A Minor Project Report on

NDVI based Analysis of Vegetation Health

Submitted to Manipal University, Jaipur

MANIPAL UNIVERSITY
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Towards the partial fulfillment for the Award of the Degree of

BACHELORS OF TECHNOLOGY

In Computers and Communication Engineering

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By

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CERTIFICATE

This is to certify that the project entitled **"NDVI BASED ANALYSIS OF VEGETATION HEALTH"** is a bonafide work carried out as part of the course ***Minor Project)*** , under my guidance by ***Rishwari Ranjan*** , student o***f Computers and Communication Engineering*** at the Department of Computer & Communication Engineering , Manipal University Jaipur, during the academic semester ***sixth***, in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer & Communication Engineering, at MUJ, Jaipur.

Place: ***Manipal University Jaipur***

Date: ***11/06/2021***

Signatureof the Instructor (s)

Dr. Hemlata Goyal

DECLARATION

I hereby declare that the project entitled **"NDVI BASED ANALYSIS OF VEGETATION HEALTH"** submitted as part of the partial course requirements for the course ***Minor Project***, for the award of the degree of Bachelor of Technology in Computer & Communication Engineering at Manipal University Jaipur during the ***sixth semester, in June 2021***, has been carried out by me. I declare that the project has not formed the basis for the award of any degree, associate ship, fellowship or any other similar titles elsewhere.

Further, I declare that I will not share, re-submit or publish the code, idea, framework and/or any publication that may arise out of this work for academic or profit purposes without obtaining the prior written consent of the Course Faculty Mentor and Course Instructor.

Signature of the Student: **Rishwari Ranjan**

Place: ***Manipal University Jaipur***

Date: ***11/06/2020***

ABSTRACT:

The arid part in the Indian subcontinent displays a significant variance in vegetation and climate. The varying climate , lack of perennial rivers and harsh weather conditions only allow sparse vegetation to grow. Proper mapping of such areas is essential for the livelihood of people . For our study we analysed Jodhpur district in Rajasthan. We wrote a python script designed using Jupyter notebook and Google Earth API which was used to select our study area , specify the time frame and download the .tiff images in a more convenient way. Landsat 8 imagery was downloaded and then processed in SAGA GIS for pre-monsoon and post-monsoon months to extract NDVI values from tiff images. Analysis of the results concluded that a significant spike in the Less Dense Vegetation category was due to rainfall in the post monsoon months.

CONTENTS

I.INTRODUCTION

Fauna available in arid zones is useful for the people and of the livestock in that area. Vegetation in this area is scarce due to low rainfall and large areas. Owing to the constantly changing conditions mapping of vegetation in this area becomes a very difficult task for the authorities. The climate of Rajasthan ranges mainly from arid to sub-humid. The state is mainly an arid state and the climate is generally marked by low rainfall with limited rainy days and sparse distribution. Extreme temperatures are recorded annually with high velocity winds leading to rapid loss of soil moisture. Only vegetation which can overcome this loss of moisture by means of thorns or foliage are able to survive in such conditions. The vegetation is mainly thorny in nature with small leaves to protect moisture loss. These are areas which fall within the rainfall zones having 100 to 500 ml of rainfall have a sandy train and are therefore more vulnerable to land degradation. Field base interpretation and remote sensing are used to study the vegetation in these areas.

Rajasthan also experiences droughts very frequently. Drought is a climatic phenomena and its impact cannot be eliminated unless there is prior information to the authorities about its occurence. As a result the crop yield in this area is drastically reduced due to shortage of water. Although there are many factors that can cause reduction in crop yield like hail etc , drought is considered as a main factor.

Jodhpur district in Rajasthan is surrounded by cities like Jaisalmer, Bikaner, Barmer and Nagar in respective directions. Total length of this area is about 197 kilometres and the longitudinal length is about 208 kilometres. Jodhpur covers 11.6 percent of the total area of Rajasthan and the general slope leans towards west. There are no renewal rivers in the region but seasonal rivers Mithali and Lunu flow during the rainy season. The soil in this area mainly consists of sandy and loamy parts. The major Kharif crop is Bajra whereas wheat and spices like chilli come under the Rabi yield.

