

Lesson 4. Working with and creating derived datasets

In which we learn:

- How to visualize Landsat ARD surface temperature
- How to calculate F° from K° using ARD surface temperature
- How to generate and apply .lyrx files
- How to calculate an NDVI raster using ISRO LISS-3 data
- How to visualize burned areas using Landsat Level 3 data
- How to visualize dynamic surface water extent using Landsat Level 3 data

How to visualize Landsat ARD surface temperature

1. Begin by creating a new **Map** view. Select the **Insert** tab on the ribbon.
2. Locate the **New Map** icon at far left and click it to open up a new view. To save time, you will paste group layers from the **Lesson 1 Data Intro Map**.
3. Activate the **Lesson 1 Data Intro Map** and select the last three group layers in the **Landsat examples** group layer (everything except for **Clipped Big Bend NP** and **Landsat ARD Lake Meredith**). Right-click and choose **Copy**.
4. Return to the new **Map** view. Highlight **Map** in the **Contents** pane, right-click and choose **Paste**.
5. Holding down the **CTRL** key, click off one of the layers to turn all layers off.
6. Highlight the **Landsat ARD DFW Heat maps** group layer, right-click and choose **Zoom to Layer**. Make this layer visible again.
7. Add a new Surface Temperature layer to the map. Highlight the **Landsat ARD DFW Heat maps** group layer again, right-click and choose **Add Data**.
8. Navigate to the sub folder **C:\..\EO_SRS_ArcGISPro\RSdata\LS_ARD\DFW\ST**. Select the file **LC08_CU_016014_20190816_20190906_C01_V01_ST.tif**.
9. With the newly added layer selected in the **Contents** pane, open the **Symbology** pane.
10. In the **Primary Symbology** window:
 - Keep *Stretch* as the symbology type for now.
 - For *Color Scheme*, pull down, check *Show Names*, slide the side bar two thirds of the way down until you see the **Temperature** color scheme. Choose it.
 - In the *Label* windows, change **2905** to **290.5 K** and **3381** to **338.1 K**. Remember that the data are stored as integers in order to reduce space and retain precision. We need to keep in mind that a factor of 0.1 should be applied to calculate the true temperature value. Layer symbology updates automatically.

11. In the **Contents** pane, flip the visibility of the top layer (20180816) on and off to compare the layer with that of 20190731. The data ranges of the two layers are similar so it is reasonable to compare the two using a stretched symbology.

12. Select the **Value** text above the layer legend and change to **Temperature in Kelvin**.

How to calculate F° from K° using ARD surface temperature

13. Open the **Raster Functions Pane** by choosing the **Analysis** tab on the ribbon, and clicking on the **Raster Functions** icon in the **Raster** group at the right side of the ribbon.

14. Start typing *Band Arithmetic* in the *Find Raster Functions* search window.

15. Click on the *Band Arithmetic* icon to open the function window in the pane. In the [Parameters](#) tab:

- For *Raster*, choose the DFW Heat map from 2019-8-16, **LC08_CU_016014_20190816_20190906_C01_V01_ST.tif**.
- For *Method*, pulldown and scroll up to find *User Defined*.
- For *Band Indexes*, type the following equation:
 - $B1 * 0.1$
- Switch to the [General](#) tab.
- For *Name* type in K
- Click the **Create new layer** button. The output layer now displays values in K°.

16. Return to the **Raster Functions Pane**.

17. Start typing *Unit Conversion* in the *Find Raster Functions* search window.

18. Click on the *Unit Conversion* icon to open the function window in the pane. In the [Parameters](#) tab:

- For *Raster*, choose the output from the previous raster function, **K_LC08_CU_016014_20190816_20190906_C01_V01_ST.tif**.
- For *From Unit*, pulldown and choose *Kelvin*.
- For *To Unit*, pulldown and choose *Fahrenheit*.
- Switch to the [General](#) tab.
- For *Name* type in F
- Click the **Create new layer** button.

