DHIRUBHAI AMBANI INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGY

M.SC. AGRICULTUR ANALYTICS

PROJECT REPORT 2024

COURSE

EARTH OBSERVATIONS SYSTEMS(EOS)

PROJECT TITLE

"SPATIOTEMPORAL ANALYSIS OF NDVI CHAGES WITH RAINFALL"

SUBMITTED BY:

NIDHI CHAUDHARY

UNDER THE GUIDENCE OF

DR. SWATI PRIYA (ID: -202419004)

November, 2024

DECLARATION

We hereby declare that the experimental work and its interpretation of Agricultural Analytics Project Report entitled "Spatiotemporal Analysis of NDVI Changes with Rainfall" or part of there has neither been submitted for any other degree or diploma of any university, nor the data have been derived from any thesis/publication of any university or scientific organization. The source of material used and all assistance received during the course of investigation have been duly acknowledged.

Nidhi Chaudhary

(id: -202419004)

Date:- 18 /11/2024

Place: - Gandhinagar

CERTIFICATE-I

This is to certify that the thesis entitled, Spatiotemporal Analysis of NDVI Changes Rainfall submitted for the degree of **M.SC. (Agricultural Analytics)** in the department of Agriculture Analytics , Dhirubhai Ambani Institute of Information and communication technology, Gandhinagar, Gujarat is a Bonafide research work carried out by Miss Nidhi Chaudhary (ID:-202419004) is under my supervision and that no part of this project has been submitted for any other degree.

Prof. Dr. Swati Priya

Project Guide

DA-IICT

DATE:- 18/11/2024

PLACE:- Gandhinagar

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ACKNOWLEDGEMENT

Words are inadequate to thank God for his grace and blessings which enable us to complete our master degree project successfully. Emotions can't be adequately expressed in words hence my acknowledgement are much more than what we are an expressing here.

I would like to express our special thanks to our **Prof. Dr. Swati Priya from Dhirubhai Ambani Institute of Information and communication technology, Gandhinagar, Gujarat** as well as our Principal **Dr. Tathagata Bandyopadhyay and coordinator shrimantha mandal** who gave us the golden opportunity to do this wonderful project on the topic **"Spatiotemporal Analysis of NDVI Changes with Rainfall"** who also helped us to do a lot of research came to know about so many new things. We are really thankful to them.

We express our special thanks to **Prof. Dr. Swati Priya from Dhirubhai Ambani Institute of Information and communication technology, Gandhinagar, Gujarat** for his guidance. Last but not the least, we are thankful to Principal. for providing us, the opportunity to do this project and providing us the best facility required for successful completion of the project work.

Nidhi Chaudhary

(ID: - 202419004)

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ABSTRACT

Now, spatiotemporal analysis emerges as a robust tool in studying vegetation dynamics as well as its association with climatic variables. In this context, this article aims to study the relationship between NDVI and rainfall patterns in Vadgam, Banaskantha, Gujarat, during 2021-2024. We used remote sensing and GIS techniques to carry out NDVI changes and determined the effect of rainfall variability on vegetation health.

An integrated NDVI data of the spatially interpolated rainfall datasets coupled with satellite images is used to understand the spatiotemporal trend of vegetation. Regions that are likely to get affected with vegetation stress or booming growth can be identified using NDVI reclassification and its correlation with rainfall. Advanced visualization techniques such as maps, graphs, and charts are used to represent the temporal trends and spatial distribution patterns.

This important study underlines the important role that rainfall assumes in patterns of change in NDVI in a semi-arid region like Vadgam. The lessons obtained from dynamics can be used to examine aspects of vegetation resilience, sustainable land management practices, and the eventual climatic variability on agricultural productivity. Findings are used to develop predictive models of vegetation trends that will help stakeholders plan and manage resources better.