Rainfall in this area is erratic and there are frequent droughts. Rainfall mainly occurs from July to September. As the crop production rate depends on the geography of the region for example hill area, weather conditions ,temperature, cloud cover, moisture, soil type ,soil composition, harvesting methods etc different combinations of these characteristics can be used to predict the vegetation cover in an area.

1.1 Normalized Difference Vegetation Index (NDVI)

The NDVI index helps to visualize an image with greenness. Using the contrast between two bands in multispectral raster dataset and also the pigment chlorophyll absorptions in the red band and the high reflectivity that plant materials give in the near-infrared (NIR) band. We use NDVI to assist in potential and dangerous fire zone prediction , desert map encroachment and most importantly monitor drought. As it balances the varying illumination conditions, surface inclination , aspect and other superfluous factors.

The NDVI index uses the separation of the two wavelengths from the multi-raster database, the pigment chlorophyll gets inclusion with a red band and the building materials in Near Infrared Band (NIR). NDVI specially utilized to monitor droughts and also presage agricultural production. As it adapts to changing lighting conditions and features slope and also other external factors NDVI is chosen to monitor vegetation worldwide. It can be calculated by the following formula.

NDVI = ((Infrared - Red Bands)/(InfraRed + Red Bands))

NDVI values range from -1.0 to 1.0, usually signifying green, while the worst values produced in cloud cover ,ice cover or snowfall , water, and near zero values are usually produced on rock and barren ground. Empty rock areas have very low values (0.1 and below) of the corresponding NDVI. The shrub and grass have moderate (0.2 to 0.3) and high (0.6 to 0.8) temperatures indicating tropical and subtropical rainforests.

Band No.	Name	Wavelength (μm)	Characteristics and use
1	Visible blue	0.45-0.52	Maximum water penetration
2	Visible green	0.52-0.60	Good for measuring plant vigor
3	Visible red	0.63-0.69	Vegetation discrimination
4	Near infrared	0.76-0.90	Biomass and shoreline mapping
5	Middle infrared	1.55-1.75	Moisture content of soil
6	Thermal infrared	10.4-12.5	Soil moisture, thermal mapping
7	Middle infrared	2.08-2.35	Mineral mapping

Table 1 : Landsat Bands

II . LITERATURE REVIEW

1.APPLICATION OF MACHINE LEARNING TO THE PREDICTION OF VEGETATION HEALTH

Pros

- Significantly more predictive power on held-out datasets than a baseline
- Tool can automatically update predictions as new MODIS data is made available by NASA
- integration of machine learning techniques and remote sensing data could be used to predict other environmental phenomena

Cons

- Low predictive performance for extreme EVI values in Sri Lanka
- Bangladesh, we see far more actual EVI values at or below zero

2.Modelling the Vegetation Response to Climate Changes in the Yarlung Zangbo River Basin Using Random Forest

Pros

- It can be integrated into water resource management and elucidates ecological processes in Yarlung Zangbo River Basin.

3. MODIS DERIVED NDVI BASED TIME SERIES ANALYSIS OF VEGETATION IN THE JODHPUR AREA

Pros

- MODIS NDVI products may be used to quickly assess the vegetation changes in response to rainfall

- The sensitivity of the MODIS to these regional variations also illustrates the considerable potential of these data for crop condition monitoring and phenology studies.

Cons

- NDVI can predict more reasonable data than EV

4 . **The Use of Remote Sensing Data for Drought Assessment and Monitoring in Southwest Asia**

Pros

- Best option incorporates the long-term NDVI characteristics calculated from AVHRR into MODIS at 500-m spatial resolution.

