1. Summary

Vegetation Growth Assessment.

In 2018, only in California, 405 wildfires took place throughout the state including the Mendocino Complex fire. This wildfire is considered one of the largest fires in California history and it burned an area of 459,000 acres with a cost of $257 million for the State of California.

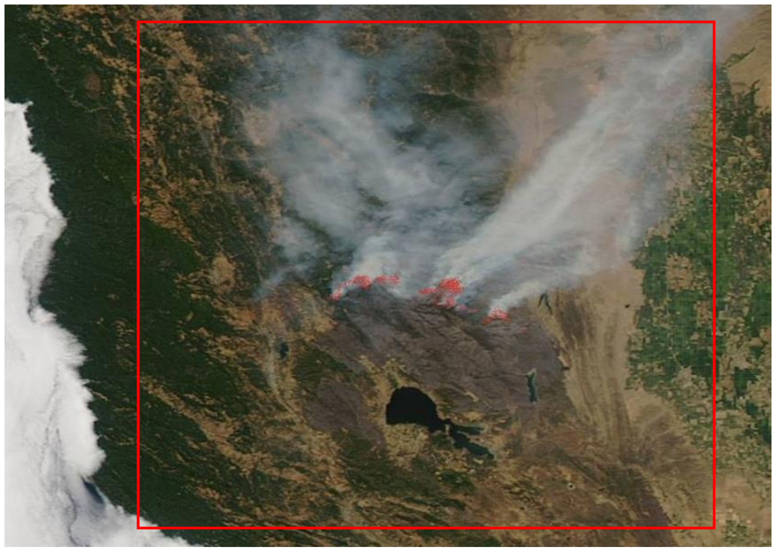

Figure 1 Mendocino Complex Wildfire

With this project, I aim to investigate the vegetation growth for the area where wildfire took place using a stablished Image Classification workflow provided by ArcGIS pro. I will use Landsat TM Imagery for two different dates, one post-fire date; that would be right after the fire was contained, and a year later the post-fire date.

I will be using the EarthExplorer to find and download the images that I will need for the for the project.

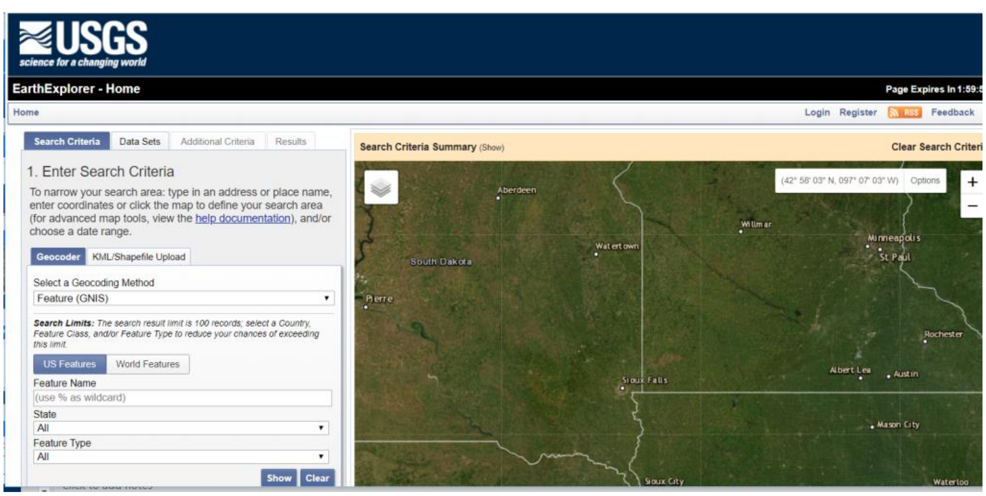

Figure 2 Searching for and Downloading Imagery

Questions to be answered by performing this image classification process are the following:

a. Is there any way to quantify vegetation growth within the area and the surroundings of the Mendocino Complex wildfire?
b. What is an estimate percentage of vegetation growth for the study area?

Image Classification

For imagery with a spatial resolution of 30 m, I used a Minimum Mapping Unit (MMU) of 3600 sq m as literature suggested.

