Wildfires, Remote Sensing and Emergency Response
How can we see the future of fires using satellites?

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Objectives:
A. Increase public awareness of the local fire danger and the impacts on the surrounding community.
B. Promoting public and private safety actions during active fire seasons.
C. Create independent work for students to encourage critical thinking and research development.

Variables:
A. WIFI or internet connection for students at home if this lesson is completed independently.
B. Student level of understanding of wildfire effects on the environment.
C. The ability to create a useful presentation that allows local emergency managers to use as guided models for similar future events.
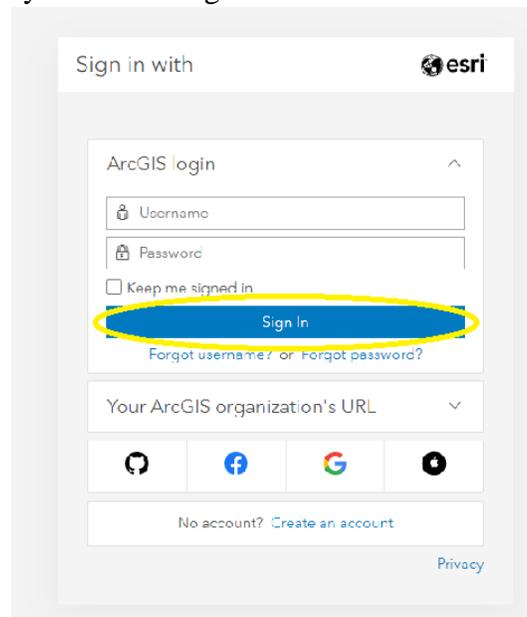
Require Steps: (Assuming students have already been taught the basics of wildfires)

INTRODUCTION

In August 2019, William Flats Fire near Keller, Washington, burned over 44,000 acres of land over a twelve day period. By using satellite imagery, students will be able to see how the fire grew and how using satellite imagery can assist emergency responders in assessing situations and providing the best management and response to wildfires based on the atmospheric and topographic conditions. **(Williams Flat Fire burning over 45,000 acres improves to 80 percenter containment, 2019)**
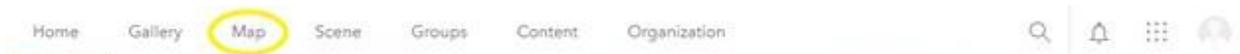
PART 1

A. ACCESS ArcGIS Online from the following link **www.arcgis.com**.
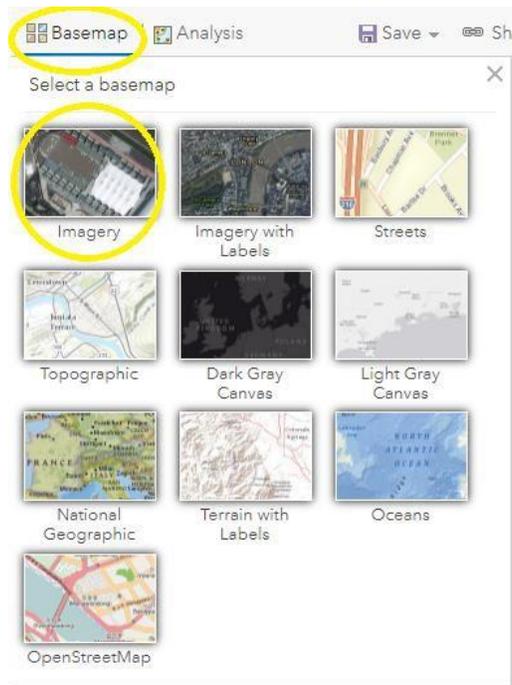
B. Click SIGN IN as displayed in the image below.