Cons

- TCI was found to be an unreliable indicator for drought assessment and is not recommended for future drought monitoring

5.**Analyzing the impact of thermal stress on vegetation health and agricultural drought – a case study from Gujarat, India, GIScience & Remote Sensing**

Pros

- Analyzed data of various climatic (heat waves), meteorological (temperature and rainfall) and vegetative (moisture condition, thermal condition and CY) parameters, and tried to establish their association and relationship

Cons

- SPI is not equipped to assess the impact of temperature on VH.

6. **Application of meteorological and vegetation indices for evaluation of drought impact: a case study for Rajasthan, India**

Pros

- SPI was computed at different time scales of 1, 2, 3, 6, 9 and 12 months using monthly rainfall data.

Cons

- In Kota the results are not in close proximity like for other districts.

7. **Predicting agricultural drought in easternRajasthan of India using NDVI and standardized precipitation index**

Pros

- Model can be successfully used for prediction of agricultural drought in the semi-arid and transitional zones in the first fortnight of August.

Cons

- The correlation between SPI and NDVI was not significant in other agro-climatic zones because of technological progress and irrigational facilities.

2.2 Outcome of Literature Review :

Studying the papers we came to the conclusion that we will be using Landsat images and processing these images using SAGA. The bands extracted from Landsat imagery will be used to calculate NDVI. This NDVI will be categorized into 4 groups and then analysed for pre and post monsoon.

2.3. Problem Statement :

We will be exploring the NDVI based Analysis of Vegetation Health

NDVI values derived from LANDSAT imagery can help us determine the vegetation health of an area.

We need to work on obtaining the LANDSAT imagery of the desired area and extract the NDVI values from them.

These NDVI values will be used to categorize the vegetation health of the area by building a relationship with rainfall data of the same area.

This will help in better planning for a drought or flood.

2.4. Research Objectives

To study the Jodhpur district in Rajasthan we first designed a python script using Jupyter Notebook. Google Earth API was then used to select the study area using specified time frames to download the .tiff images. Landsat 8 imagery was then downloaded and processed in SAGA to extract the NDVI values from .tiff images. Analysis of the results thus concluded a significant spike in the Less Dense Vegetation category which was due to excess rainfall in the monsoon months.

III. Methodology and Framework

3.1. System Architecture

System for Automated Geoscientific Analyses - is a Geographic Information System (GIS) software with immense capabilities for geodata processing and analysis.SAGA GIS is intended to give scientists an effective but easily learnable platform for implementing geoscientific methods. This is achieved by the application programming interface (API).

Jupyter Notebook - The Jupyter Notebook is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text. Uses include: data cleaning and transformation, numerical simulation, statistical modeling, data visualization, machine learning, and much more.

3.2. Algorithms and techniques

We used the Landsat imagery downloaded by our script to analyze NDVI patterns in SAGA. The datasets used were strategically chosen from pre-monsoon and post-monsoon months to get best results. The results were divided into four categories to get the best idea of vegetation index based on NDVI values.

IV. Work Done

4.1 Details

The USGS Earth Explorer data portal is your one stop shop for obtaining geo-spatial datasets from our extensive collections. Users can navigate via interactive map or text search to obtain Landsat satellite imagery.

The Earth Engine has the Landsat and Sentinel-2 collections as part of the Google Cloud public data program.We used the LANDSAT imagery in our project from Earth Engine via their API.Their NDVI image collection of Landsat 7 Collection 1 Tier 1 composites are made from Tier 1 orthorectified scenes, using the computed top-of-atmosphere (TOA) reflectance.These composites are created from all the scenes in each 8-day period beginning from the first day of the year and continuing to the 360th day of the year.

We used the Landsat imagery downloaded by our script to analyze NDVI patterns in SAGA. The datasets used were strategically chosen from pre-monsoon and post-monsoon months to get best results.