19. If there is time, repeat the process for the 20190731 DFW data. The results can be used to test the LRYX file generated in the next section.

How to generate and apply LYRX files

20. Now that surface temperature is expressed in F°, is there a better way to visualize the raster? A classified map is a useful alternative. Highlight the new **F** layer in the **Contents** pane and activate the **Appearance** tab.
21. Click on the arrow below the **Symbology** icon and choose the option to **Classify**. The Symbology pane opens up. The defaults are used. Let's make some changes:
 - For *Method*, choose *Defined Interval*.
 - For *Interval Size*, type in *10*.
 - For *Color scheme*, choose the same *Temperature* color scheme chosen in step 10 above.
 - With the Defined Interval method and an interval size of 10 the map legend and the map view are much easier to interpret.
22. Highlight the new **F** layer in the **Contents** pane if needed and activate the **Share** tab to the left of the **Appearance** tab.
23. Locate and click on the **Layer File** icon in the **Save As** group on the right side of the ribbon.
24. The **Save Layer(s) as LYRX** File window opens by default to the project folder. You will see other .lyrx files. Choose the file named **Temperature in F.lyrx** and choose to overwrite it.
25. Click **Save**.
26. Now you can apply the LYRX file to other raster layers that have similar value ranges. To do so, select the target layer and open the **Symbology** pane:
 - Click on the three horizontal bars at the top right corner of the **Symbology** pane.
 - Choose Import...
 - In the Import Symbology window, double-click on Folders to open, then on the Pro project folder named ArcPro_RS_2019.
 - Choose the LYRX file named **Temperature in F.lyrx** and click OK. The Map view and Contents pane will update.
27. When done, turn off visibility of the **Landsat ARD DFW Heat maps** group layer.

How to calculate an NDVI raster using ISRO LISS-3 data

28. Activate the **Lesson 1 Data Intro Map** and select the map layer **R2 LS3 08-29-2019 24m bands 5,4,3,2** from the **ISRO ResourceSat** layer group.
29. Return to the new **Map** view. Highlight **Map** in the **Contents** pane, right-click and choose **Paste**.

30. Highlight the **R2 LS3 08-29-2019 24m bands 5,4,3,2** layer, right-click and choose **Zoom to Layer**. Make this layer visible.
31. Reopen the **Raster Functions Pane** by choosing the **Analysis** tab on the ribbon, and clicking on the **Raster Functions** icon in the **Raster** group at the right side of the ribbon.
32. Start typing *NDVI* in the *Find Raster Functions* search window.
33. Click on the *NDVI* icon to open the function window in the pane. In the [Parameters](#) tab:
 - For *Raster*, choose the the **R2 LS3 08-29-2019 24m bands 5,4,3,2** layer. In this particular layer composite, Band 3 is visible red and Band 2 is the infrared band.
 - For *Visible Band ID*, choose 3.
 - For *Infrared Band ID*, choose 2.
 - Check the box for *Scientific Output*.
 - Click the **Create new layer** button.
34. The *NDVI Raster Function* output has stretch symbology applied. Note that the values fall between the expected value range of -1 to +1. Let's repeat using a different option.
35. Return to the **Raster Functions** window. This time select the *NDVI Colorized* icon.
36. In the [Parameters](#) tab:
 - For *Raster*, choose the **R2 LS3 08-29-2019 24m bands 5,4,3,2** layer. In this particular layer composite, Band 3 is visible red and Band 2 is the infrared band.
 - For *Visible Band ID*, choose 3.
 - For *Infrared Band ID*, choose 2.
 - For *Color Scheme Type*, accept the default *Color Map*.
 - For *Colormap*, accept the default *NDVI3*.
 - Click the **Create new layer** button.
37. The *NDVI Colorized Raster Function* output has a color map applied to values that have been converted to 8 bit values ranging from 0 to 255. Note that it is possible to create a custom color map that can be saved and applied to 8 bit single band raster products.
38. When done, turn off visibility of the **R2 LS3 08-29-2019 24m bands 5,4,3,2** layer and layers derived from it.

