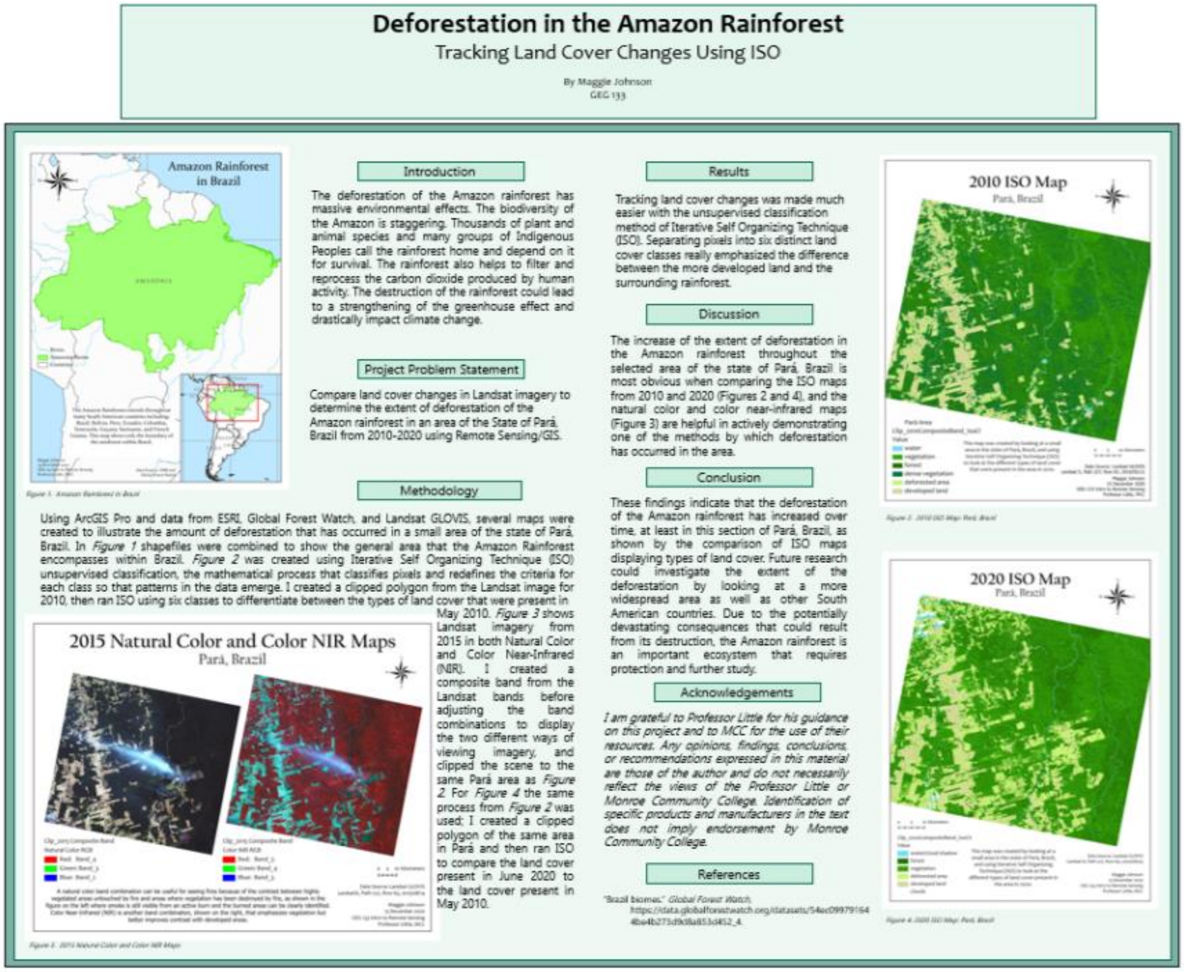
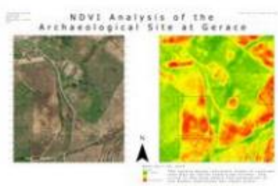
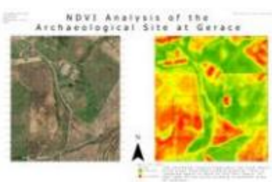
**GEG 133 Final Projects**



# *Secrets in the Soil: An NDVI Analysis of the Archaeological site at Gerace*

By Jonathan Broida
GEG 133




## Introduction

The Roman Villa at Gerace has yielded a plethora of archaeological material, yet there are still countless more treasures waiting to be uncovered underground. However, knowing exactly where to start digging can be a difficult task. Fortunately, advancements in remote sensing techniques offer a solution to the problem and may help archaeologists pinpoint archaeological sites with potentially lucrative finds. NDVI is one such method that can be used to help archaeologists. The natural vegetation and farmland around Gerace makes it and especially interesting area to test the utility of NDVI analysis.