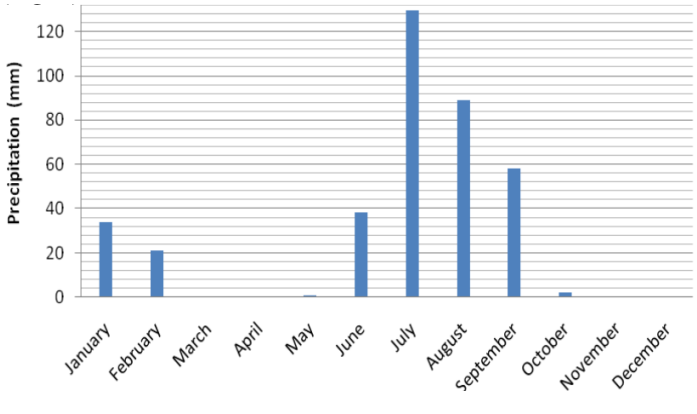


Table 2

As we can observe the majority of the rainfall received is in the month of July to August we will analyze pre and post monsoon data to establish a correlation

4.2 Results and Discussion

Visual NDVI Jupyter Notebook

We wrote a script in Python using Jupyter Notebook which in real time lets you

- Select the desired area of NDVI calculation with the help of an interactive map with search and draw features.
- To Select the desired time range
- Download the TIFF image to your own PC.

Our Jupyter Notebook can be found at https://github.com/rishwarii/VisualNDVI for further reference and use.