For this process, I followed the following stablished workflow:

a. Segmentation
b. Classification Method
c. Training Samples
d. Train the Classifier
e. Run Classification
f. Merge Classes
g. Reclassify Classes
h. Generation of the Classified Image
i. NDVI processes for Pre and Post clipped images

2. Purpose

The purpose of the project is to gain hands-on experience as well as a better understanding about the workflow that it is used to perform image classification using the ArcGIS Pro software application.

By using lectures and lab material given in class my aim is to analyze and classify Landsat imagery for the Mendocino Complex wildfire. I will be comparing pre and post classified outputs regarding vegetation growth for the area of interest. I will be running Normalized Difference Vegetation Index (NDVI) procedures for pre and post images so I can get another perspective about vegetation growth over the area of interest.

I believe that by implementing what I learned during class in this project, I will able to improve my skills at analyzing and performing image classification to satellite imagery.

3. Description of the image processing tasks

This project uses the following workflow.

a. **Segmentation**: a process that groups pixels based on their similarity.

b. **Classification Method**: supervised classification was used in this case.

c. **Training Samples**: I used 5 different classes as it follows,
   - Water
   - Urban
   - Agriculture
   - Vegetation
   - Burnland

d. **Train the Classifier**: using the training polygons selected the classifier was trained accordingly.

e. **Run Classification**: preliminary classified image.

f. **Merge Classes**: a process that allows merge classes when needed.

g. **Reclassify Classes**: a process that allows to fix misclassified classes.

h. **Generation of the Classified Image**: Final step in the process to obtain the final classified image.

i. **NDVI processes for Pre and Post clipped images**: processes ran to assess healthy vegetation over the area of interest.

4. **Summary of any difficulties/issues and how you resolved them**

I used the EarthExplorer to search for and locate the data and I found the application handy and easy to use but looking for the right Landsat Imagery was tedious and time-consuming. Data downloading and extraction did not present any issues at all.

The classification process went very well, however, I struggled a little bit when I was picking the training polygons for my training samples. I did the picking several times for both images as I wanted to obtain a good classified image and I helped myself by using different band combinations to visualize better the classes I selected for the analysis. For example, I used color infrared (NIR) to detect healthy vegetation and SWIR along with NIR to detect fire scars.

Also, I found ArcPro crashing or not displaying layers correctly when I was training the Classifier. I worked around the issue by keeping layers on the table of content at minimum, sometimes, inserting another map tab; very helpful, to copy over the new data being generated.

5. **Discussion of the output, the interpretation(s) made on the output and/or intermediate image files**.

I used various band combinations to start the process of identifying and picking the respective classes for the image classification procedure. I found this interesting and useful since I was able to identify easily some of areas for the classes I selected before. For example, when I wanted to check healthy vegetation, I used the NIR band combined with Red and Green bands. Healthy vegetation reflects a lot of NIR as it is shown in the picture below.