C. After accessing ArcGIS Online, click on **MAP** to create a new project or map in the ribbon at the top of the page.

D. CLICK BASEMAP and **CLICK IMAGERY** for the new background of the user's map.

E. In the upper right search box, search **FRANKLIN D. ROOSEVELT LAKE** located in Washington State. When the Williams Flat Fire was burning, a large portion of the north side of the river was burned in the fired. Zoom into the imagery to a 2 mile scale (found in the bottom left hand corner of the map and denoted with the black and white scale bar as seen in the image to the right)


Looking at the imagery, this is directly on the southside of the river to where the wildfire took place, evident by the new growth and vegetation across the burn scar on the northwest side of the river. The burn scar appears as a darker brown area. Using the Map Notes tool, you will outline this area to make it more visible.
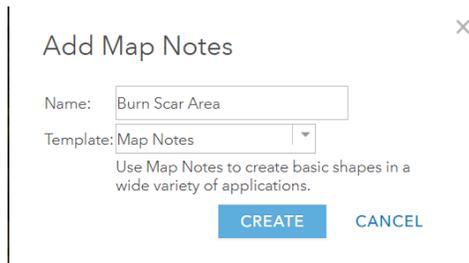
F. CREATING A MAP NOTE

1. Click Add at the top of the map ribbon.

2. Choose Map Notes
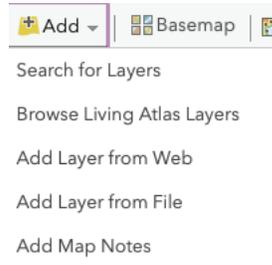
3. In the name box, change the name to Burn Scar Area and click CREATE.

4. Using the Freehand Area tool, you will outline the region on the map that appears as a burn scar. Click Freehand Area.

5. To draw the area, holding down the right mouse button, you will outline the area where there is regrowth vegetation or visible burn scar. Double click to create the end point. This action will create a filled polygon denoting the area.

6. Title the area "Williams Flat Burn Scar".

7. Add to the Description "Burn scar area from the Williams Flat Fire August 2019" and click close. This will create the layer on your map.

8. Next, with Map Notes still open in the tray on the left, choose Pushpin from the points. Click within the polygon to drop a pushpin.

9. Title the point Williams Flat Burn Scar.

10. Choose Change Symbol and scroll down to the red star.

11. Change the symbol size to 40 pixels. Click OK and then click CLOSE to save.
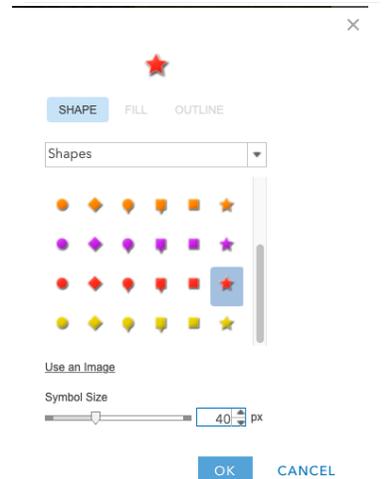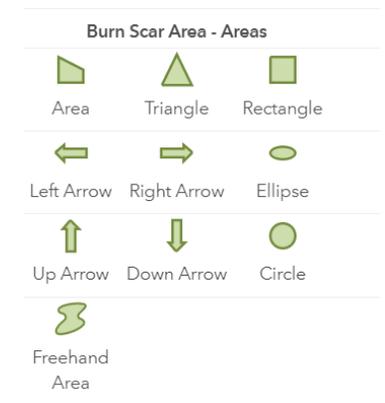
G. ADDING LAYERS The next step will involve adding new layers to the map that will represent the data that will be displayed.

1. Click Add and using the dropdown menu, choose BROWSE LIVING ATLAS LAYERS.

2. Using the search feature, search for USA COUNTIES. You will use the USA Counties layer created by Esri.

3. To add this layer, click the plus sign in the bottom right corner of the item. This will add the layer to your current map.