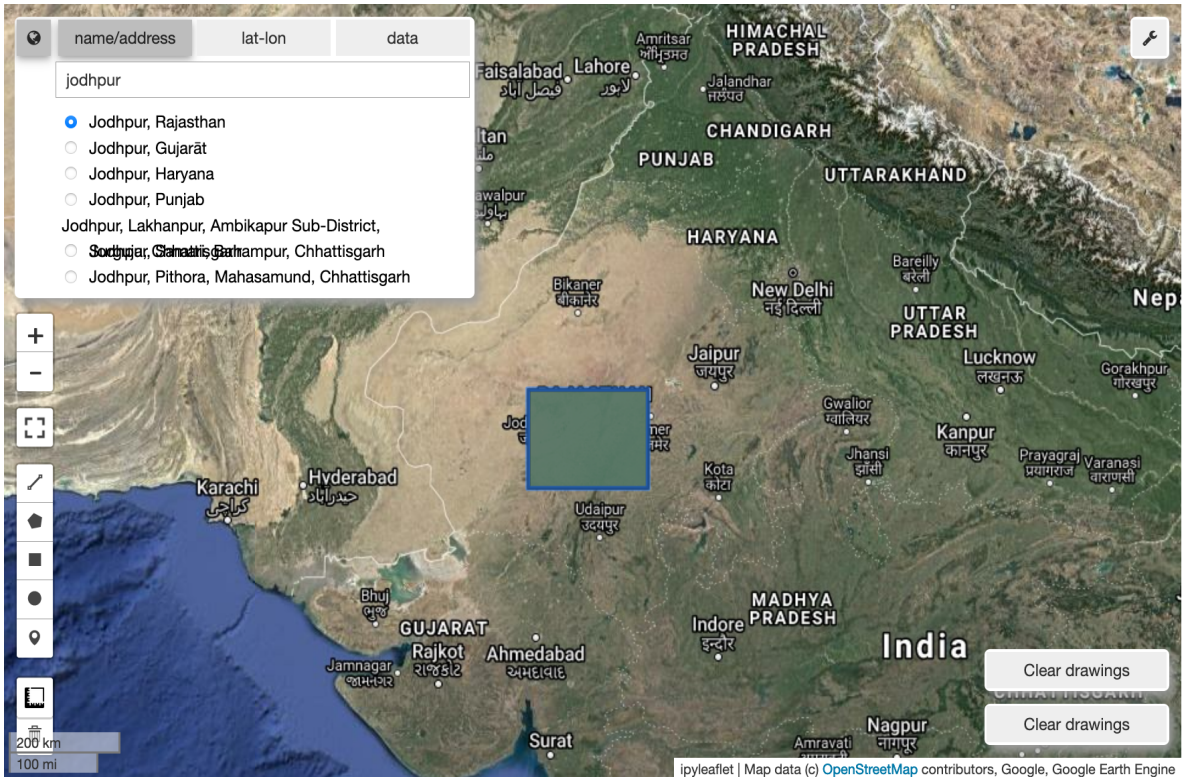


Image 1

The UI of the notebook was exported in Voila for a more interactive feel

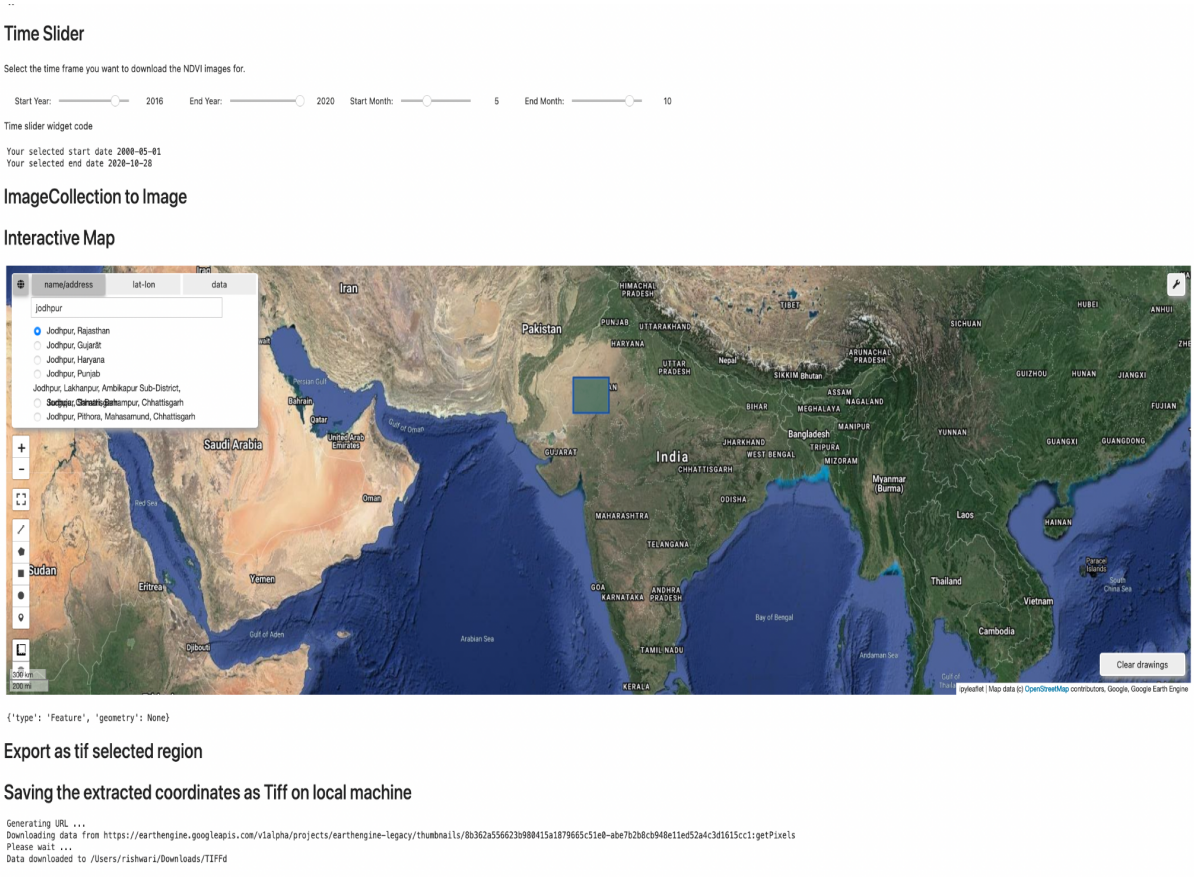


Image 2

4.2.1 Extracting NDVI bands from TIFF images

We downloaded the Landsat dataset of the Jodhpur area from USGS earth explorer .This data set will be processed in SAGA GIS to acquire the NDVI bands from the GEOtiff images.

