Change in Vegetation Due to Wollemi National Park Wildfires

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1. Abstract

For this project the study area of Wollemi National Park was used. From May 2019 until September of 2020 Australia has been ravaged by wildfires. This has largely been due to the increase and change in global temperatures. Due to global warming wildfires are becoming a lot more common and more severe. So, for this project the study area of Wollemi National Park was looked at because it is the largest wilderness area in Australia. Wollemi National consist of 50,703-hectares of land. The park is home to many different species. The park is also home to some rare species. For example, there is a pine tree that grows in the park called the Wollemi pine that is only found inside of this park and nowhere else in the world. Wollemi National Park is a very diverse wilderness area that must be protected at all cost. The point of this project is to look at the areas in the park that were most affected by the recent wildfires. By figuring out which areas are most susceptible to very severe wildfires these areas can be better protected in the future. In this project two NDVI maps were created to show the areas most affected after the fires by loss of vegetation. One NDVI map is from before the fire and one is from after and by comparing them side by side, we can see the areas most affected by vegetation change after the fires. Also change detection analysis was done using the minus tool on the images from before and after the fires to show us which areas changed the most. Lastly, an NBR index map was created to look at the areas that suffered from high severity burns. With all of this information, analysis can be done to find the areas that need to be most watched during fire season. A python toolbox was also created with all the tools necessary to create these maps and do this type of analysis, in the hopes that it will speed up the process in the future and help with this type of analysis.

2. Introduction

Wollemi National Park the study area for this project is one of the largest National parks in Australia. It is home to a ton of wildlife and even some rare species. The park is home to Wollemi Pine which is a pine tree that can only be found inside the park. The Wollemi pine is not found anywhere else in the world. The park is also home to a lot of different animal species. There are plenty of rivers and streams inside the park, so there are plenty of fish and other aquatic species. This is one of the reasons this area was selected as the study area for this project. This area is so biodiverse that it needs to be protected and taken care of during these wildfires and extremely bad wildfire seasons that Australia has been having. This project is important because the analysis from this data can be used to not only protect this area and maybe help prevent the spread of wildfires in this area, but the analysis and tools can be applied to other areas that experience severe wildfires. Wildfires are the same in most areas and therefore can be detected using the same remote sensing tools and technology. This project is not taking a different approach from other similar projects. Remote sensing of wildfires is usually

done the same way. However, with the final python toolbox being created for arcpro this type of remote sensing wildfire analysis should be able to be done easier and smoother.

Wildfires have always been a problem for any natural area where there is vegetation. Wildfire across the globe "have become more frequent and severe due to anthropogenic warming" (Massetti, 2019). Regions like Southern and central Australia that were already extremely fire-prone areas are now at an even higher risk. It is estimated that from May 2019 until September of 2020 that fires burned across 46 million acres of Australia. This was the largest fire season on record for Australia (Wintle 2020). This fire season was "unprecedented in geographical scale, duration, and intensity, and has had major impacts on species and ecosystems that were already under immense stress from prolonged drought" (Wintle 2020). The problem with large wildfires or very frequent wildfires is they can do much more than damage vegetation. Wildfires can affect and compromise water quality. Wildfires can cause damage to water supplies during active burning and for years after the fire has been put out. Wildfires often impact downstream water runoff changes as well decreasing water quality that can affect ecosystems and drinking water treatability (Emmerton 2020). Wildfires can cause and increase in eutrophication and sedimentation. Wildfires in Australia are destroying a lot more than just the vegetation. However, the destruction of vegetation Is leading to the other problems. Burn severity maps can be used to assess the of fires on vegetation, habitats, and soils. Remote sensing and Landsat 8 data can be used to calculate a burn severity map. By using a raster calculator, a burn severity map can be created that will show which areas in the Landsat 8 image have been most severely affected in terms of vegetation change (Cardil 2019).

In Australia, the recent wildfire has destroyed large amounts of land and have also degraded the water quality and water ecosystems. The paths of these large fires and the destroyed vegetation needs to be mapped to help with learning more about these wildfires and creating preventive strategies to limit damage of the wildfires the next time around. The main objectives of this project are to show the changes in vegetation before and after the recent wildfires as well as show the area that the wildfires covered in Wollemi National Park in Australia. Another objective is to use python to create a toolbox with the needed tools to complete this analysis, making the process of doing this type of analysis faster in the future.

