

Deforestation in the Amazon Rainforest Tracking Land Cover Changes Using ISO

By Maggie Johnson
GEG 133



Figure 1. Amazon Rainforest in Brazil

Introduction

The deforestation of the Amazon rainforest has massive environmental effects. The biodiversity of the Amazon is staggering. Thousands of plant and animal species and many groups of indigenous Peoples call the rainforest home and depend on it for survival. The rainforest also helps to filter and reprocess the carbon dioxide produced by human activity. The destruction of the rainforest could lead to a strengthening of the greenhouse effect and drastically impact climate change.

Project Problem Statement

Compare land cover changes in Landsat imagery to determine the extent of deforestation of the Amazon rainforest in an area of the State of Pará, Brazil from 2010-2020 using Remote Sensing/GIS.

Methodology

Using ArcGIS Pro and data from ESRI, Global Forest Watch, and Landsat GLOVIS, several maps were created to illustrate the amount of deforestation that has occurred in a small area of the state of Pará, Brazil. In Figure 1 shapefiles were combined to show the general area that the Amazon Rainforest encompasses within Brazil. Figure 2 was created using Iterative Self Organizing Technique (ISO) unsupervised classification, the mathematical process that classifies pixels and redefines the criteria for each class so that patterns in the data emerge. I created a clipped polygon from the Landsat image for 2010, then ran ISO using six classes to differentiate between the types of land cover that were present in May 2010. Figure 3 shows Landsat imagery from 2015 in both Natural Color and Color Near-Infrared (NIR). I created a composite band from the Landsat bands before adjusting the band combinations to display the two different ways of viewing imagery, and clipped the scene to the same Pará area as Figure 2. For Figure 4 the same process from Figure 2 was used; I created a clipped polygon of the same area in Pará and then ran ISO to compare the land cover present in June 2020 to the land cover present in May 2010.

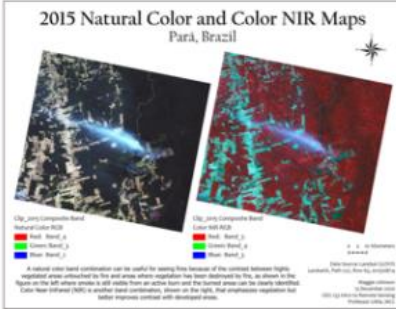


Figure 2. 2015 Natural Color and Color NIR Maps

Results

Tracking land cover changes was made much easier with the unsupervised classification method of Iterative Self Organizing Technique (ISO). Separating pixels into six distinct land cover classes really emphasized the difference between the more developed land and the surrounding rainforest.

Discussion

The increase of the extent of deforestation in the Amazon rainforest throughout the selected area of the state of Pará, Brazil is most obvious when comparing the ISO maps from 2010 and 2020 (Figures 2 and 4), and the natural color and color near-infrared maps (Figure 3) are helpful in actively demonstrating one of the methods by which deforestation has occurred in the area.

Conclusion

These findings indicate that the deforestation of the Amazon rainforest has increased over time, at least in this section of Pará, Brazil, as shown by the comparison of ISO maps displaying types of land cover. Future research could investigate the extent of the deforestation by looking at a more widespread area as well as other South American countries. Due to the potentially devastating consequences that could result from its destruction, the Amazon rainforest is an important ecosystem that requires protection and further study.

Acknowledgements

I am grateful to Professor Little for his guidance on this project and to MCC for the use of their resources. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the Professor Little or Monroe Community College. Identification of specific products and manufacturers in the text does not imply endorsement by Monroe Community College.

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Figure 3. 2010 ISO Map Pará, Brazil



Figure 4. 2020 ISO Map Pará, Brazil

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

By Jonathan Broda
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 an 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 bloom 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 four satellite imagery provided a better-than-expected outcome, imagery taken near 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.