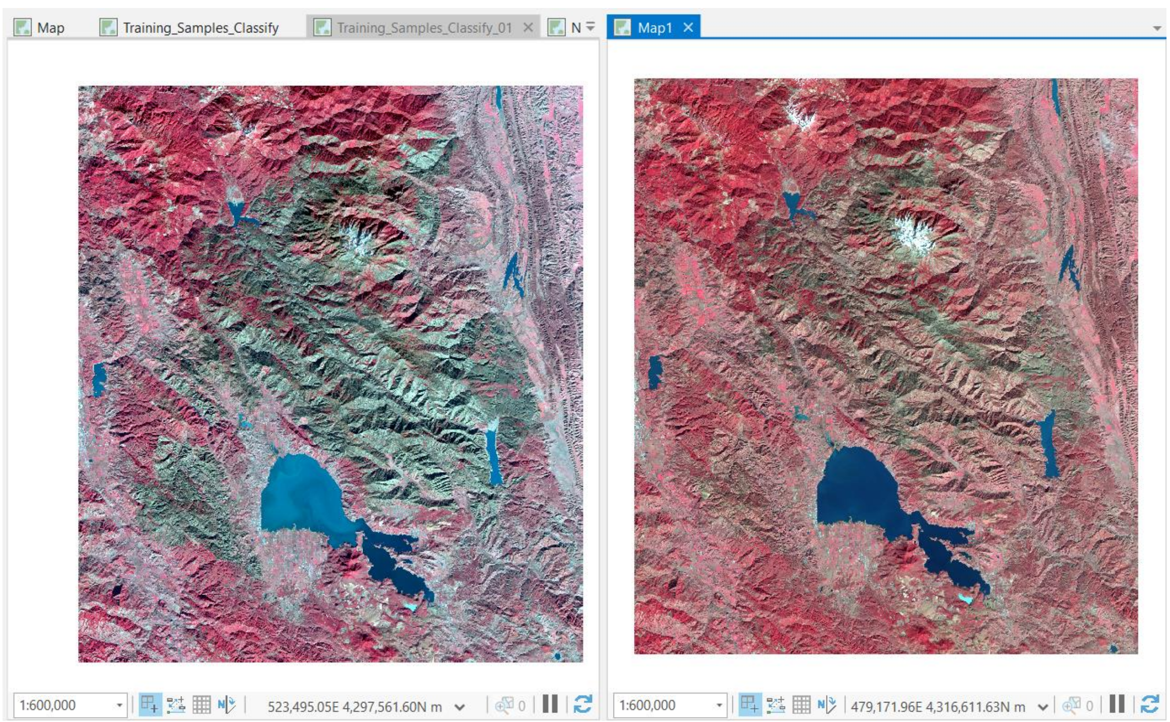

Figure 3 NIR Band

To find out about agriculture, I used SWIR, NIR and Red bands. This combination was very useful to find agriculture areas that were literally hidden when using other type of band combination – for example, natural color band combination.

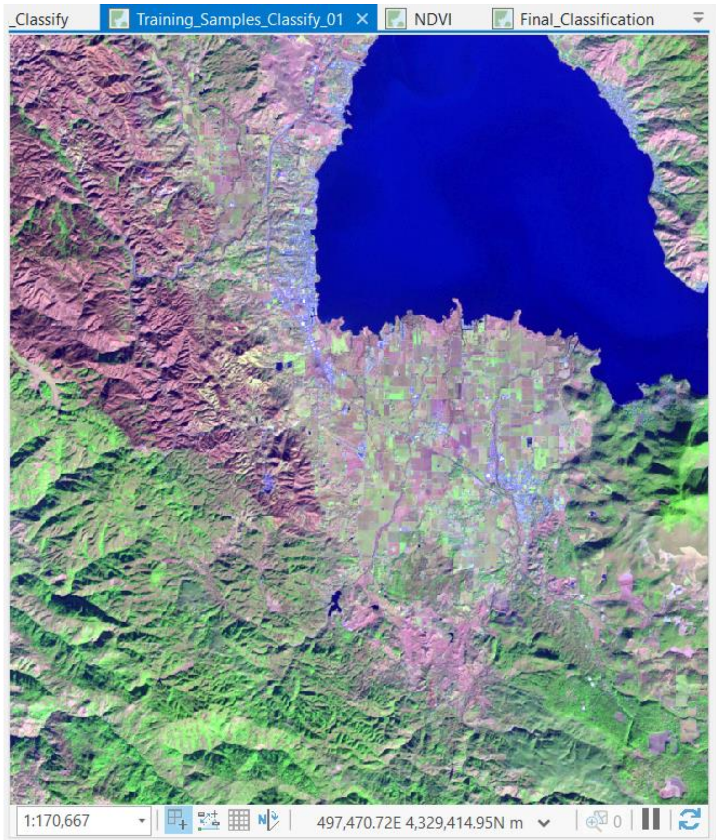

Figure 4 Agriculture Class

To find burned area, I used Red, NIR and SWIR. Fire scars were presenting dark purple colors as it is shown in the figure below.