4. Once you have added this layer, you will add the following layers.

   a. USA NLCD Landcover by Esri

   b. USA SSURGO Soil Hydrologic Group by Esri

   c. Terrain: Slope in Degrees by Esri

   d. Terrain: Slope Map by Esri

   e. Terrain: Aspect Map by Esri

   f. USA Population Density by Esri (this layer will actively change for the current year)
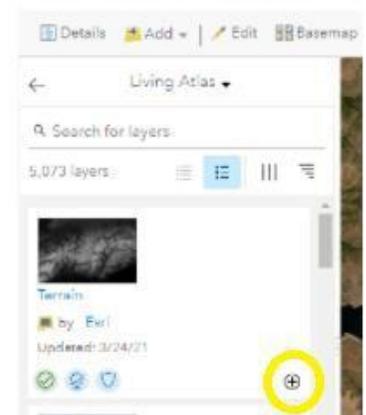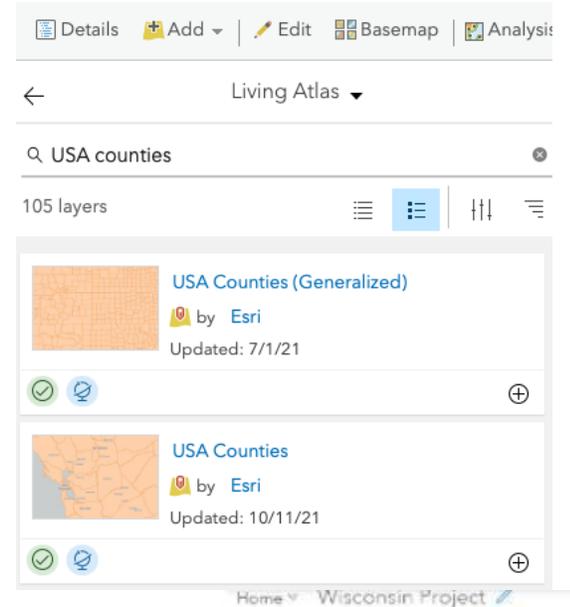
5. Click the Details tab (make sure you are on the Content tab) to see the layers you have just added. Each layer may be toggled on and off by clicking the checkmark. To expanded each layer, click the grey arrow. The legend for each layer can be seen when layer details are expanded.
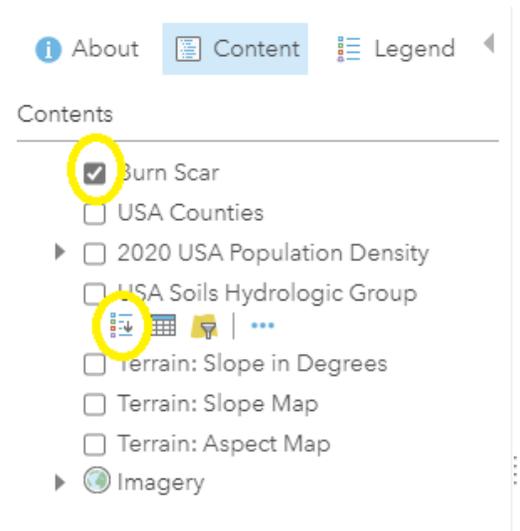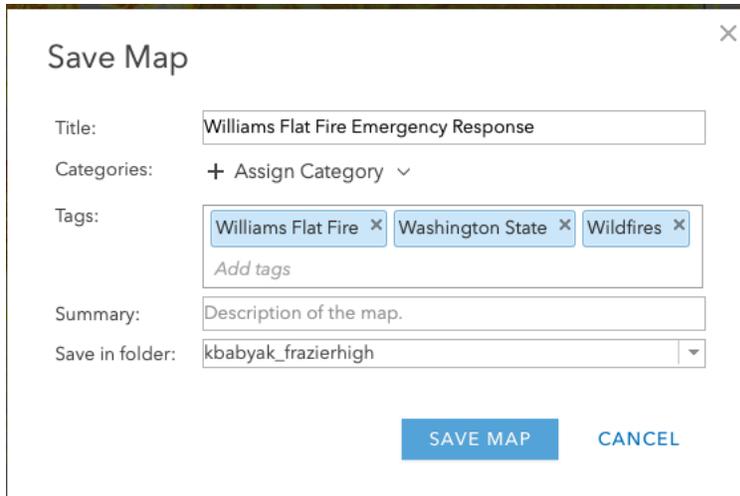
H. SAVING THE MAP

1. Click Save at the top of the map, found toward the center of the screen.

2. Title the Map "Williams Flat Fire Emergency Response"

3. For Tags enter "Williams Flat Fire" "Washington State" "Wildfires"

4. Click Save Map

Remember to save your map frequently as there is no autosave feature on ArcGIS.