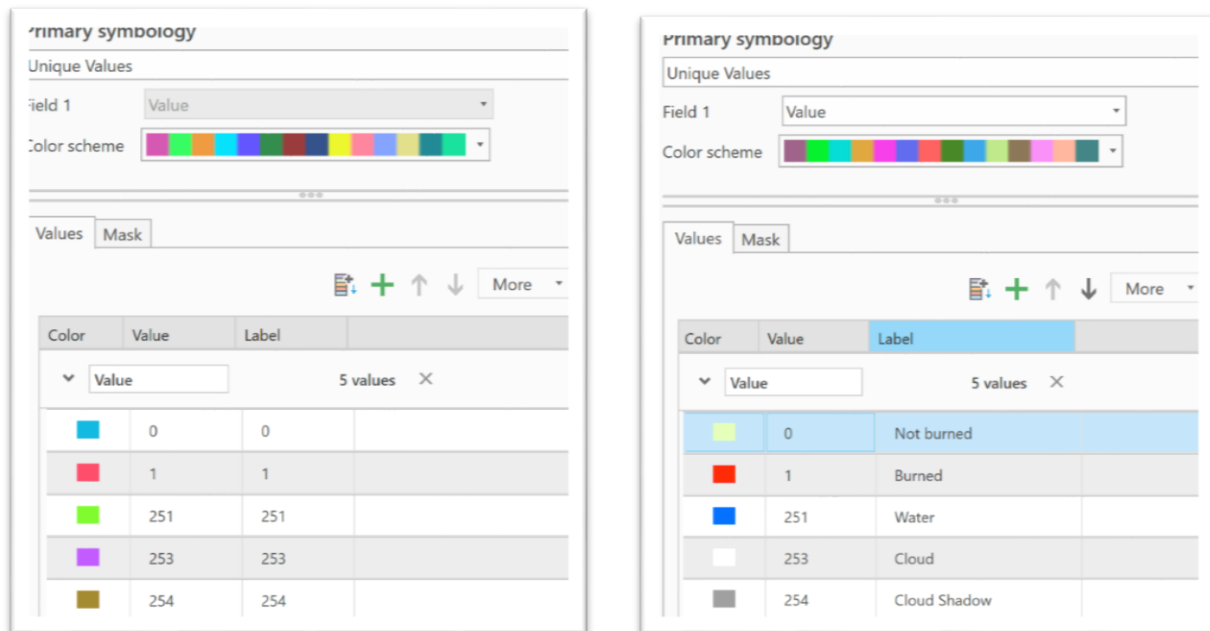
How to visualize burned areas using Landsat Level 3 data

In this section, you will populate an empty mosaic data, and apply thematic symbology using unique values symbology found in the USGS [Landsat Burned Area Product Guide](#). Note that the file name designation **BC** in the **Level 3 Burn Area** product stands for *Burn Classification*.

39. Highlight the **Mendocino Burn scar** group layer, right-click and choose **Zoom to Layer**. Make this layer visible.