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TABLE OF CONTENTS

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CHAPTER I

INTRODUTION

Why I Picked this Topic

The unique perspective in understanding how vegetation reacts over time to changes in environmental conditions, especially rainfall, is presented through the topic of **"Spatiotemporal Analysis of NDVI Changes with Rainfall."** NDVI is critical to understanding the health and changes observed in vegetation; by correlating its variations with those of the patterns of rainfall, valuable information regarding ecosystem resilience, agricultural productivity, and sustainable land management may be retrieved. Understanding how vegetation in any specific region reacts to changes in rainfall under a changing climate provides very timely insights and, therefore, significant information. Focusing on NDVI changes over the past few years, I try to identify trends and factors, which might be useful in forecasting potential future vegetation patterns and supporting resource planning in agriculture as well as environmental conservation.

Why I Chose Vadagam, Banaskantha, Gujarat as the Study Area

I have chosen Vadagam in Banaskantha, Gujarat, as my study area for this project since it's my native place and a region with peculiar climatic challenges and with agriculture practices closely linked with the variability of rainfall. Familiarity with Vadagam will enable me to really understand the context of the area, coupled with an inner motivation to provide useful insights that might be useful for the community. In fact, the semi-arid conditions of Banaskantha, combined with variable rainfall patterns, make it an excellent region to study the response of vegetation towards seasonal and annual variations in the amount of rainfall. This will bring me closer to answering local agricultural planning needs while contributing to larger studies in the environment that might help sustain practices happening in tune with the region's ecological and climatic scenarios.

Overview of NDVI and its Significance

The Normalized Difference Vegetation Index is one of the key remote sensing metrics; it can be used for detecting the greenness or health condition and also the amount of vegetation coverage from satellite data. It provides information as regards to the vibrancy and density of plant life by measuring the difference in reflectance between visible light and near-infrared light from vegetation. Over time NDVI has been an important component in the assessment of ecological changes, detection of drought situations, and aiding agricultural management practices.

Importance of Spatiotemporal Analysis

The spatiotemporal analysis of NDVI along with rainfall deepens the understanding of how vegetation dynamics shift over time and across different locations. This analysis is vital for pinpointing areas experiencing considerable vegetation stress and grasping the influence of climatic conditions on these changes. By integrating remote sensing information with climate data, informed decisions can be made regarding land-use planning, agricultural efficiency, and environmental preservation.

Research Questions

- How has NDVI evolved from 2021 to 2024 within the study region?
- In what ways does rainfall variability affect NDVI patterns?
- How does the distribution of rainfall affect the variability of NDVI and can specific kinds of rainfall pattern related to vegetation health?

Objectives

- How has NDVI evolved from 2021 to 2024 within the study region?
- In what ways does rainfall variability affect NDVI patterns?
- investigate how the patterns of rainfall might impact variability in NDVI and find out the impact that rainfall has on vegetation health.

The main objectives of this research are:

- To perform a spatiotemporal analysis of NDVI alterations from 2021 to 2024.
- To evaluate the effect of rainfall on variations in NDVI.
- To investigate the impact of rainfall on vegetation health using NDVI metrics.
- To model the combined influences of temperature and rainfall on vegetation over time.
- To deliver visual representations (maps, charts, and figures) of these changes.

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CHAPTER II

REVIEW OF LITERATURE

The Significance of NDVI in Environmental Monitoring

NDVI has become a leading indicator in the monitoring of vegetation health and dynamics, primarily in regards to climate change. NDVI measures the amount of vegetation cover and, therefore, signifies the status of the ecosystems and how they react to altered climatic conditions. Scientists found that NDVI is more than just a number-it tells how the plants thrive as they face environmental changes. For instance, NDVI has been reported to have a strong link with the physiological response of plants against temperature and rainfall while being an essential index applied in environmental monitoring (Pettorelli et al., 2014).

Exploring Spatiotemporal Changes in NDVI

The power of remote sensing lies in its ability to analyze spatiotemporal changes in NDVI across different landscapes. Researchers such as Zhang et al. (2020) have effectively utilized satellite imagery to capture and visualize how NDVI evolves over time and space. In this regard, their findings illustrated a significant spatial variability in vegetation responses to climatic change thus upholding the need for localized studies. It is the spatial perspective that gives a more subtle view of vegetation dynamics, hence pointing out spots within the region, which would be more exposed to the impacts of climate change.