## Questions and Goals

NDVI (Normalized Difference Vegetation Index) data analysis provides a method to reveal buildings and other archaeological features buried underground. The remote sensing method determines vegetation health by detecting the amount of near-infrared (NIR) light they reflect. Underground features can disrupt the root systems of plants and negatively affect their health, resulting in less NIR reflection. Remote Sensing/GIS will be used to compare the NDVI of LANDSAT images of the site at Gerace to find the location of buildings and archaeological features hidden underground.

## Results

Figures' 1-4 show the results of the NDVI analysis over the four years. Possible structures have been highlighted using symbols. Additional information can be found in the figures and tables. The brighter red and orange color represents less light reflectance while the greener color represents more. Areas that are bright red and orange have less healthy vegetation growing in the soil. The square outlines represent areas of interest that may yield structures below the ground. All potential findings will have to be ground truthed at a later time.

## Methodology

The satellite imagery used in this project was selected over a four-year period (2017-2020) to limit the potential for seasonal and weather abnormalities to influence the findings. The month of April was prioritized because it provided the best opportunity to maximize NIR reflectance in the surrounding vegetation around Gerace. Sicily tends to experience short Spring cycles and most of the plant life tends to brown quickly and even die by the beginning of June. April had a healthy distribution of green vegetation to help ensure success when conducting the NDVI analysis. After the analysis, the images were then compared and examined to determine if any structures could be found hidden beneath the surface soil.

## Discussion

The findings from the project are largely inconclusive but still offering encouraging results. The NDVI analysis was successful but it is hard to determine whether the areas highlighted are significant archaeological sites. While using the 3mm satellite imagery provided a better-than-expected outcome, imagery taken neared to the ground may have improved the overall results. It was hypothesized that data may reveal more linear objects hidden underground. It is possible that there are no linear structures to be found but that is highly unlikely considering the number of structures that have been uncovered in the area.

## Conclusion

The findings from this study may not provide an answer but it certainly shows that using NDVI for archaeological work is a promising investment. A study that takes advantage of aerial imagery from a plane rather than a satellite would certainly push the envelope for what is possible when combining remote sensing with archaeology.

## Acknowledgements

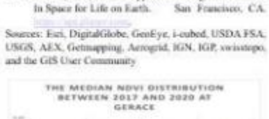
I am grateful to my Professor, Jonathan Little. Without his encouragement and support this project would not have been possible. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author and do not necessarily reflect the views of Professor Little or Monroe Community College. Identification of specific products and manufacturers in the text does not imply endorsement by Monroe Community College.

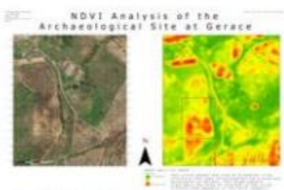
## References

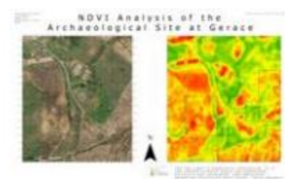
Broida, Jonathan, "The Villa and Agricultural Economy of Late Roman Sicily: An Archaeobotanical Perspective" (2019). History Master's Theses. 32.

Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA.

Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



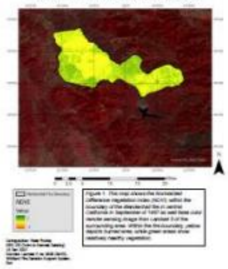



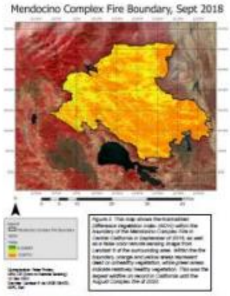

# The Intensification of California Wildfires

Peter Fowley
GEG 133 (Intro to Remote Sensing)

Mendenhall Fire Boundary, Sept 1987



Mendocino Complex Fire Boundary, Sept 2018



## Introduction

While wildfires have long affected California and the western United States, climate change is intensifying the problem. The year 2020 saw the largest and most destructive wildfires on record in California, with the size of August Complex fire shattering the record set only two years earlier by the Mendocino Complex fire as the largest in the state's recorded history. With climate change continuing to deteriorate the situation, it is important to measure how the extent of these fires has increased in recent decades so socioeconomic, environmental, health, and safety impacts of future wildfire seasons might be projected.

