

# EXERCISE

## Resampling and Pansharping using Raster Functions in ArcPro



### Introduction

The resample function should be used when you want to analyze raster's with different resolutions e.g. Landsat (30m) and Sentinel-2 (10m) or before you pansharpen raster bands. This function changes the cell size of a raster and can be applied to individual images, raster datasets, and mosaics. You can also change the radiometric resolution (level of detail) in each pixel. If you resample a lower resolution raster image to a higher resolution (30m pixels to 10m pixels) for analysis your accuracy will still only be as good as the larger pixel. There are [numerous option](#) to resample your raster too, each applies to different data types such as discrete or continuous data.

In this exercise we will use the panchromatic band in Landsat 8 images to sharpen the 30-meter visible and near infrared bands. The imagery we are using was collected in February 2020 over Los Padres National Forest near Santa Barbara CA and is not corrected for surface reflectance. This forest spans 1.75million acres of both Central, Coastal, and Transverse landscapes. It is home to more than 487 fish and wildlife species.

### Objectives

- Learn how to Resample Landsat using resample functions and change the bit depth. Pan sharpening Landsat to 15m panchromatic band

### Required Data

- LC08\_Band2 – Blue Band
- LC08\_Band3 – Green Band
- LC08\_Band4 – Red Band
- LC08\_Band8 – Panchromatic Band

### Prerequisites

- Esri ArcGIS Pro



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# Part 1: Create a Composite Image

By making a composite of the bands we want to use to resample and pansharpen we will be able to reduce the number of times we have to run the same processes.

## A. Inspect the Data

1. In the Map tab click the **Add Data** button
2. Navigate to your course downloads then **Resampling\_Exercise** folder
3. **Load** in bands 2 (blue), 3 (green), 4 (red), and band 8 (panchromatic). Below is a list of Landsat bands and their resolution
  - i. If ArcPro prompts you to build pyramids you can choose yes or no. Pyramids speed up rendering but might also take a minute to build. Depending on your computer's power you can decide.

Band Number	$\mu\text{m}$	Resolution
1	0.433–0.453	30 m
2	0.450–0.515	30 m
3	0.525–0.600	30 m
4	0.630–0.680	30 m
5	0.845–0.885	30 m
6	1.560–1.660	30 m
7	2.100–2.300	30 m
8	0.500–0.680	15 m
9	1.360–1.390	30 m
10	10.6–11.2	100 m
11	11.5–12.5	100 m

Of its 11 bands, only those in the very shortest wavelengths (bands 1–4 and 8) sense visible light – all the others are in parts of the spectrum that we can't see. The true-color view from Landsat is less than half of what it sees. To understand the value of all the bands, let's look at them each in turn:

4. Take a minute to get to know the data. **Right click** on Band 2 to open the **properties**
5. Select the **Source** tab and expand **Raster** Information
  - i. Note the cell size, Pixel type and Pixel Depth. The red, blue, and green bands will have a 30-meter cell size, with a 16-bit unsigned pixel depth.

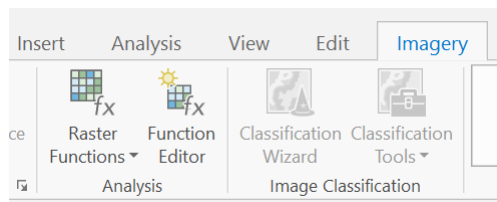
**Note:** The pixel type and depth explain the images radiometric resolution or the amount of detail each pixel has. An unsigned pixel type means your pixels will have no negative numbers (0 to 255) whereas signed pixels can have negative values.

