NDVI BASED ANALYSIS OF VEGETATION HEALTH

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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.

1.0. 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

2.STUDY AREA

Jodhpur district hold the coordinates at 26° N and 27° 37' North Latitude and 72.° E and 73°52' East Longitude , which falls in the arid zone of the state topologically and comprises 11.60 % of the complete arid region. With the terrain slope towards the west and without any perennial river in the district it's quite arid.

2.1 Climatic conditions

Jodhpur faces frequent droughts due to erratic rainfall in the area. The majority of the rainfall almost 82% occurs in bulk over the months of July to September.

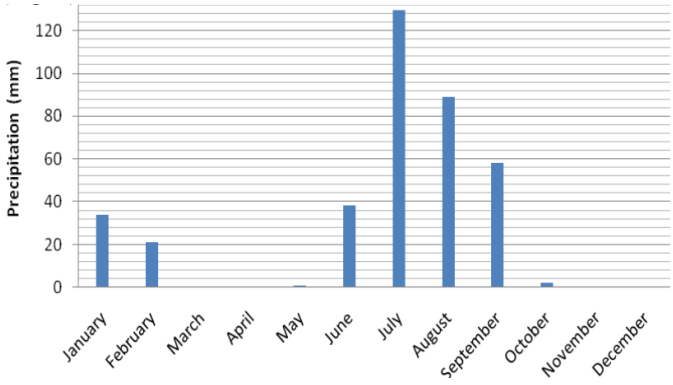


Table 1 : Monthly Precipitation Data for Jodhpur

3.0 DATASET AND TECHNOLOGY USED

3.1 Satellite data

Landsat satellites offer high-quality and varied images of the Earth's surface. Landsat images being limited-resolution and remote-sensing images are special images, but contain vast amounts of data collected in various locations with visible and invisible light. This information can be used to describe what the earth looks like, including what species of plants exist or to what extent a natural disaster affected the environment.

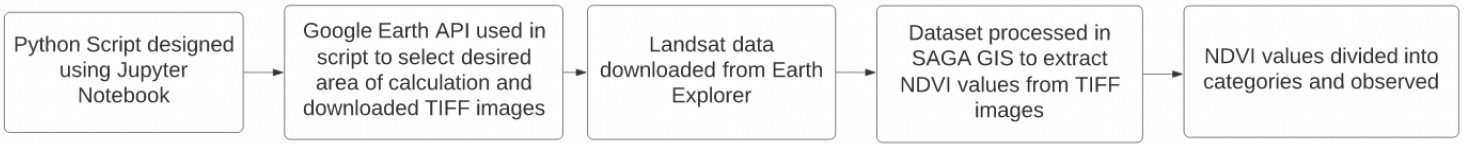
As of now there are present are two Landsat satellite imagery satellites Landsat 8 - (2013 - 2021) and Landsat 7 (1999 -2021)

Landsat has following unique features

1. Regular international installations are provided.
2. They are available at no cost to all.
3. Landsat's archives dates back to 1972.

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 2 : Landsat Bands and respective characteristics



3.2 Procurement of Satellite Images

3.2.1 USGS Earth Explorer

The USGS Earth Explorer data portal has an abundance of geo-spatial datasets. With an interactive map users can access Landsat imagery with ease.

3.2.2 Google Earth Engine

Google Earth Engine hosts a multi-petabyte collection of geospatial datasets and satellite imagery which have planetary-scale analysis capabilities which are available to scientists, researchers, and developers to detect changes, map trends, and quantify differences on the Earth's surface.
Google Earth Engine hosts the Landsat collections which are part of the Google Cloud public data program. Google Earth Engine also has APIs which enable the analysis of various datasets.

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 collections are created from all the scenes in the 8-day period start from the first day of the year and end to the year's 360th day.

3.3 Processing of LANDSAT data using SAGA

SAGA which stands for System Automated Geoscientific Analysis is a robust software widely used by scientists and researchers for analysis of geospatial data. It is an open source software and is of great use for analysing geographical data.

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.

4.0 RESULTS & DISCUSSION

4.1 Visual NDVI Jupyter Notebook

A Python script using Jupyter Notebook written by us was used to get TIFF images 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. The coordinates of the polygon drawn are used to fetch the data from Google Earth Engine .
- We also need to select a desired time range for which we need our data. This can be done using the date selection slider widget in the python script.
- The API will fetch the desired data from the Earth Engine database with the required filters which will be downloaded to your PC's download folder for offline use and further processing in other softwares.