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CHAPTER III

STUDY AREA AND SOFTWARE USED

Study Area:-

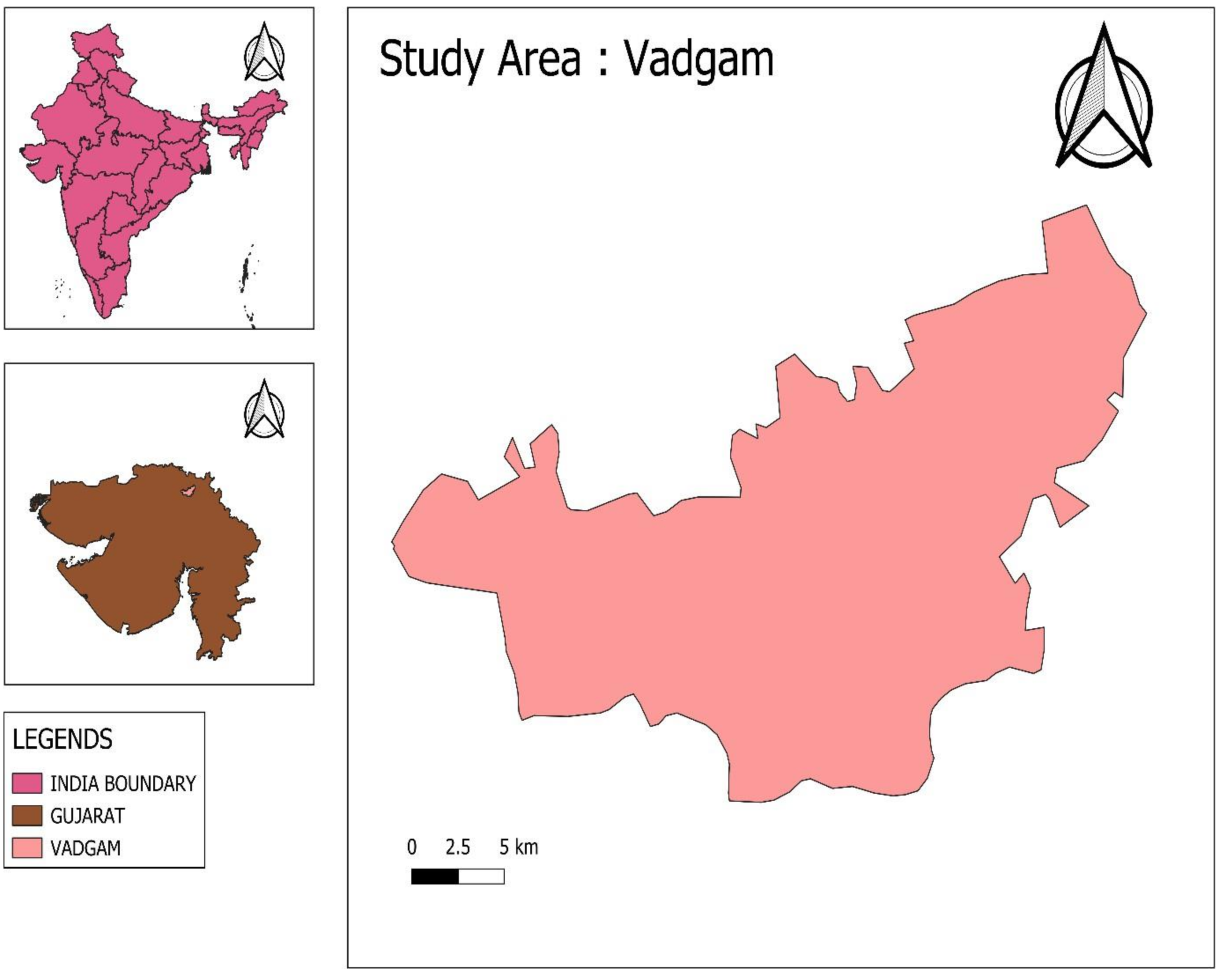

Figure. No. 1 Study Area Vadagam

Software Used:

QGIS

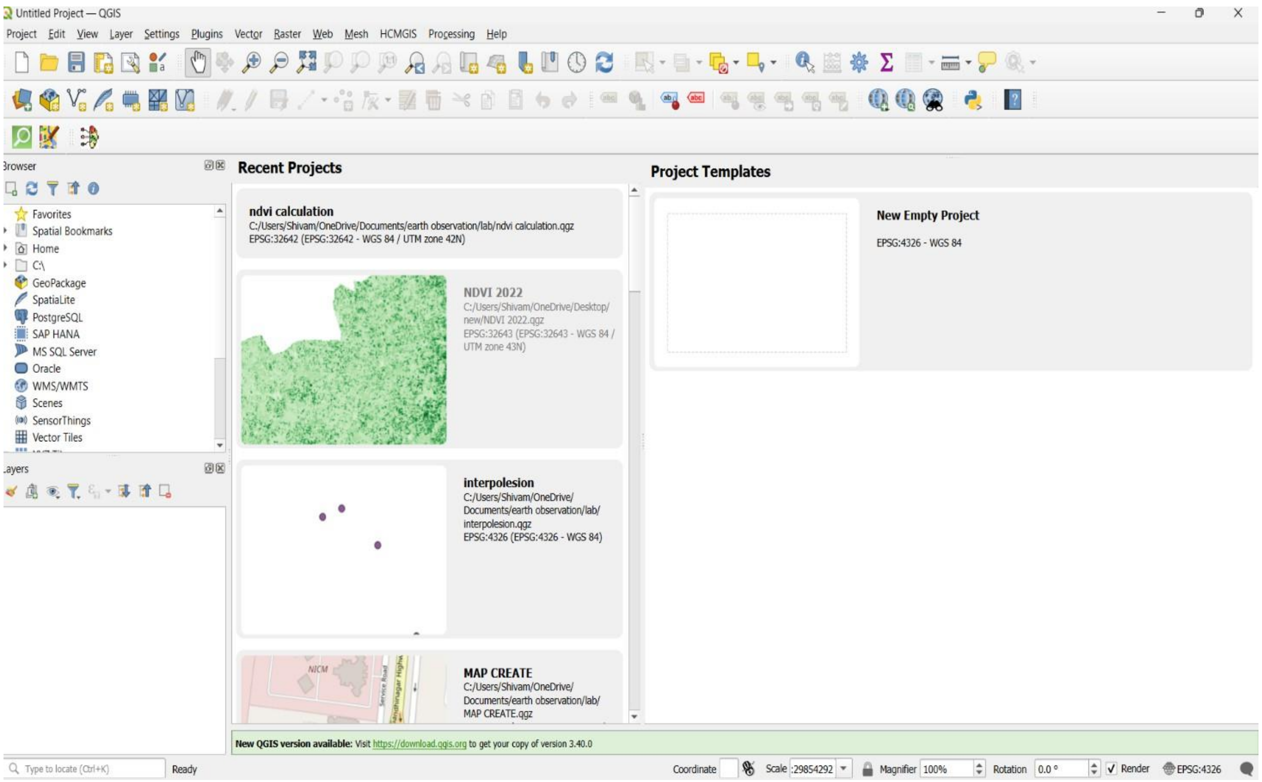

Figure. No. 2. Interface of QGIS

QGIS, also known as **Quantum GIS**, is a geographic information system (GIS) software that is free and open-source. QGIS supports Windows, macOS, and Linux. It supports viewing, editing, printing, download and analysis of geospatial data.

Anaconda navigator(Jupiter notebook)

Anaconda Navigator is a desktop application that is built on top of the conda package and environment manager. Navigator enables you to use conda to manage environments and packages, but in a graphical application instead of a command line interface (CLI)