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

THE MEDIAN NDVI DISTRIBUTION BETWEEN 2017 AND 2020 AT GERACE

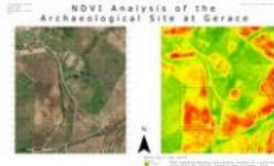


Figure 1. The square here represent areas of interest that may be worth investigating further. The circle in the area shows the location of the Roman Villa at Gerace.

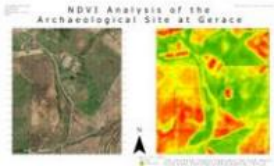


Figure 2. The red square again highlights the area where there is less than healthy growing. This is opposite to what we have seen. In the right of the area recently another area of interest.



Figure 3. This image was taken in May of the 2019 excavation site at Gerace. Directly to the left is the north-south road. In the background, the Roman Villa at Gerace is visible. The area is not as consistently well-tended, and the vegetation was still looking well into the beginning of summer. (Photo: Jonathan Broda)

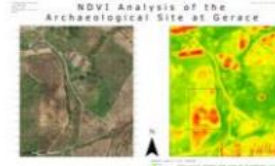


Figure 4. This image shows the NDVI output from imagery taken right in 2020. The red square shows the area of interest. The square here was highlighted as an area of interest that appears to be worth investigating further.

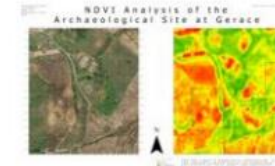



Figure 5. The red square is especially interesting. It is the oldest red area. In the background, the Roman Villa at Gerace is visible. The area is not as consistently well-tended, and the vegetation was still looking well into the beginning of summer. (Photo: Jonathan Broda)



Figure 6. Workers removing a wall around the site because it was found to be a Roman wall. The wall was found to be a Roman wall. (Photo: Jonathan Broda)

The Intensification of California Wildfires

Peter Fowley
GEG 133 (Intro to Remote Sensing)



Mendocino Fire Boundary, Sept 1987

Figure 1. This fire shows the Mendocino fire boundary (red line) and the difference vegetation index (DVI) for the area of the fire (yellow and green). The fire was active on September 1987 and burned for approximately 200,000 acres. The DVI is a measure of vegetation health, with higher values indicating healthier vegetation. The fire boundary is shown in red, and the DVI is shown in yellow and green.

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 wildfire on record in California, with the cost of August Complex fire shattering the record set only two years earlier by the Mendocino Complex fire. In the region's 100-year 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 as socioeconomic, environmental, health, and cultural 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. Radar 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 for several multiple years will be assessed to identify if there has been a trending change.

Methodology

LandSat 5 and LandSat 8 remote sensing images obtained via the USGS Earth Explorer were used for raster data in this project. Vector data was obtained from the Mendocino Fire Decision Support System and the National Interagency Fire Center and was used to generate fire boundary maps for this project. Wildfire average 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 Earth Engine via the Band Combination Routine 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 ArcGIS StoryMap.

References

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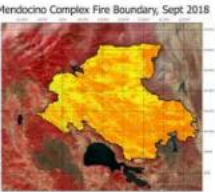
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Mendocino Complex Fire Boundary, Sept 2018

Figure 2. This fire shows the Mendocino Complex fire boundary (red line) and the difference vegetation index (DVI) for the area of the fire (yellow and green). The fire was active on September 2018 and burned for approximately 1,000,000 acres. The DVI is a measure of vegetation health, with higher values indicating healthier vegetation. The fire boundary is shown in red, and the DVI is shown in yellow and green.



August Complex Fire Boundary, Sept 2020

Figure 3. This fire shows the August Complex fire boundary (red line) and the difference vegetation index (DVI) for the area of the fire (yellow and green). The fire was active on September 2020 and burned for approximately 1,000,000 acres. The DVI is a measure of vegetation health, with higher values indicating healthier vegetation. The fire boundary is shown in red, and the DVI is shown in yellow and green.