Part 2 Using RealEarth to Extrapolate Data

Creating layers of data is informative but adding layers of historical data give an indication for regions that may be directly affected by future fires in the same region.

A. Creating an Account

1. To create and add these layers, use the following link for the data (RealEarth) Each student will create their own user account by clicking Tools in the tray on the left hand side and then choosing User Tools.
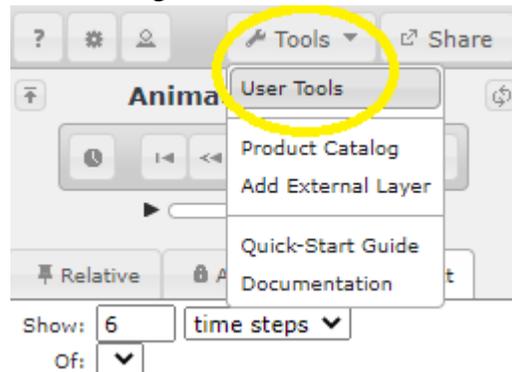
2. A new window will appear. Click "Continue using HTTP" to advance to the next page.

3. A new pop-up will appear that will prompt you to login or register. Unless you have an account with RealEarth, you must register to create the user account. Click **Register** to create a new user account.
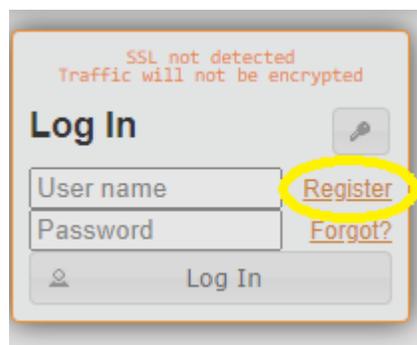
4. Complete the required registration and click Register. A verification email will be sent to the user and that will allow access for RealEarth. If you do not see the verification email, check your spam or junk folder for the email. You must complete the verification email before continuing.

5. Using the login box, login to RealEarth. This will open a second tab and will log the user into the original page.

   Troubleshooting: If RealEarth does not let you create a product without a watermark, it may prompt you to purchase a plan. As an educator, you can request free access

B. Creating the Map

1. Return to the RealEarth home by switching back to the tab. The User Tools tab can remain open.

2. In the tray on the left side of the page, under Products, ensure that the category being searched in "All categories".

3. Search for the layer titled Williams-Flats and press enter. Your search will yield "Williams-Flats-DNB". Within this product will be four Day/Night Bands from the VIIRS sensor, ranging from 2019-08-01 to 2019-08-18.

4. Click the plus sign in the upper right hand corner to add the data to the map.

Alternatively, you can drag and drop the file onto the map.

5. Using the animation tool in the Animation and Times section of the tray, click the First Frame button to return the imagery to the first date of record. This will be 08-01-2019. Using the Advance button, click one more to the 08-06-2019 imagery.

