.

You can use the time slider to see how places change over time.

c. Click and drag the circle on the slider to go back to the first image in the Time Line.

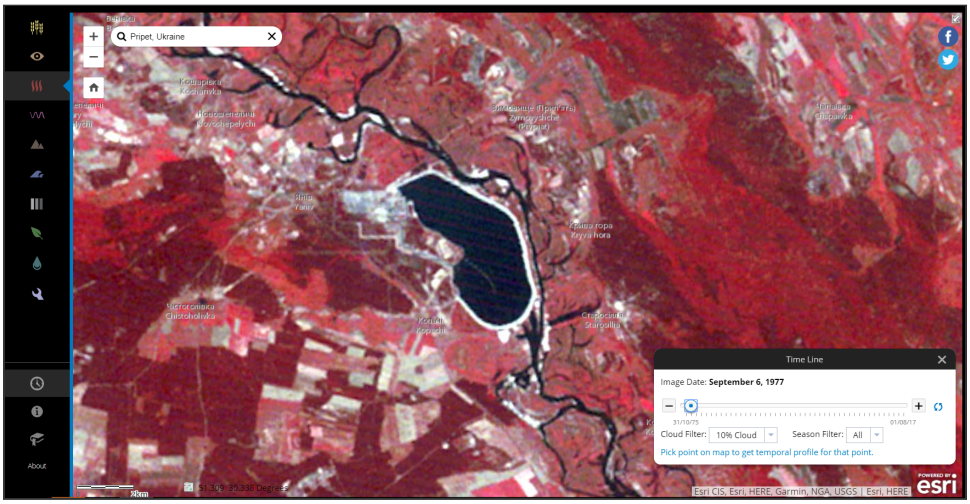
Hint: You can also use the Plus and Minus sign buttons in the Time Line pop-up to move forward or backward one image at a time.

The first image is dated October 31, 1975.

Color Infrared image of Pripet, Ukraine, from October 31, 1975, at a zoom level of 2km.

The vegetation here is bright red. Water is dark blue. Buildings are white. You can see the retaining wall of the reservoir under construction.

d. Use the Plus sign button to go to the next image, dated September 6, 1977.



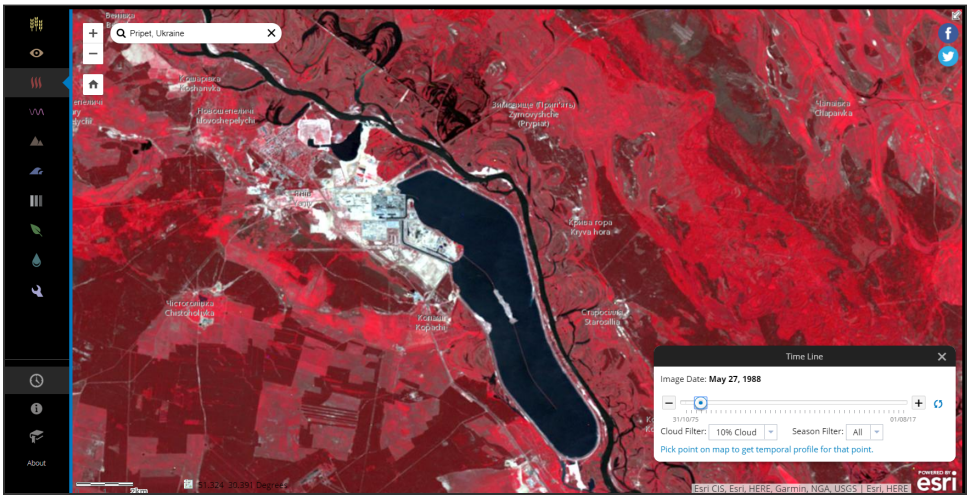
Color Infrared image of Pripet, Ukraine, from September 6, 1977, at a zoom level of 2km.

The reservoir is full. You can identify farms, roads, and buildings based on their shape.

e. Click through the timeline images, and notice the harvesting that is happening in the fields over time.

Hint: ArcGIS automatically enhances the image based on your current view, so try zooming and panning.

When the fields are shallow, they show up as a light pink/white. When you get to May 27, 1988, there is an abrupt change. All of the fields have been abandoned and are red. This date is two years after the nuclear power plant accident.



Color Infrared image of Pripet, Ukraine, from May 27, 1988, at a zoom level of 2km.

The time slider images provide historical context for the area and how it has changed over time. Another significant event happened in April 2015, when more than 400 hectares of forest burned.

f. Click the Plus sign button to jump ahead to April 29, 2015.

g. Click the Natural Color symbol button to view a sharper image in natural color.