Before NDVI band calculation

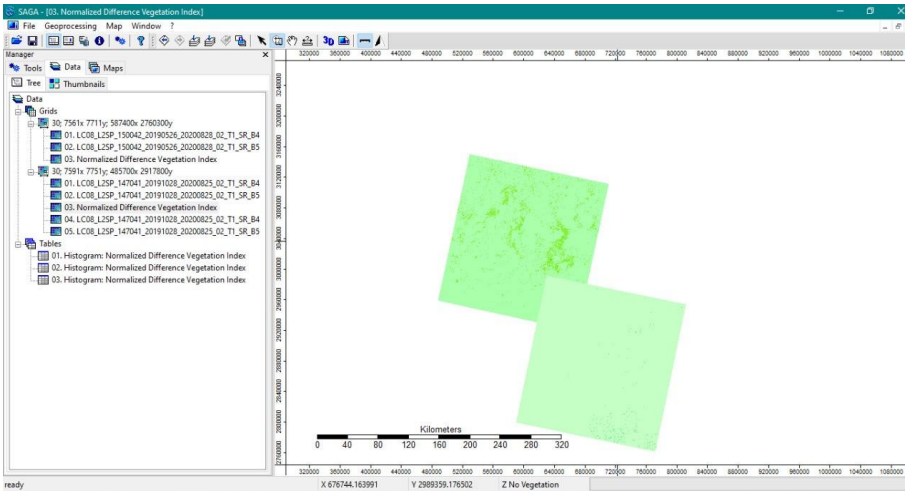


Image 3

After NDVI band calculation

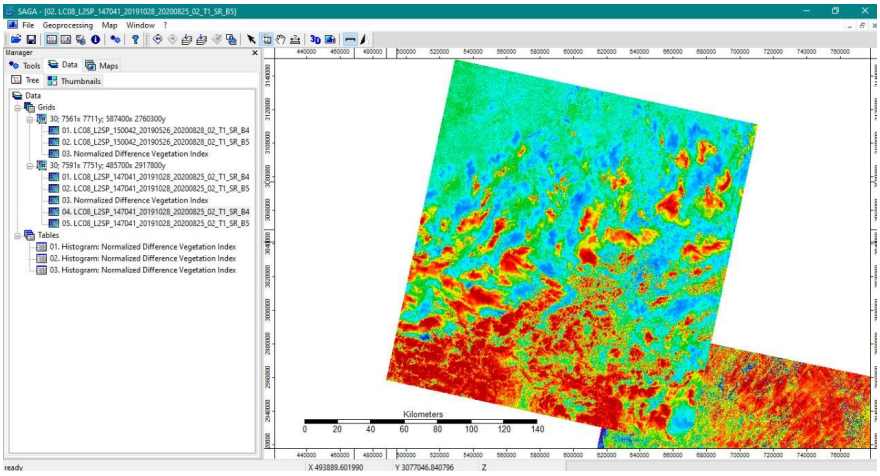


Image 4

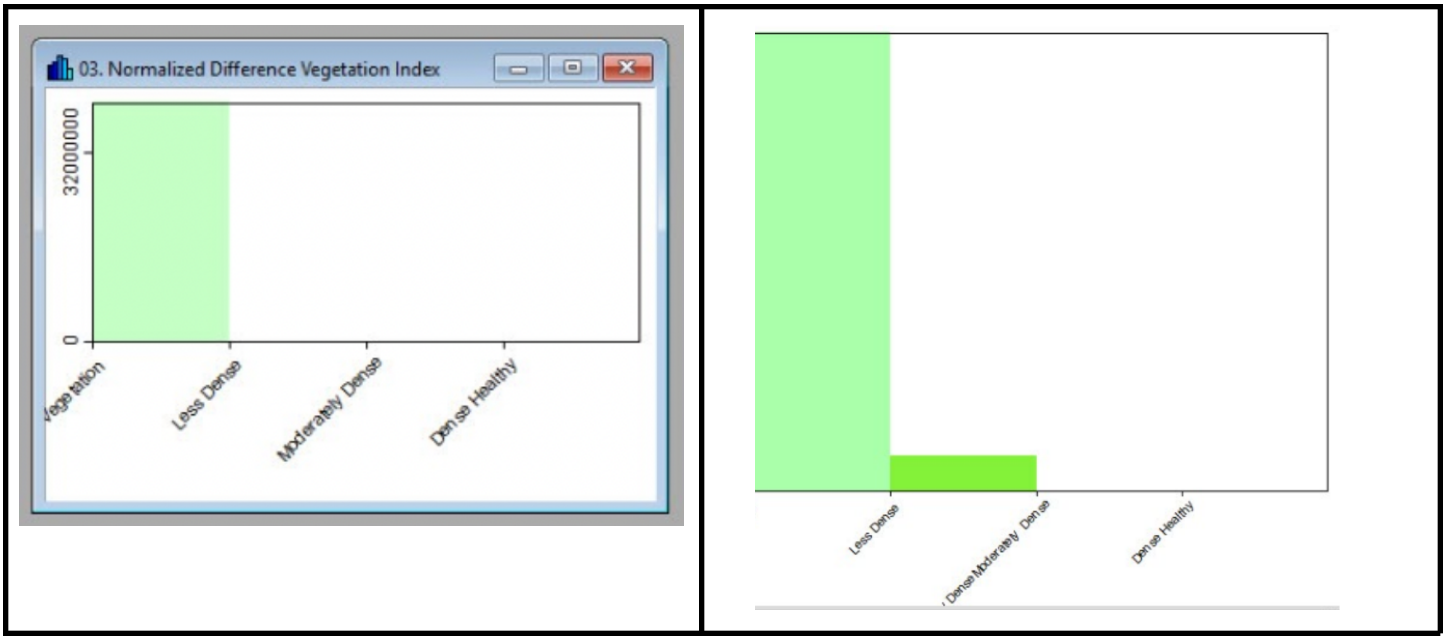
4.2.3 Change in categorical NDVI values

We divided our NDVI range into 4 categories as shown in Table.

	COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
1		No vegetation	No vegetatior	-1.000000	0.200000
2		Less dense vegetation	Less dense veg	0.200000	0.400000
3		Moderatly dense vegetation	Moderatly den	0.400000	0.600000
4		Dense healthy vegetation	Dense healthy	0.600000	1.000000

Table 3

We observed a spike in the category of Less Dense vegetation after the major rainfall months of June - July. We compared results from May 2019 with December 2019.



MAY 2019 ***DECEMBER 2019***

As our region receives the majority of the rainfall in the months of July - August the change we observed in NDVI values in December justifies and corroborates the assumption we had.

4.3 Individual Contribution :

- Research Paper Survey : We read 4 papers each
- Python Script : Rishwari Ranjan
- SAGA Analysis : Ankit Sahai
- Documentation : Rishwari and Ankit

V. CONCLUSION AND FUTURE

The objective of this paper was to analyse vegetation cover in Jodhpur area based on NDVI values.It was seen that rainfall is a major factor in contributing towards the growth in vegetation cover of an area. The NDVI values provided a useful source in assessing the green cover. SAGA based analysis for categorical NDVI shows us the spike in vegetation after monsoon months to prove rainfall was the major factor in a better vegetation cover in Jodhpur due to lack of other factors like absence of perennial rivers.

With more available data and more extensive analysis of the regions a predictive model can be constructed which will help in predicting vegetation health in the future which will help the local farmers with their irrigation planning and crop harvesting.

VI . REFERENCES

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