You should see a large bright area on the center of the map near Lake Roosevelt.
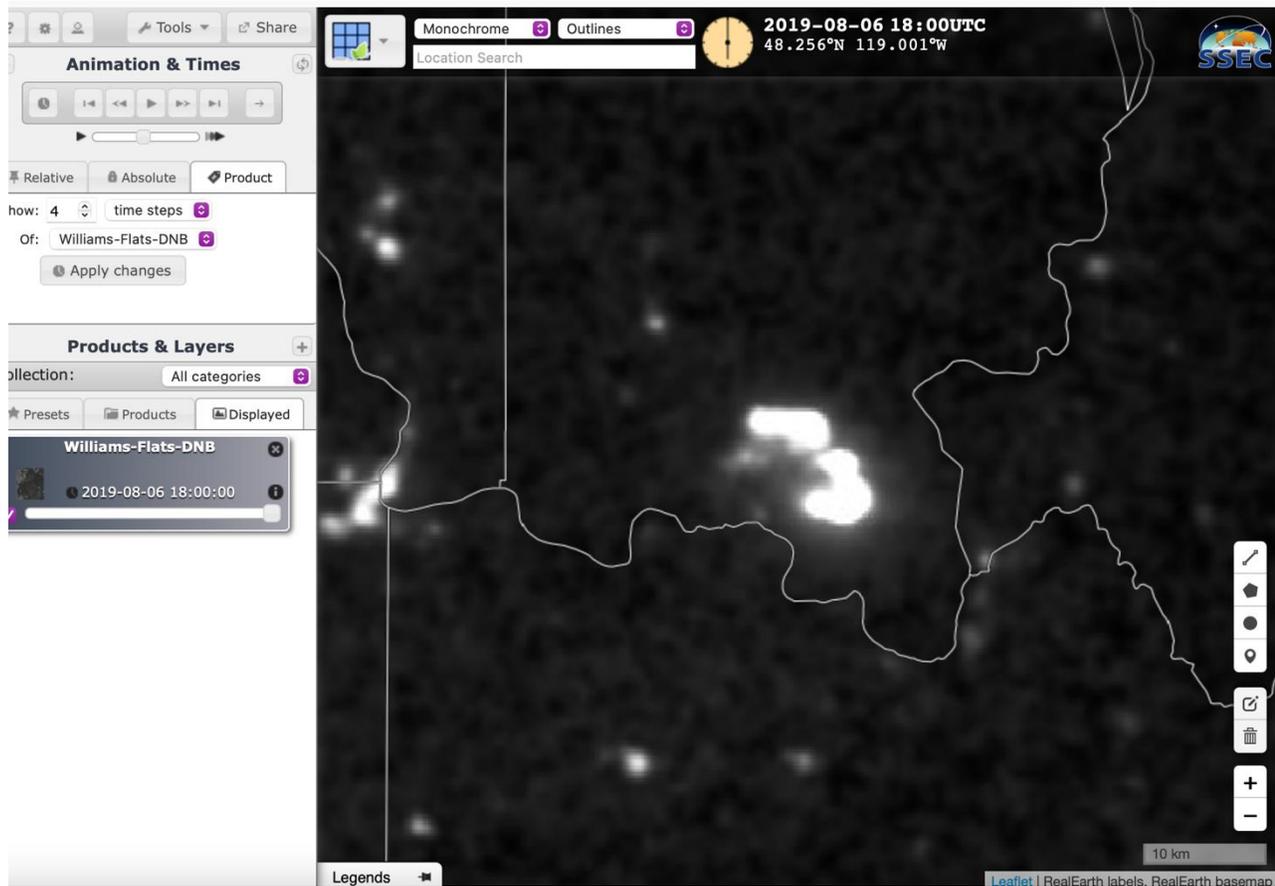
6. You will now share this imagery to ArcGIS as a web layer. Click Share at the top of the tray. A new box will open up over the map.
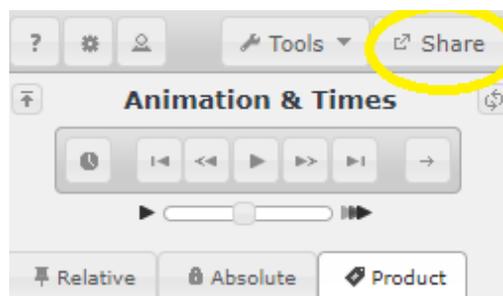
7. In the box, you should see a preview of the data. Scroll to the bottom and right click WMTS. This will open a menu to allow you to copy the link
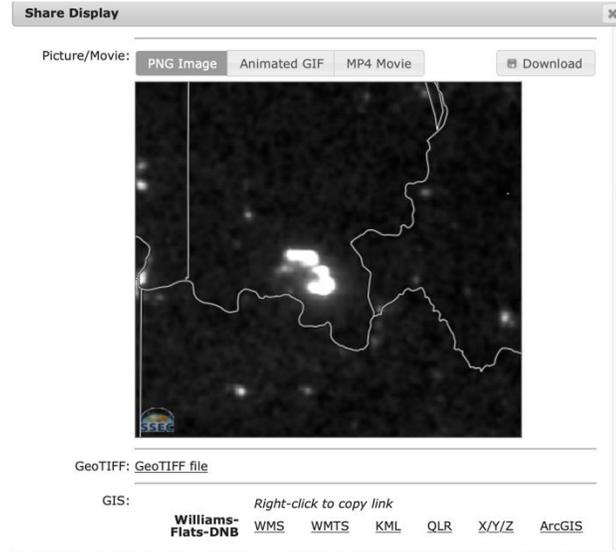
8. Using this link, reopen ArcGIS. Click Add+ and then choose "Add Layer from Web". In the dropdown menu, select "A WMTS OGC Web Service". Copy the link from RealEarth into the box. If you are prompted that it will not be accepted due to the http:// address, add an "s" to make it https://