6. Now check out the **raster information** of the panchromatic band (**band 8**)
  - i. Note that the cell size has changed but the pixel type and depth remain the same
7. **Zoom** into Santa Barbara just below the Los Padre NF in the center of the image on the coast
8. **Toggle on and off** Band 8 and notice its sharpness compared it to another visible bands

**Note:** Because the panchromatic band captures a much wider range of light the image is sharper than the individual bands. Panchromatic sharpening combines the high-resolution detail of the pan band with the lower resolution color information of the other bands. ([NASA Earth Observatory](#))

## B. Make a Composite Image

1. From the Imagery tab, in Analysis group, click Raster Functions to open the **RasterFunctions** pane
2. Search **Composite** in the **Systems** tab and select **Composite Bands**

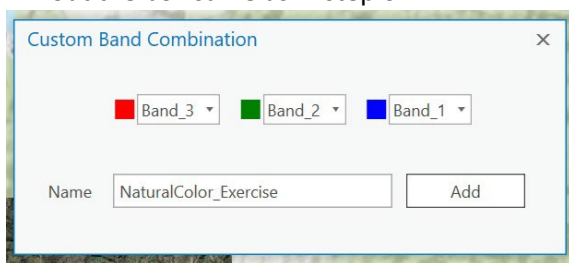


3. In the **General** tab Make the **Output Pixel Type** is same as what you found when investigating the imagery
  - i. 16-bit Unsigned

**Note:** This is where you can change your pixel depth. If you were to choose 3- bit unsigned your image would show more detail in each pixel BUT it would also basically double the file size. So instead of having a 1.6 GB image you'd create a 3.5 GB image. If you want to use the pan sharpened image for display purposes you might consider increasing the pixel depth to add in more detail on the other hand if you are going to run a large amount of data for analysis you might want to reduce the level of detail per pixel so it processes faster.

4. In the **Parameters** tab add in bands 2, 3 and 4. The band at the top of the list will become band 1 in the output and the next will be band 2, and so on.
  - i. Be sure that the list is ordered 2, 3, 4 therefore the blue band becomes band 1, green is 2, red is 3
5. Click **Create new layer**
6. In the **Contents** pane click on the red square next to band 1 to open the symbology. **Change** the **Primary Symbology** for RGB to match the correct band numbers. Leave the stretch type at Percent Clip. If you choose stretch type as none the image will look hazy because it has not been atmospherically corrected.
  - i. Red = 3
  - ii. Green = 2
  - iii. Blue = 1
7. **Save this specific band combination** by going to the Appearance tab in the Rendering box and click Band Combination and select **custom**

8. **Fill** out the box same as in step 6



9. **Name** it NaturalColor\_exercise

10. Click **Add**

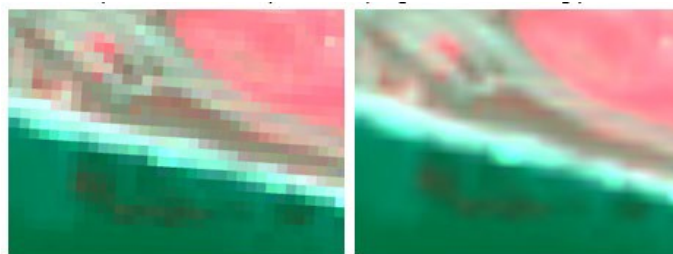
## Part 2: Resample Composite Image

### A. Resample Image

We want to pan-sharpen bands 2 through 4 (our composite bands layer) so we must first resample the composite pixel sizes to match the pan bands 15-meter.

1. In the **Raster Function** pane, Search for **Resample** in the Systems tab
2. Click **General** and make the **Output Pixel Type** the same as what you found when investigating the imagery
  - i. 16-bit Unsigned
3. Click **Parameters** and select your **composite bands** from the Raster drop down
4. **Expand** the **Resampling Type** and select **Nearest Neighbor**
  - i. There are numerous options that apply statistics to the pixel differently. The default is nearest neighbor because it works with both discrete and continuous value types. We are working with continuous data here (land classifications are discrete data). More information for each resampling type can be found [here](#).
5. The **Input cell size** is the original pixel size you noted previously
  - i. For the composite bands it will be 30-meters
6. The **Output cell size** will be what you want to transform it too. Set this to 15 meters, the same resolution as the panchromatic band
7. Click **Create New Layer**
8. **Inspect** your new layer by **checking that the cell size** has changed via Properties, Source, Raster Information drop down
9. Change the **symbology** to match the bands to the correct color as detailed above. If you saved you combination go to Appearance, Band combination, select **NaturalColor\_exercise**.
10. Next you will compare the results using different resampling types. Rerun steps 1-9 but select **Bilinear Interpolation** for the Resampling Type. This resample technique is specifically meant for continuous datasets.
11. Rename the output **Bilinear\_Resample** by right clicking on the layer, open properties and in the general tab change the name.