3. Materials and Methods

For this project, the plan is to create NDVI maps as well as maps showing Normalized Burn Index maps for Wollemi National Park. These maps will be used to show the change in vegetation before and after these large fires. These maps will also show the total area affected and how severely it was affected by the wildfires. The main purpose with these maps is to show the change in vegetation from before the fires to after, that way National Park employees know which areas to keep an eye on and help to return to their natural state.

To start with Landsat 8 data will be acquired for the area of study in Sydney Australia. After the Landsat 8 imagery is compiled all the bands will be put together in one composite image layer. That composite bands layer will then be used to produce an NDVI map. The raster calculator will be used to create the NDVI map from the infrared red bands of the Landsat 8 data. This map will allow the vegetation to be easily identifiable and will be useful for noting the changes in the vegetation in Sydney after the fires. Next the Landsat 8 data will be used to create a Normalized Burn Index map. The Landsat 8 bands 5 and 7 will be put into the raster calculator. The raster calculator formula will be NBR =(Band5-Band7)/(Band 5 +Band7). This will be calculated for the data acquired from after the fires. This NBR data will show which areas suffered most severely from the fires. This data can then be compared to the NDVI maps to see if there is correlation between the two and which areas were more significantly burned and had a high loss of vegetation. The product will be NDVI maps that will show the changes in vegetation and a Normalized Burn Index map that show the areas most affected by the wildfires. Also, a change detection map will be created using Sentinel 2 data. The Sentinel 2 images, one from before and one from after, will be subtracted using the minus tool to create an image showing the high areas of change between the two images. Then the tools used will then be automated using python to make so that the python code could be used in futures studies to speed up the process.

Data Table

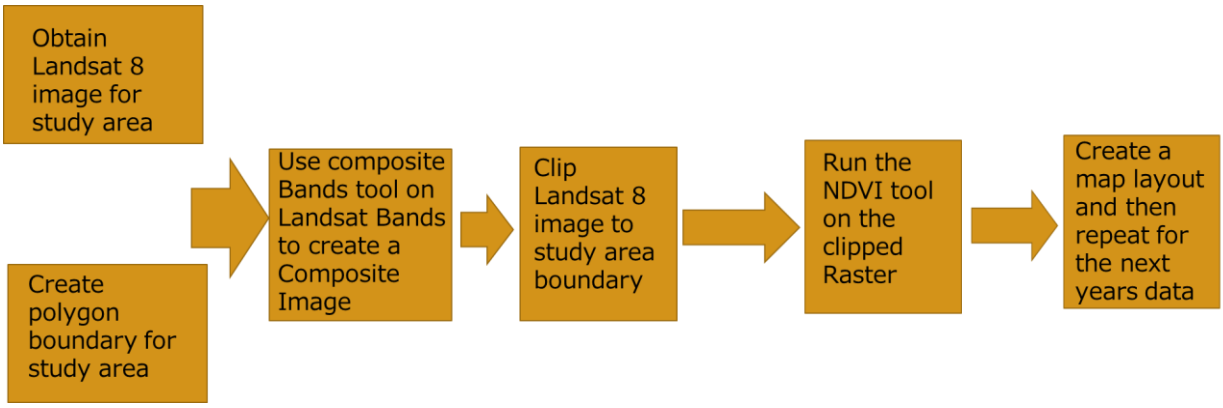
Sensor/Satellite	Imagery Date(s)	tudy Area	Website Source	Spatial Resolution	Spectral Bands
Landsat 8	2019-12 -31	Wollemi National	Earth Explorer	30m	1-11

		Park			
Landsat 8	2020-05-07	Wollemi National Park	Earth Explorer	30m	1-11
Sentinel 2	May 2019	Wollemi National Park	Earth Explorer	60m	1-13
Sentinel 2	May 2020	Wollemi National Park	Earth Explorer	60m	1-13