Natural Color image of Pripet, Ukraine, from April 29, 2015, at a zoom level of 2km.

h. Zoom out one level so that you can see the burn scar toward the left of the screen.

Hint: You may need to pan the map to see the burn scar.

Natural Color image of Pripet, Ukraine, from April 29, 2015, at a zoom level of 4km.

You can see where the smoke is coming out from the northern edge of the burn.

i. Click through using the Plus sign button to view the subsequent time steps until you get to October 31, 2015.

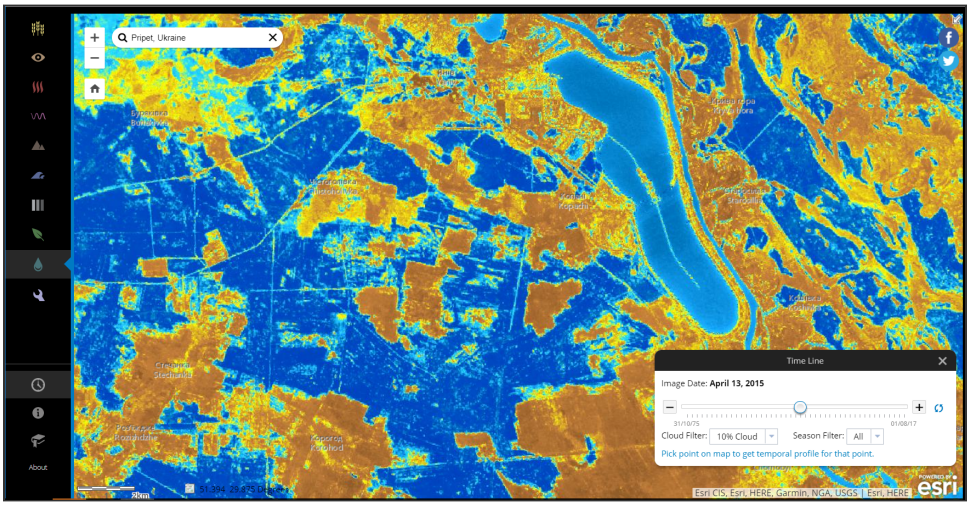
Natural Color image of Pripet, Ukraine, from October 31, 2015, at a zoom level of 4km.

Over time, the risk of forest fires increases because the landscape here naturally supports larger vegetation. As that vegetation grows, it consumes more of the radioactive material that is in the soil.

One of the ways that you can get a sense of where there is increased fire risk is by using the normalized difference vegetation index (NDVI). This index is designed to show where vegetation is stressed due to a lack of water. Look at a more recent image-one area of particular concern is the Red Forest, which has higher levels of radiation than the surrounding areas.

The above image is from a couple of weeks before the fire started. This natural color image shows where there is vegetation, but it does not tell you much about the health of the vegetation. You can use the normalized difference vegetation index to gain a better understanding of the moisture content that is in the forest.

j Click the Rain Drop symbol button to turn on the moisture index.

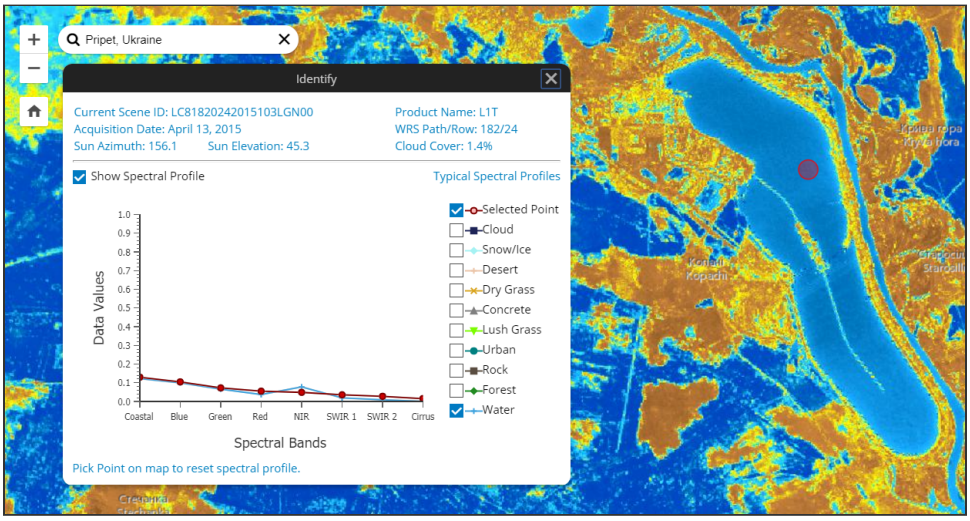


The deeper the blue areas are, the more water there is in the vegetation. Usually, you would expect a forest to be saturated. But when it is under stress, you will see more of the turquoise colors. This means that the forest does not have enough water, which can happen because of a drought or seasonally, depending on where you are in the world and how the vegetation has adapted to its resources and the climate.