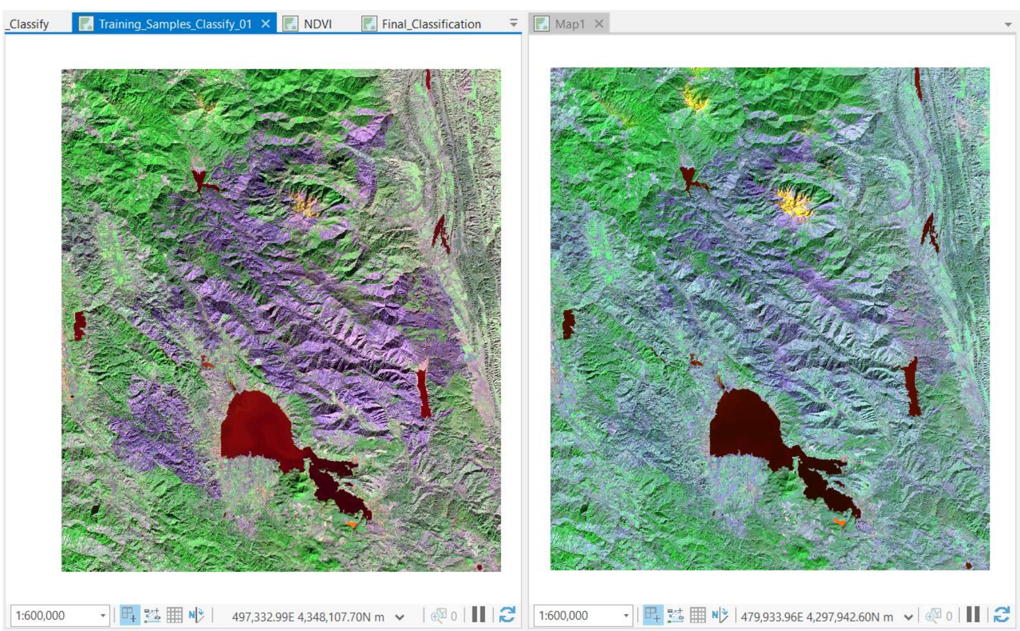

Figure 5 Burnland Class

I applied the same procedure to successfully identify all the classes. Then, I picked the training samples and proceeded with the next steps in the workflow.

For the classification process I used the Image Classification Wizard available in ArcPro. The main objective of an Image classification procedure is to categorize all the pixels found in an image into land covers or other themes. In my case, I chose 5 different classes that included Water, Agriculture, Burnland, Urban, and Vegetation.

When I was finished with the process of picking the training samples, I ran the Normalized Difference Vegetation Index (NDVI) which is a process that calculates the difference between NIR and Red bands to measure vegetation content. The index is defined mathematically as

$$NDVI = (IR + R)/(IR - R)$$

Where IR and R are the Near Infrared and Red bands respectively.

I did this using the NDVI tool in ArcPro for both Pre and Post images as it is shown in the image below.