9. Click "Get Layers" and select the Williams-Flats-DNB: 2019-08-06 18:00 UTC layer. Then Add Layer. This will add the RealEarth data to your GIS.

Figure 1 After the Williams Flat Fire imagery is added, the map in ArcGIS Online should appear as this image. Make sure that the burn scar layer is turned off.

10. Next you will add the following layers to your ArcGIS map. Be sure to save your map often as there is no autosave feature in ArcGIS Online.

11. Using the same process, add the following layers from RealEarth

- Williams Flats Fire VIIRS True Color

- Williams Flats Fire VIIRS False Color

Alternatively, the remaining imagery can be added by using the links below.

a. Williams Flats Fire VIIRS False Color

b. Williams Flats VIIRS True Color

When adding the layers, you will be prompted to "Get Layers". For each of the layer files, be sure to add the following dates: 08-01-2019, 08-06-2019, 08-14-2019. You will use these layers later in analysis.


12. Once the data has been added to the original ArcGIS Online map, click the Save button at the top of the ribbon to save your map.

PART III Analysis of Data

Now you have added data to your map, you can analyze the map to identify the fire growth as well as see how real time imagery can be used by emergency responders to make decisions during an emergency event.

A. **Using Data for Analysis**

You may have noticed that two imagery layers were added, one labeled the True Color and one labeled the False Color. False color imagery uses infrared radiation to shift how we "see" the imagery. The combination of shortwave IR, near IR and Red imagery can build a new view for researchers and emergency personnel. Adjusting the image to compensate and highlight reflections help make the fire and the smoke more visible. This is done by using red wavelengths to represent blue colors, enhancing the green of the vegetation and adjusting the shortwave IR to represent red which enhances the color of the fire due to the thermal properties of shortwave IR (S.Batzil, personal communication, November 17, 2021). We will use the three different imageries (the DNB, False Color and True Color) to analyze the movement of the fire over a 15 day period.

1. In your ArcGIS Online map, you can drag and drop your imagery layers so that they are in calendar order. To do this, when in the Content view, select the layer you would like to move and "grab" the three dots to the left of the layer's title. This will give you the ability to move the layer up and down in the order. Arrange your layers in order, from 08-01-2019 to 08-18-2019.
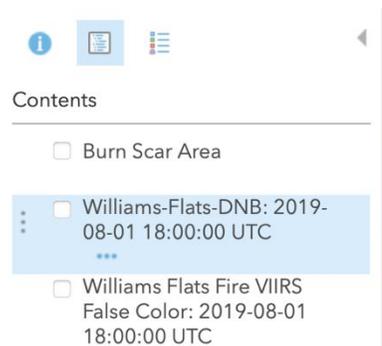

2. Starting with the "Williams Flats Fire VIIRS True Color: 2019-08-01" layer, turn on the layer and note the landscape at that time. *Do you notice anything that would indicate a fire?* Moving through the layers associated with 08-01-2019, examine each layer and determine if there is any indication of a fire.