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

Image 1 : Interactive Map in Jupyter Notebook

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

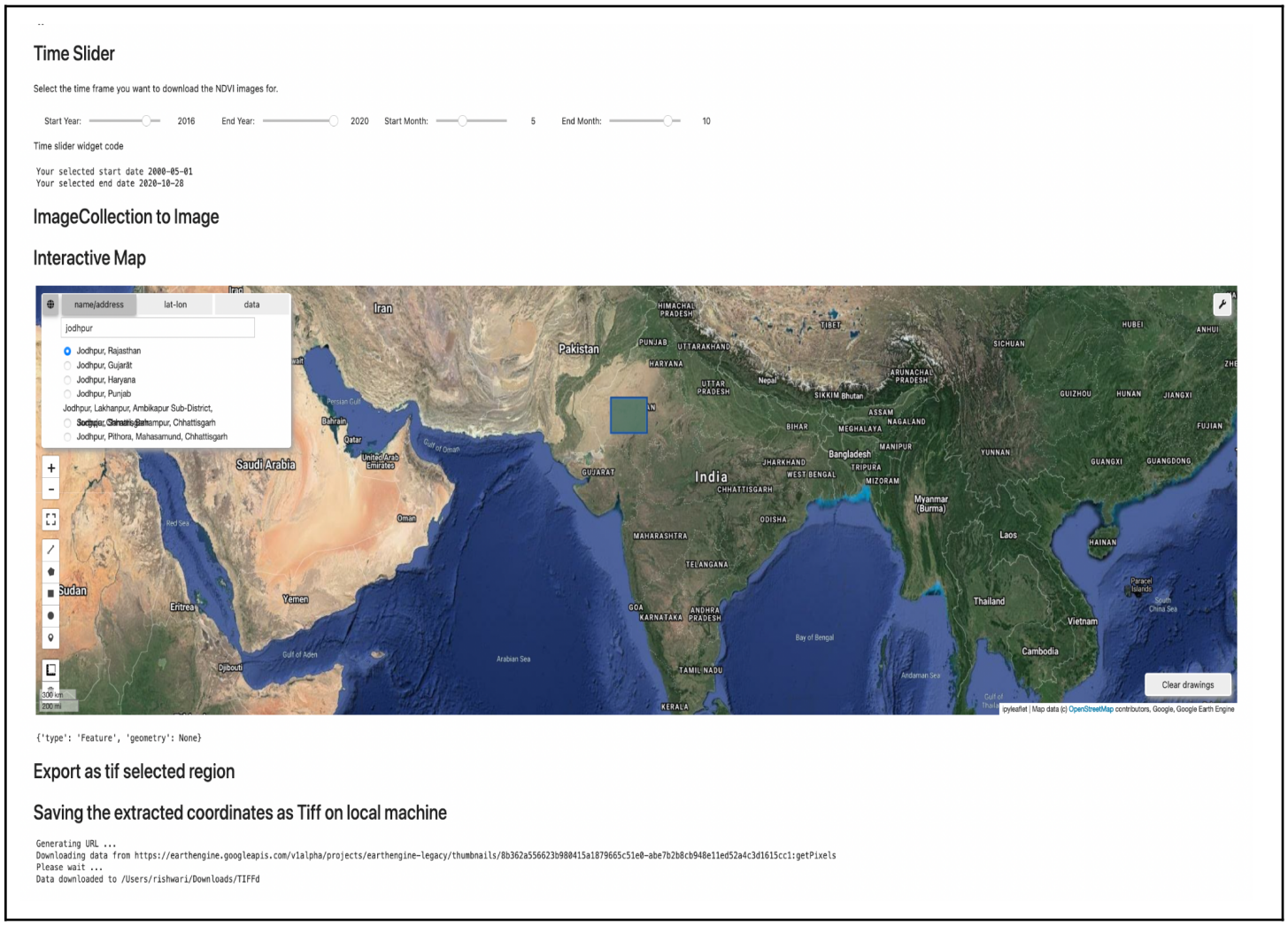


Image 2 : Jupyter Notebook Interface in Viola

4.1 **Extracting NDVI bands from TIFF images**

We downloaded the Landsat dataset of the Jodhpur area using our python script.This data set will be processed in SAGA GIS to acquire the NDVI bands from the GEOtiff images.

In SAGA we loaded both the TIFF images and used Band 4 and Band 5 as we are using Landsat 8 imagery to calculate the NDVI values

We analyse both the results and segregate the obtained values into 4 classes to further draw conclusions if any change was observed in pre and post monsoon vegetation categories.