Results

The maps in Figures 2 through 4 each show the boundary raster data, with Normalized Difference Vegetation Index (DVI) overlaid within the fire boundaries, and have color-coded raster images of the area around the fire boundaries. NDVI is a method of remote sensing used as a measure of vegetation health. Since healthy vegetation absorbs more red light and reflects a large amount of near-infrared light, the multiplicative remote sensing process on Landsat satellite can measure the difference 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 ground satellite from burnt areas than it is from healthy vegetation.

Discussion

The four largest wildfires in California history both occurred in the last three years in the same general area, with 2020 August Complex fire with a burned area of 1,000,000 acres, being much larger than the cost of 2018, record-breaking Mendocino Complex fire, which burned an area of 475,123 acres. However, according to both remote sensing data from each a small sample size does present tell the whole story.

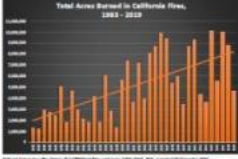
Conclusion

The implications of these findings are dire, California's situation is a microcosm of similar happenings across the western United States and reinforce the need for citizens to face the realities of our planet's climate crisis. Until then, the magnitude 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 environmental, economic, and the other aspects of people's lives. Additionally, wildfire intensification in other regions around the world should continue to be studied.

Acknowledgements

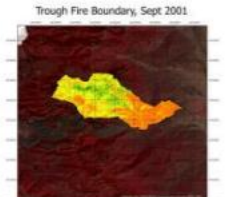
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Total Acres Burned in California Fires, 1987 - 2020

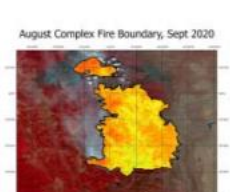
This bar chart illustrates the total acres burned in California from 1987 to 2020. The x-axis represents the year, and the y-axis represents the total acres burned, ranging from 0 to 1,000,000. The data shows a significant increase in the total acres burned over the period, with 2020 showing the highest total, exceeding 1,000,000 acres.

Year	Total Acres Burned
1987	~65,000
1988	~100,000
1989	~150,000
1990	~200,000
1991	~250,000
1992	~300,000
1993	~350,000
1994	~400,000
1995	~450,000
1996	~500,000
1997	~550,000
1998	~600,000
1999	~650,000
2000	~700,000
2001	~750,000
2002	~800,000
2003	~850,000
2004	~900,000
2005	~950,000
2006	~1,000,000
2007	~1,050,000
2008	~1,100,000
2009	~1,150,000
2010	~1,200,000
2011	~1,250,000
2012	~1,300,000
2013	~1,350,000
2014	~1,400,000
2015	~1,450,000
2016	~1,500,000
2017	~1,550,000
2018	~1,600,000
2019	~1,650,000
2020	~1,700,000



Trough Fire Boundary, Sept 2001

Figure 4. This fire shows the Trough fire boundary (red line) and the difference vegetation index (DVI) for the area of the fire (yellow and green). The fire was active on September 2001 and burned for approximately 24,000 acres. The DVI is a measure of vegetation health, with higher values indicating healthier vegetation. The fire boundary is shown in red, and the DVI is shown in yellow and green.



August Complex Fire Boundary, Sept 2020

Figure 5. This fire shows the August Complex fire boundary (red line) and the difference vegetation index (DVI) for the area of the fire (yellow and green). The fire was active on September 2020 and burned for approximately 1,000,000 acres. The DVI is a measure of vegetation health, with higher values indicating healthier vegetation. The fire boundary is shown in red, and the DVI is shown in yellow and green.

Fire	Acres Burned
Mendocino, 1987	65,458
Trough, 2001	24,927
Mendocino Complex, 2018	459,123
August Complex, 2020	1,032,648

Figure 6. Burned acreage of each of the fires (Figure 1 through 4). Data courtesy of the California Department of Forestry and Fire Protection and the Mendocino Fire Decision Support System.