3. Now, using the same method, toggle on and off the layers for 08-06-2019. The Williams Flats Fire was first reported on 08-02-2019. This imagery is from four days into the fire.
Which imagery layer provides the most comprehensive view?
What do you notice in that layer?
Does any layer give you any indication about what direction the fire might be moving?
4. Turn off all layers and turn on the "Williams Flats Fire VIIR False Color: 08-04-2019". On this layer, you can see three things, the burn area, the smoke and the vegetation.
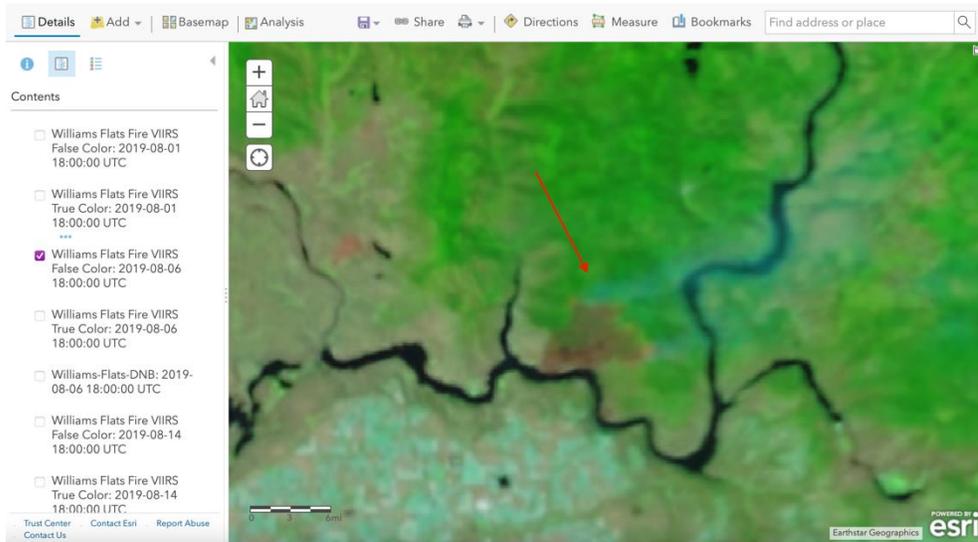
Which direction is the wind blowing?

If you were an emergency responder, how could you use this information to determine evacuations?

5. Turn off the False Color 2019-08-06 layer and turn on the DNB for this date. *What do you notice about the Day and Night Band imagery? How could this data be used by emergency responders?*

6. Next, toggle between the "Williams Flats Fire VIIRS True Color: 2019-08-14", "Williams Flats Fire VIIRS False Color: 2019-08-14" and "William Flats DNB: 2019-08-18".
How has the fire changed by this point, 12-16 days after it started?
Can you see any evidence of the fire?
What layer shows this evidence best?
How might emergency management in the county use this data?

7. With the "Williams Flats Fire VIIRS False Color: 2019-08-14" layer still on, turn on your original layer, named "Burn Scar". *How closely did your burn scar outline match the burn scar from the 08-14-2019 imagery?*

8. Finally, turn off all layers except for the "Terrain: Slope Map". On this map, steeper inclines are indicated with red while flatter slopes are indicated with yellows and oranges. You can click on the Show Map Legend in the Detail view to see the legend for the colors.
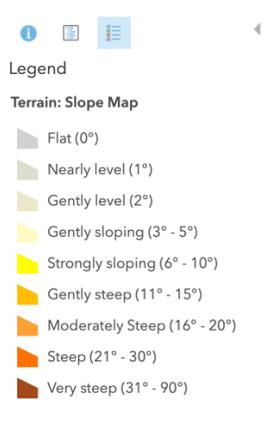
Look where the fire occurred (if you are having trouble finding this, turn on your Burn Scar layer).

What information would emergency responders need to know about this area if they were on the ground?

Would a slope map aid emergency response in their preparations for each subsequent day of the fire?

Resources for Students:

"Williams Flats Fire burning over 45,000 acres improves to 80-percent containment"
https://www.khq.com/news/williams-flats-fire-burning-over-45-000-acres-improves-to-80-percent-containment/article_c59ee970-b636-11e9-90ef-ff55ae41b3bc.html

"Flying through a Fire Cloud"
https://earthobservatory.nasa.gov/images/145446/flying-through-a-fire-cloud