Before NDVI band calculation

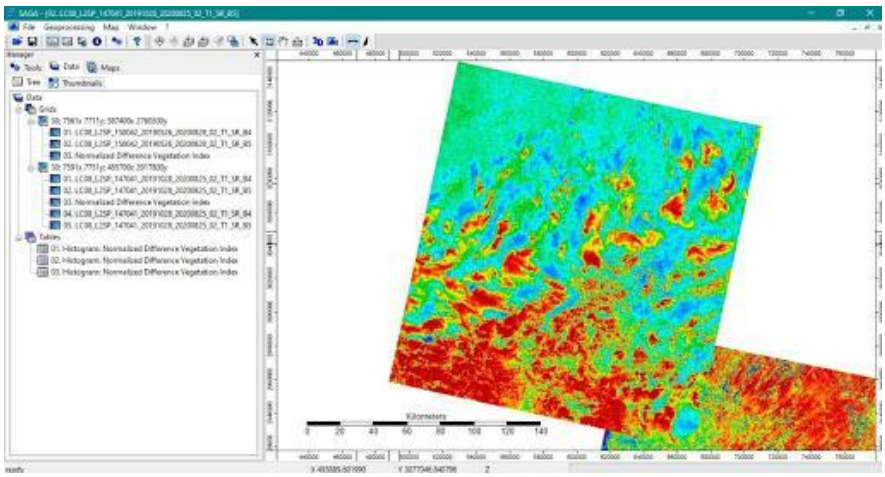


Image 3 : Before NDVI

After NDVI band calculation

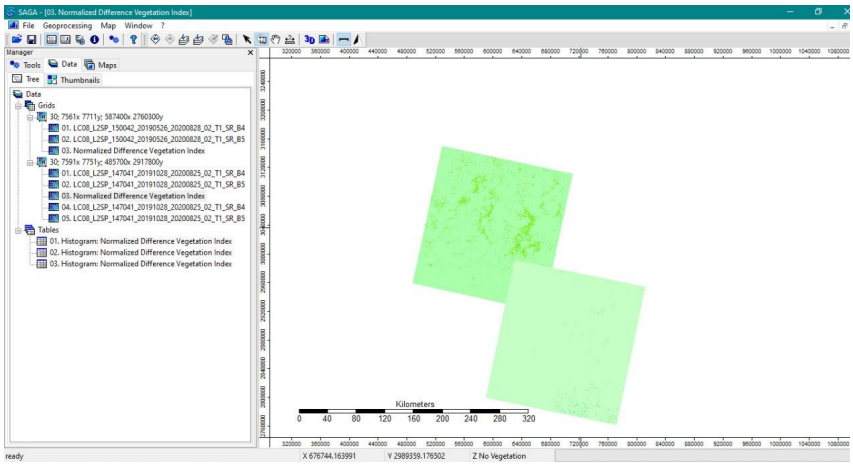


Image 2 : After NDVI

4.2 Change in categorical NDVI values

We divided our NDVI range into 4 categories as shown in the 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

Image 3 : Categories of NDVI

We observed a spike in the category of Less Dense vegetation after the major rainfall months of June - July. This justifies the fact that more healthy vegetation flourishes in the subsequent months of a healthy rain.
We compared results from May 2019 with December 2019.

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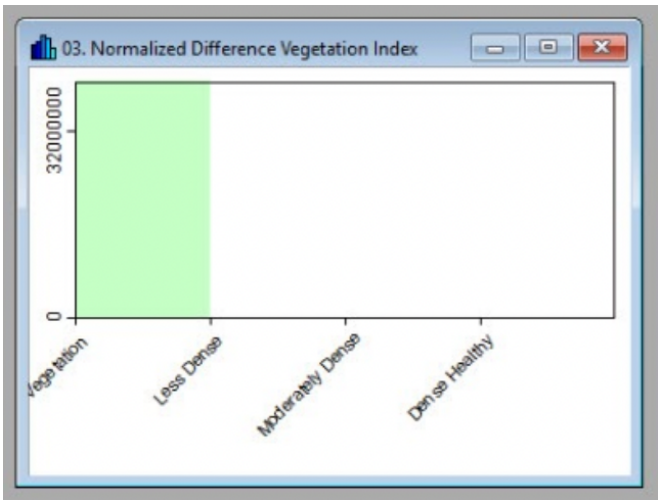
<td> 
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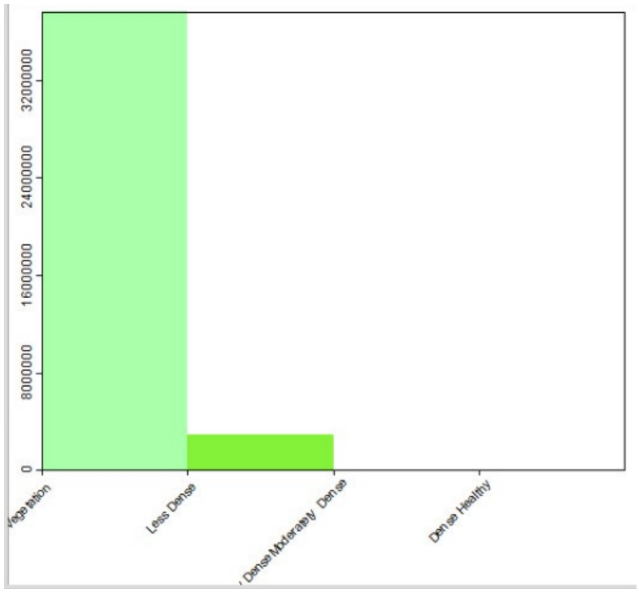
<td> 
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<td>MAY 2019</td>
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CONCLUSION AND FUTURE SCOPE

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.

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