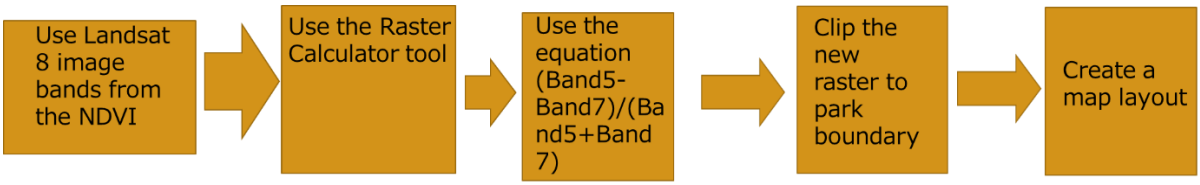
*This data table shows where all data was acquired for this project.

Map Process Flowcharts

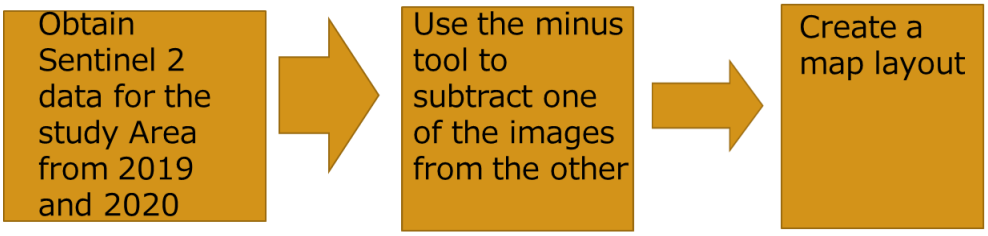
NDVI Workflow



NBR Workflow



Change Detection Workflow

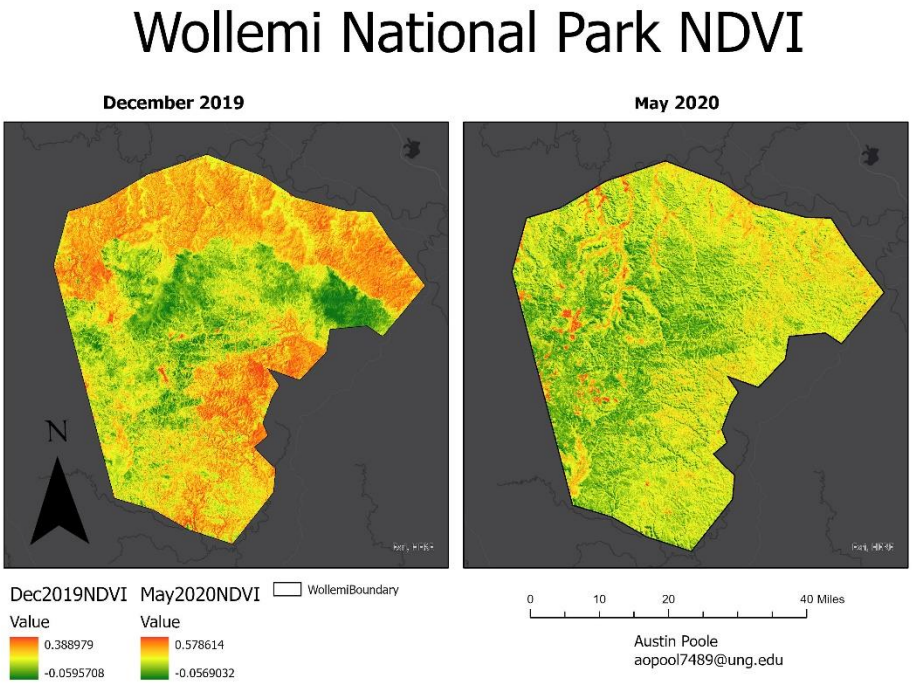


4. Results

The results for this project will be two NDVI maps. One looking at Wollemi National park before the wildfires of the past season occurred, the next will be one using a Landsat

image from shortly after the last severe fire had burned. Taking these two NDVI maps form before and after the wildfires and comparing them we can see what areas had the most vegetation change. Then using the same Landsat image from after the fire a Normalized Burn Index Map will be created to show the severity of the wildfires. This will create a map showing which areas inside the park were more susceptible to severe burns and fires.