40. While pressing the **CTRL** key, highlight the top 4 **LC08_CU_...BC.tif** files and click in one check box to make all 4 layers visible. The fifth file can be removed from the map or kept invisible.
41. Keeping the 4 layers highlighted, activate the **Appearance** tab. For each of the four layers in turn:
 - click open the down arrow below the **Symbology** icon in the **Appearance** tab
 - choose the **Stretch** symbol option.
42. Next, highlight the **Mendocino Burn scar** group layer. Right-click and choose **Add Data**.
43. Navigate to the default project geodatabase, **C:\..\EO_SRS_ArcGISPro\ArcPro_RS_2019\ArcPro_RS_2019.gdb**, and add the mosaic dataset named **CA_Wildfire**.
44. Open the **Geoprocessing** pane, return to the **Search (Find Tools)** view if not already there, and open the **Add Rasters to Mosaic Dataset** geoprocessing tool. This tool may be in your *Recent* list.
45. In the **Parameters** tab:
 - For *Mosaic Dataset*, choose **CA_Wildfire**.
 - For *Raster Type*, choose *Raster Dataset*.
 - For *Processing Templates*, keep the default.
 - For *Input Data*, choose *File*.
 - Click open the folder icon and navigate to **C:\..\EO_SRS_ArcGISPro\RSdata\LS_ARD\MendocinoFire2018\BA**. Don't panic when you see an empty file list and the message *No items match your search*.
 - Look to the lower right of the window and change *File List (*.csv)* to *All files*. Don't panic when you see a very full file list now.
 - Look to the upper right window that says *Search BA* and type in the text *_BC.tif* to filter the results. Choose the 4 *_BC.tif* files, skipping any *.ovr* or other file types in the folder.
 - Click the **Run** button. The empty mosaic dataset updates and the Image shows raster data using a **Stretch** symbology.
46. Now highlight the **CA_Wildfire** mosaic dataset **Image** layer in the **Contents** pane:
 - click open the down arrow below the **Symbology** icon in the **Appearance** tab
 - choose the **Unique Values** symbology option. A **Warning** window opens, asking to build a raster attribute table
 - choose **Yes**.
47. With the Symbology pane open, notice that the raster attribute table calculated 5 unique values in the raster. Table 4-3, **BC Layer Pixel Values**, on page 8 of the USGS [Landsat Burned Area Product Guide](#) (included on the workshop USB flash drive) lists all possible numeric thematic values for the BC product. Use the following before and after graphics as a guide

for updating the **Unique Values** symbology. If needed, ask your instructor for assistance in updating colors and labels.



48. Once the symbology is updated:

- return to the **Contents** pane
- turn off the green **Footprint** outline
- zoom to Source Resolution of the **Image** raster layer to view the level of detail in the classified image.

Time permitting, we will create a chart of the distribution of Band 1 with a square root transformation. On the chart, it is possible to query the count of pixels have the value of 1 (classified as burned area). Multiply the count (1,647,217) by the area of a 30x30m pixel and convert to an appropriate area measurement to determine number of acres, hectares or square miles burnt. ArcGIS Pro includes many other tools for further raster data analysis.

49. Collapse and turn off visibility for the **Mendecino Burn scar** group layer.

How to visualize dynamic surface water extent using Landsat Level 3 data

50. In this final exercise, put your new skills to work. Begin by highlighting the **Landsat ARD Mississippi Flooding** group layer, right-click and choose **Zoom to Layer**. Make this layer visible.

51. Download the USGS [Landsat Dynamic Surface Water Extent Product Guide](#) (or locate the PDF on the workshop USB flash drive).

52. Go to **Section 4 - Product Characteristics** (page 8 in the PDF)> look over the list of available products. Identify the GeoTIFFs represented in the **Landsat ARD Mississippi Flooding** group layer.
53. Based on your interests, choose one or more of the SW (surface water) products and locate any not already loaded into the **Contents** pane. GeoTIFFS are located in **C:\..\EO_SRS_ArcGISPro\RSdata\LS_ARD\MississippiFloodMemphis\SW**.
54. Locate the appropriate table of product specifications in section 4.2 of the USGS product guide.
55. Use product specification as a guide to experiment with symbology, LYRX file generation, and or mosaic dataset development.
56. Alternatively, work with surface reflectance data for the same area and dates located in **C:\..\EO_SRS_ArcGISPro\RSdata\LS_ARD\MississippiFloodMemphis\SR**.

But you didn't cover raster reprojection and coordinate systems!

Jarlath O'Neil-Dunne of the University of Vermont and VermontView/AmericaView has created an excellent Penn State University video series related to [Projecting Raster Data](#) using ArcGIS Pro. Your instructor highly recommends any GIS or remote sensing related video or topic by Jarlath O'Neil-Dunne.