12. Once you have these both in your Table of Contents **zoom in** until you start to see pixels. Notice the difference in smoothness. Examples are below, the image on the left is the NearestNeighbor and the right is the bilinear interpolation. Depending on the type of data (continuous vs discrete) you should choose your resampling method accordingly.



## Part 3: Pansharpening Resampled Composite

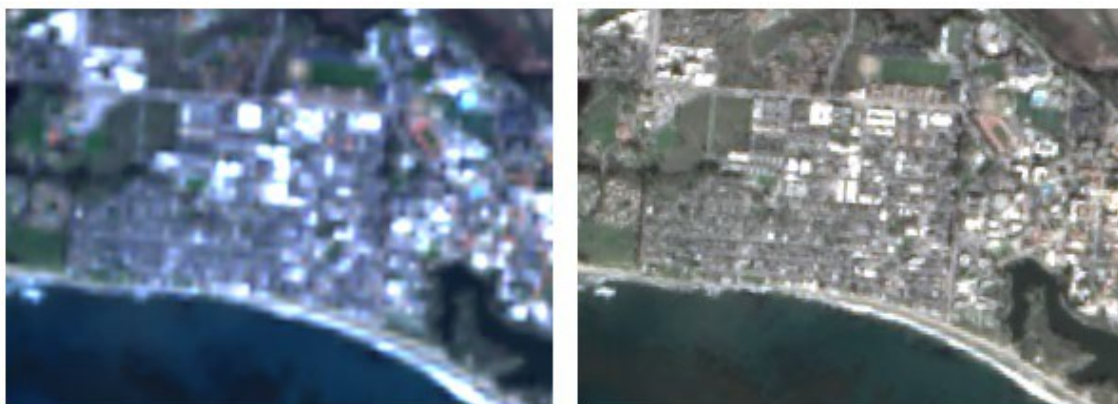
Pan-sharpening an image artificially enhances the spatial resolution of a multiband image by fusing it with a higher-resolution panchromatic image. It's important to understand that this process alters the radiometry and spectral characteristics of the imagery and should be used with caution for analytical purposes ([ERSI](#)). However, this process is useful for visualization and image interpretation.

There are five methods to choose from when creating a pan-sharpened image. The methods each use different models to improve the spatial resolution while maintaining the color. For certain methods you can add in a fourth band such as NIR. You can also change the weighting of bands that might improve output color quality. This is specifically useful if you do add in a fourth band ([ESRI](#)).

### A. Pansharpen Image

1. In the **Raster Function** pane search for the **Pansharpen** function
2. In the General tab change **Output Pixel Type** to 16-Bit Unsigned
3. In the **Parameters** tab fill in the following
  - i. Multispectral = Bilinear\_Resample\_Composit\_Bands
  - ii. Panchromatic = LC08\_Band8
  - iii. Pansharpening Type = IHS
4. Click **Create new layer**
5. Adjust the **Band Combination** to a natural color combination or select your saved band combination
  - i. Red = 3
  - ii. Green = 2
  - iii. Blue = 1
6. **Inspect the difference.** Zoom into Santa Barbara and use the swipe tool to see the difference in the level of detail. (Swipe found in the Appearance tab under effects)

**Note:** Notice the different colors that are displayed between the two images pre and post pan sharpening. Yes, the pansharpened image is crisper but your data has been altered noticeably. Pansharpened images are good especially for display purposes but would not be ideal for multi date analytical comparisons.



### Optional:

7. If you want to see how an increase in pixel depth changes your result, repeat steps 1 through 5 and change step 3 to 32-bit unsigned
8. Feel free to try different pan sharpening methods to see how the outputs compare.

**Congratulations!** You have successfully completed this exercise. You now know how to create a composite, resample an image and how to pansharpen an image using raster functions. You also know how adjust band combinations and save them for future use.