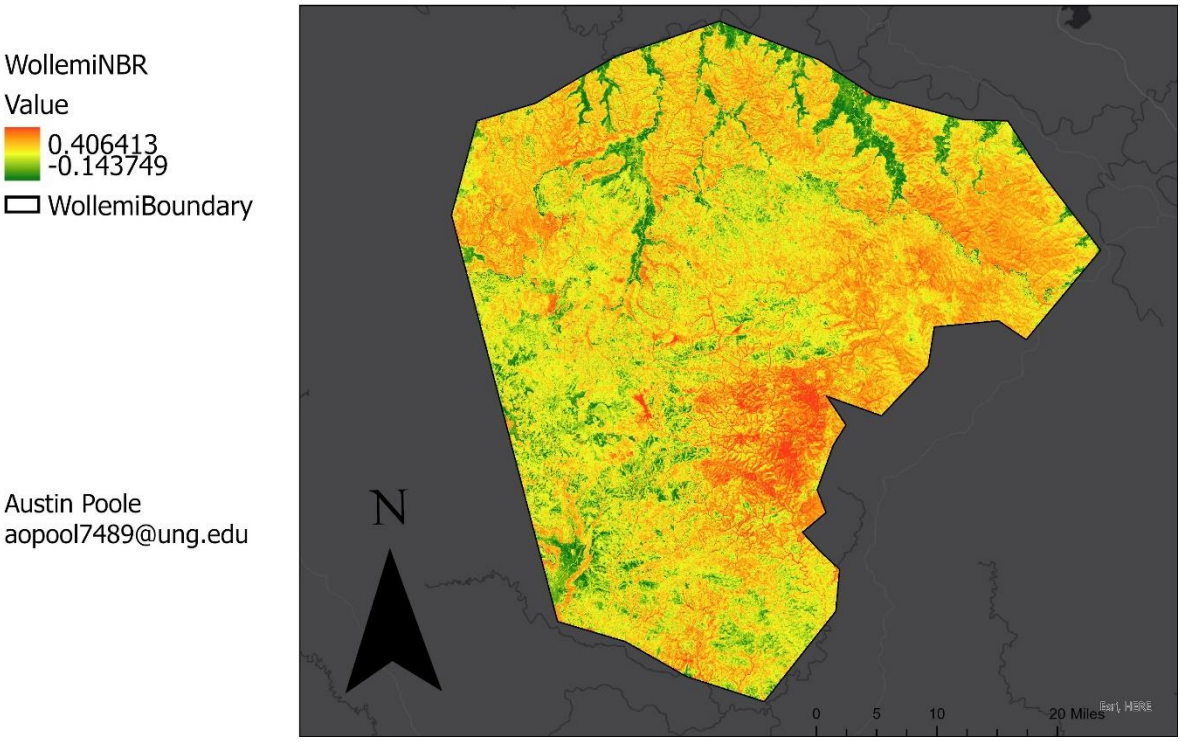
NDVI Maps



The NDVI maps show that from December 2019 to May 2020 there were some drastic changes in vegetation inside the park. In December there were dense forested areas along the northern and eastern borders of the park however, in May those areas have become way less dense. The values from the NDVI for the northern and eastern border suggest that in December those were very thick dense forest that have turned into shrublands by May. There are other factors that could have played a part, but from other research data we can assume that this was more than likely an effect of the wildfires.