## Project Problem Statement

The goal of this project is to analyze burned acreage from recent and historical California wildfires to determine if they have statistically become more severe in recent years compared to years past. Raster and vector data from four specific fires that each occurred in August and September of four different years will be analyzed, and total burned acreage data across multiple years will be assessed to identify if there has been a trending change.

## Methodology

Landsat 5 and Landsat 8 remote sensing imagery obtained via the USGS GloVIS site was used for raster data in this project. Vector data was obtained from the Wildland Fire Decision Support System and the National Interagency Fire Center and was used to generate fire boundary maps for this project. Wildfire acreage data from the National Interagency Fire Center via ArcGIS Online and the California Department of Forestry and Fire Protection were used for statistical comparison between wildfires from different years. The coordinate system used for each map is WGS 1984.

Normalized Difference Vegetation Index (NDVI) maps were generated through Esri's ArcGIS Pro using the Band Combination feature and the NDVI and Clipping raster functions. The chart in *Figure 6* and *Figure 7* were generated using Microsoft Excel. This poster was produced with Microsoft PowerPoint.

## References

[illegible]

## Results

The maps in *Figures 1 through 4* each show fire boundary raster data, with Normalized Difference Vegetation Index (NDVI) raster data shown within the fire boundaries, and false color infrared raster images of the areas around the fire boundaries. NDVI is a method of spectral analysis used as a measure of vegetation health. Since healthy vegetation absorbs most red light and reflects a large amount of near-infrared light, the multispectral remote imaging sensors on Landsat satellites can measure the differences in reflected light in different areas of the electromagnetic spectrum to determine plant health. The maps provided show that in large swaths of the burned areas, more red light is reflected back to the Landsat satellites from Earth since there is little to no healthy vegetation there.

*Figure 7* shows the total burned acreage of each of the fires depicted in *Figures 1 through 4*.

## Discussion

The two largest wildfires in California's history both occurred in the last three years in the same general area, with 2020's August Complex fire—with a burned area of 1,032,648 acres—being more than twice the size of 2018's record-breaking Mendocino Complex fire, which burned an area of 459,123 acres. However alarming in their massive sizes, data from such a small sample size alone cannot tell the whole picture.

Assessing wildfire burned acreage data since 1983, which is the year the National Interagency Fire Center denotes as the earliest year with data that can be relied upon, there has been a steady upward trend of total burned acreage in recent years, as can be seen in *Figure 6*. This suggests that California wildfires are indeed becoming a greater threat than in years past.

## Conclusion

The implications of these findings are dire. California's situation is a microcosm of similar trends happening across the western United States and reinforce the need for citizens to face the realities of our planet's climate crisis. Until then, the escalation of wildfire intensification is likely to continue with major cost to humans.

Further research is needed to assess the impacts of intensifying wildfires on the environment, economy, and the other aspects of peoples' lives. Additionally, wildfire intensification in other regions around the world should continue to be studied.

## Acknowledgements

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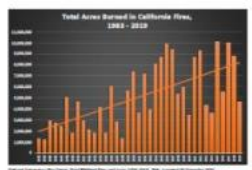
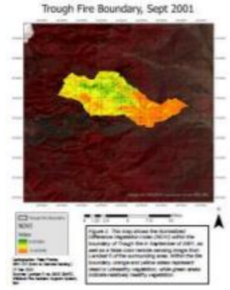
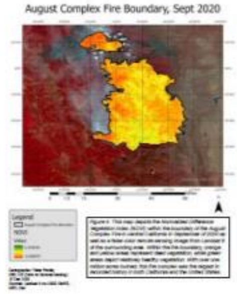



*Figure 6. Total acreage burned in California from 1983 – 2019*

Trough Fire Boundary, Sept 2001



August Complex Fire Boundary, Sept 2020



| Fire | Acres Burned |
|---|---|
| Mendenhall, 1987 | 65,468 |
| Trough, 2001 | 24,927 |
| Mendocino Complex, 2018 | 459,123 |
| August Complex, 2020 | 1,032,648 |

*Figure7. Burned acreage of each of the fires Figures 1 through 4. Data courtesy of the California Department of Forestry and Fire Protection and the Wildland Fire Decision Support System.*