Step 4: Examine the spectral profile for a location

The Identify button provides more details for a location, including its spectral profile. The spectral profile shows you how much energy is being reflected for each part of the electromagnetic spectrum.

a. Click the Identify button, and then click the water in the reservoir.

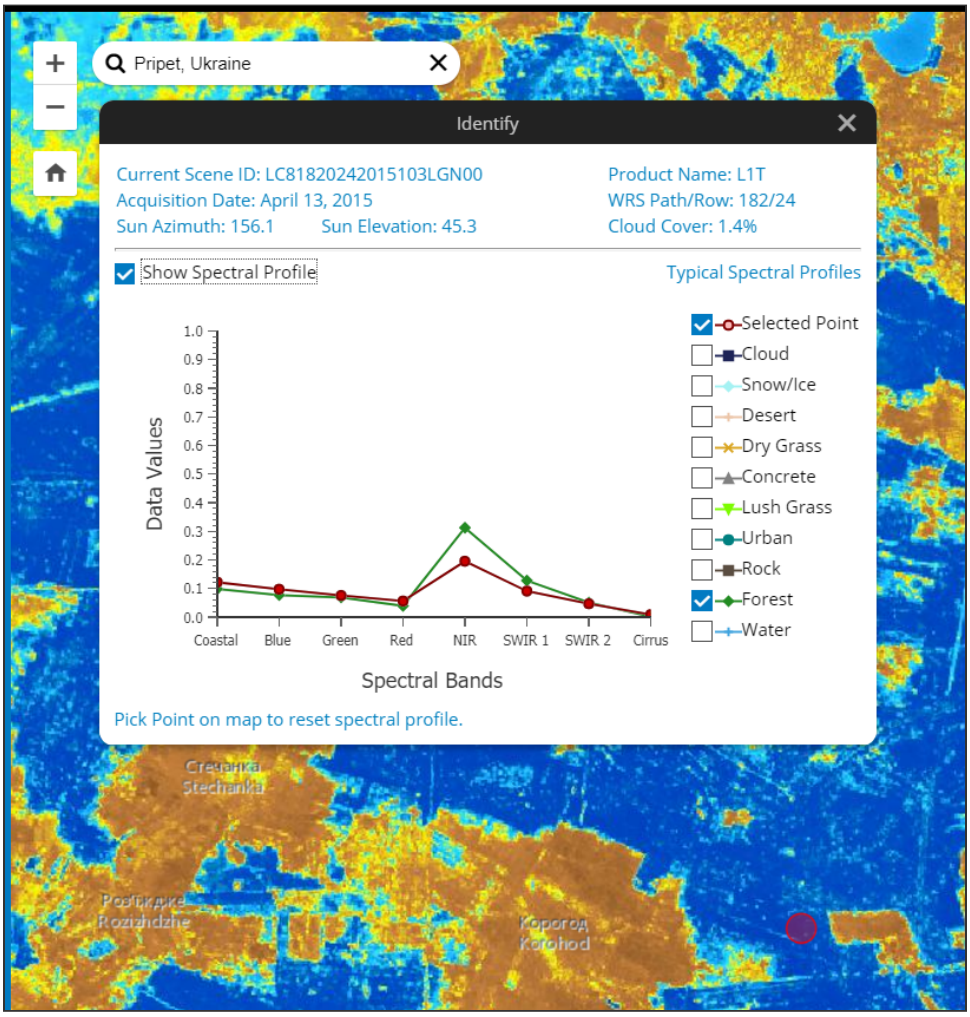


Spectral profile for a reservoir near Pripet, Ukraine.

You have a very low, flat spectral profile. This is because water, especially deep still water, does not reflect much energy. In fact, it absorbs much of it. You can infer this because deep, calm water often appears dark blue.

b. Next, click a forested area.

Hint: The deeper blue areas are forested.



Spectral profile for a forested area near Pripet, Ukraine.

Trees tend to be green. This is because they are reflecting green energy while absorbing all of the blue and red energy. They also reflect a great deal of near-infrared energy, which the human eye cannot see. Scientists use this spectral profile to identify vegetated areas. Depending on the quality of the sensor, they can even use it to identify specific tree species. In another exercise in this course, you will examine how to use information about burn scars and vegetation to better understand how a forest recovers after a major fire.

Conclusion

In this exercise, you learned how imagery can be used to understand historical context. The story told through the images allowed you to understand the impact that the nuclear power plant accident and forest fires had on Pripyat.