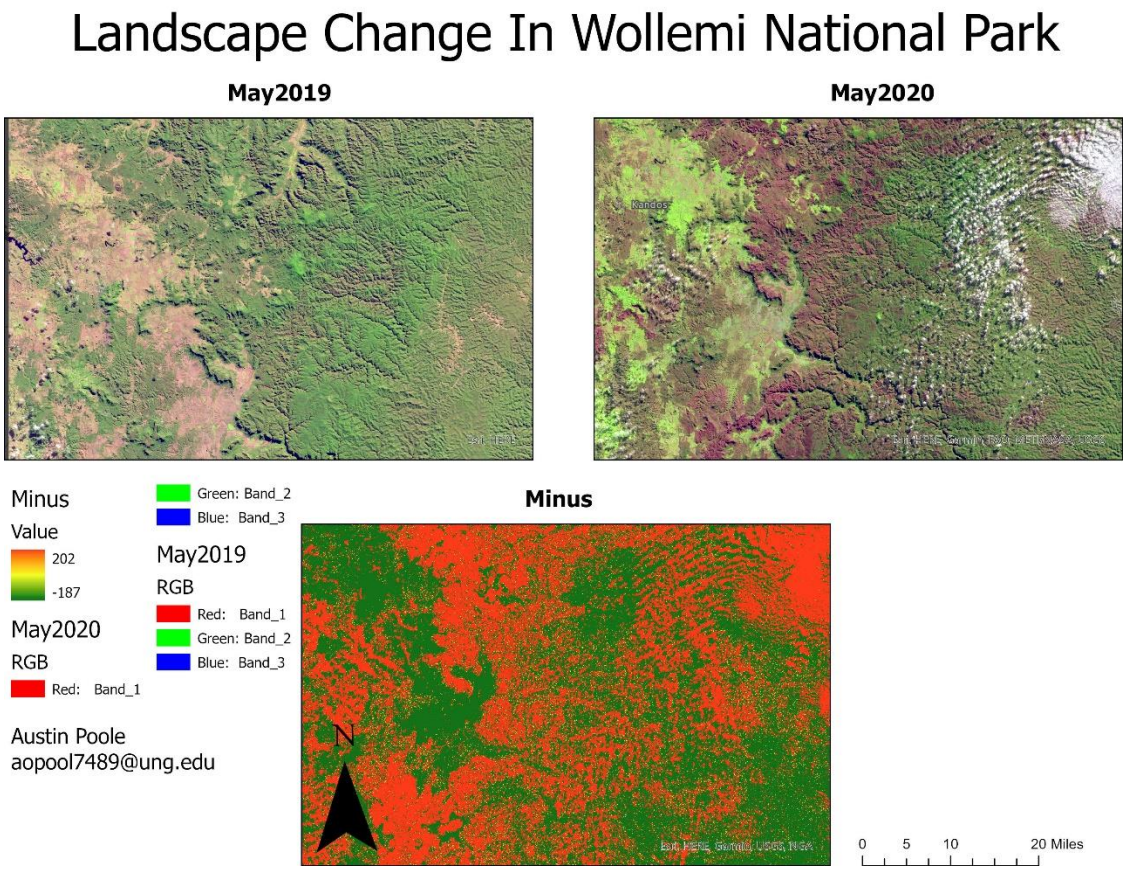
NBR map

NBR Wollemi National Park



The NBR shows what areas are barren and have no vegetation. Areas within certain values can be considered burned areas. This map shows the areas that had high vegetation change in the NDVI to be possible burn areas. Like the NDVI maps, the northern and eastern border of the park seems to be the most affected area. This means that more than likely the damage to the vegetation at the borders of the park are from wildfires.

Change Detection Map



The Change detection map shows that the areas most affected between May 2019 and May 2020 were along the northern and eastern boundaries of the park. This is the same area that the data from the NDVI map NBR maps suggest might be burned areas. With this data, National Park employees can look at ways to restore these burned areas and work toward preventing future wildfires from getting out of hand in these areas. This data analysis could use to help protect wildlife and the wilderness are that is Wollemi National Park.

5. Conclusion

In conclusion, the data and analysis from this project can be used in the future to assure the protection of Wollemi National Park. The NDVI maps that were created can be used to look at which areas in the park had the most significant changes in vegetation from before and after the fires. Then using the change detection map and some sentinel 2 data, vegetation can be looked at again to make sure that there are actually high degrees of vegetation change in those areas of the park. Lastly, the NBR map can be used to see if there are any areas inside the park that meet the NBR index requirements to be considered a burned area. From this data and analysis, the conclusion can be drawn that along the northern and eastern boundary of the park there were some areas that showed signs of damage from wildfire. Now with this data and a newly created python toolbox containing the tools to do this research and analysis the park can better be looked out for and cared for in the future. This data shows which areas in the park need the most protection during the fire season and the toolbox will allow for future analysis that way problem areas can be more accurately pinpointed.

6. References

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