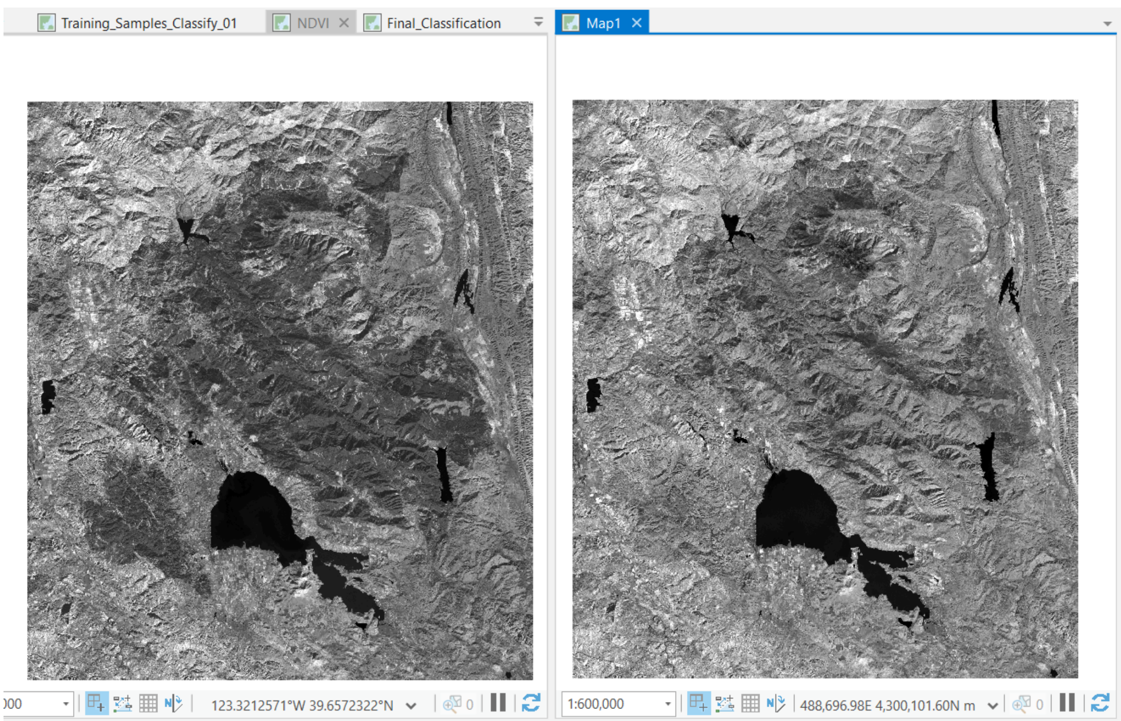

Figure 6 NDVI

On the left, the image was taken in Jan 30, 2019, and it shows the wildfire scars as dark patches (the black ones are water features) indicating that the NDVI values are lower than the ones around the patches. Lower values indicate also that those areas do not contain healthy vegetation at all, which makes sense, as those areas were where the wildfires occurred. The image on the right, it shows the same area after one year has passed. The image was taken on Feb 6, 2020, and it is clearly showing the vegetation recovery until that date. The image looks brighter when it is compared to the previous one and indicates higher NDVI values. This also suggests that healthy vegetation could be growing in the area as expected.

My analysis continued by finalizing and running the classification processes for the images of 2019 and 2020 for the area of the Mendocino Complex Fire and the quantitative analysis results showed that vegetation cover for this area was greater.

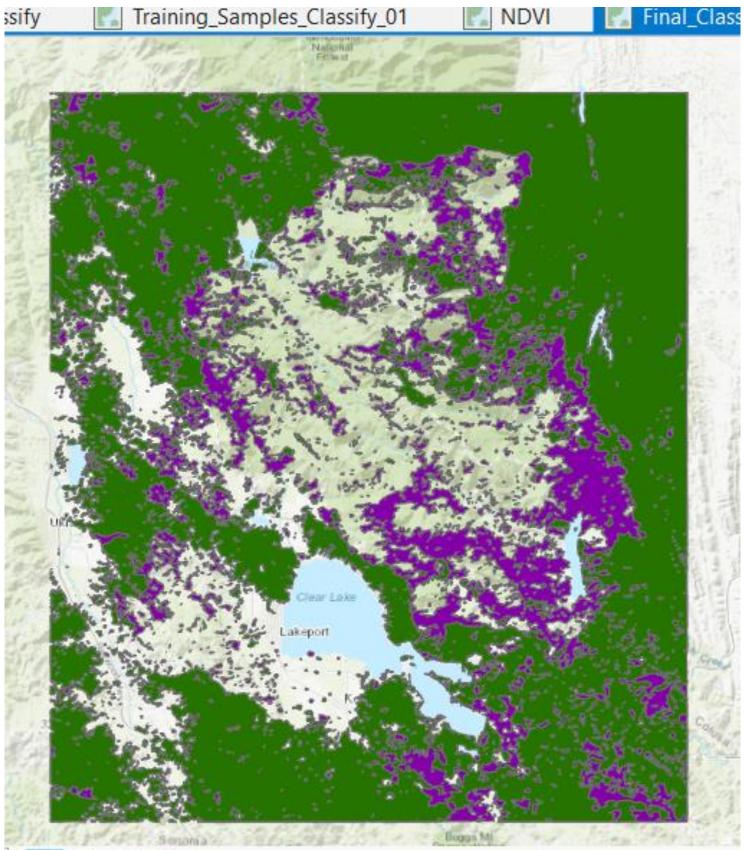

Figure 7 Percent Coverage

I selected the respective class, in this case, the Vegetation class, and I converted the classified images into polygons using the raster-to-polygon tool. Then areas for Pre-Fire vegetation and Post-Fire vegetation were calculated and added to the calculations to estimate a percent increase of %13.4 approximately.

This analysis, and the respective result, is still a process that needs to be refined. Values here are only estimates, and they need to be taken with care since I did not perform any accuracy assessment. I hope to add this step in my workflow for the near future and then improve the classes I picked for the area and the analysis in general.