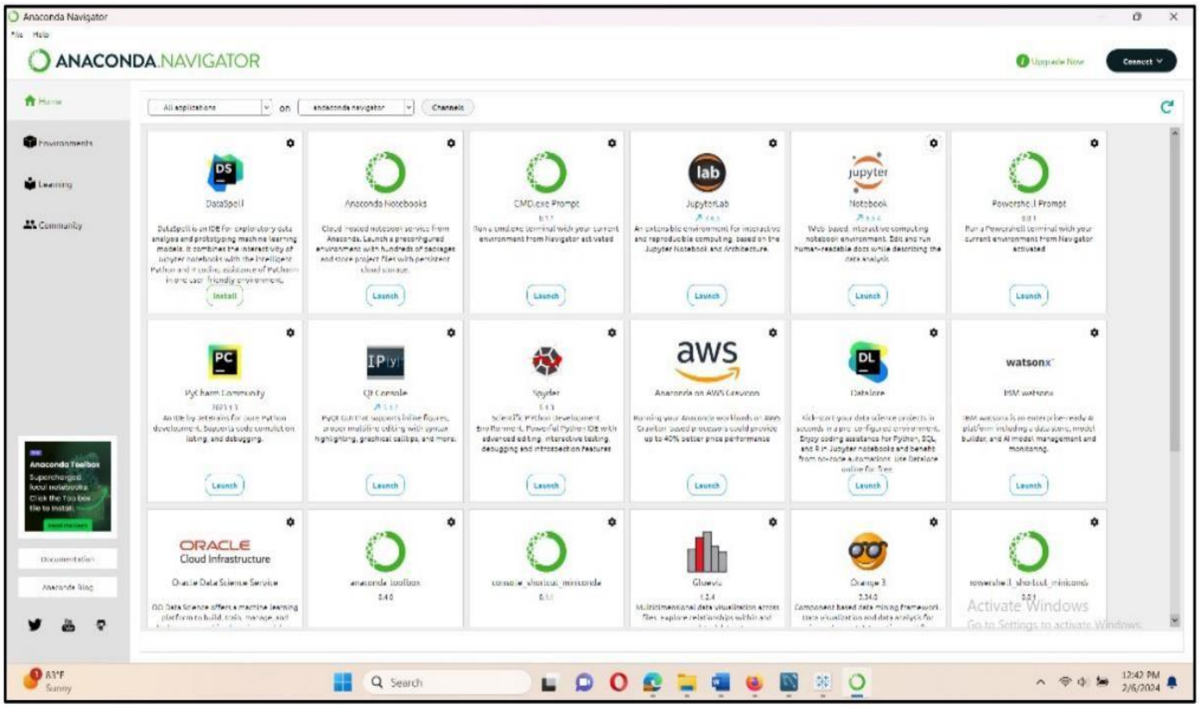

Figure. No. 3. Anaconda navigator

Python:

Employed for data preprocessing, including automating NDVI calculations and managing large datasets for analysis.

Figure. No. 4. python

Copernicus Browser:

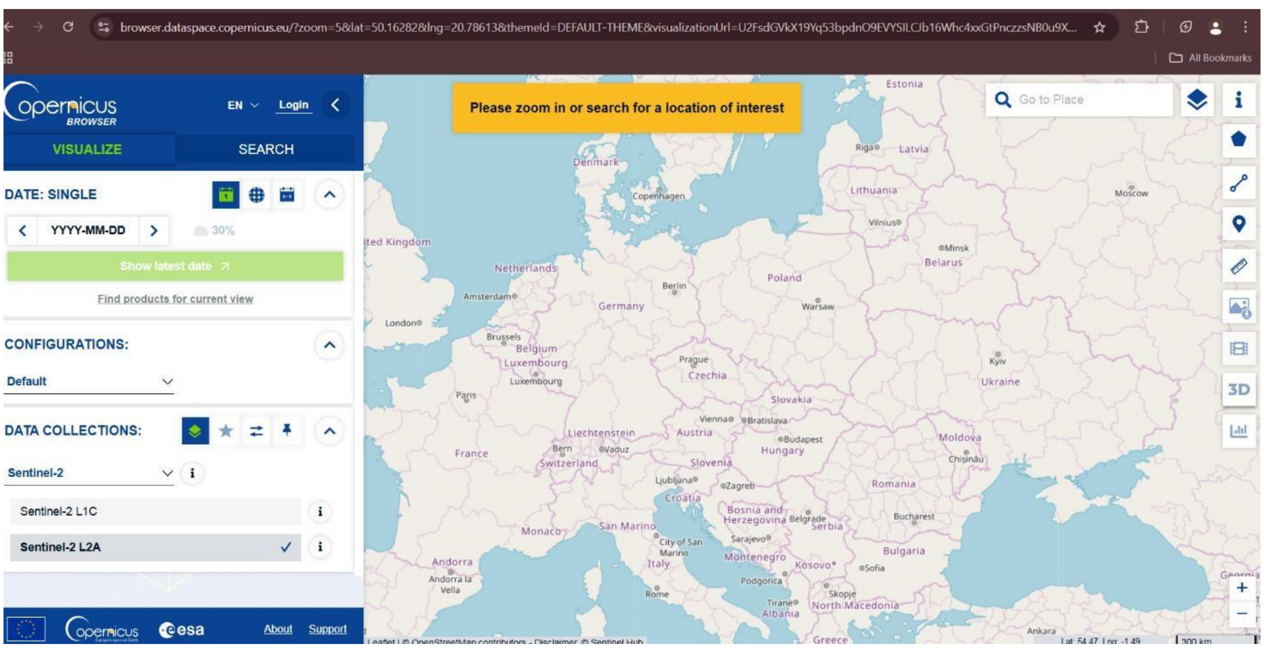

Figure. No. 5. COPERNICUS BROWSER

The tool allows access to, visualization, and downloading free Earth observation data from the Sentinel satellites with the tool of the Copernicus Browser. It is used for environmental monitoring and land-use analysis, emergency response, climate studies, high-resolution imagery, and data on applications such as vegetation health, urban expansion, and emergency management.

IMDLIB- A PYTHON LIBRARY

IMDLIB is a Python library for accessing, analyzing, and visualizing India Meteorological Department data like rainfall and temperature, useful for climate studies and weather pattern analysis.

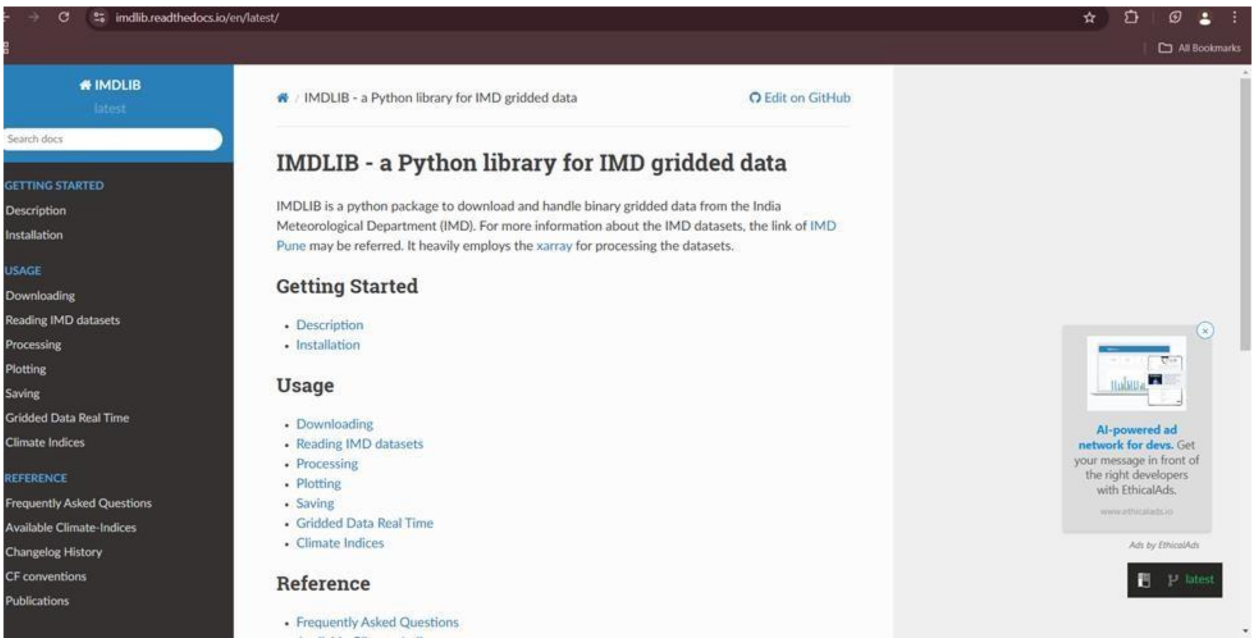

Figure. No. 6. IMDLIB- A PYTHON LIBRARY

GOOGLE EARTH:

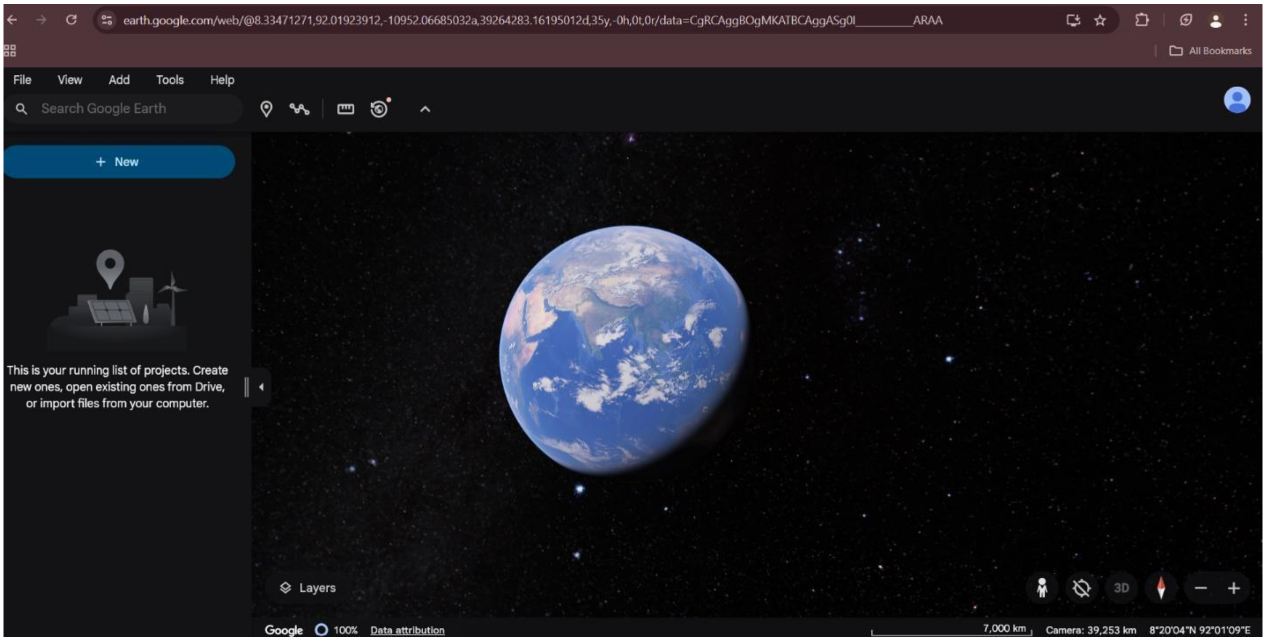

Figure. No. 7. GOOGLE EARTH

View 3D maps, explore satellite imagery, measure distances, and see the world come alive with geographic data for research, trip planning, or education purposes by using Google Earth.

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CHAPTER IV

METHODOLOGY

Here's a detailed methodology section tailored to my topic, Spatiotemporal Analysis of NDVI Changes with Rainfall. This section outlines the steps for data collection, processing, analysis, and interpretation.

1) Data Collection

- **BAND :- (RED/NIR)**

Source :- NDVI data will be collected from satellite imagery obtained from sources such as Sentinel-2.

Period :- Data will cover the years 2021 to 2024(OCTOBER)

For this task I used Copernicus browser which is a open source; first we signed in on the browser to create an account. Go to search select sentinel 2-la2 ,cloud cover less than 10,then we selected the time range for which we wished to observe the image. Based on the location we selected we get the images available during that duration download the desired format and resolution.

The Copernicus program, managed by the European Space Agency (ESA) and the European Commission, provides a wealth of satellite data through various services. This data is invaluable for Geographic Information System (GIS) applications, including environmental monitoring, land use planning, and disaster management. This report outlines the process of selecting and downloading specific datasets from two key Copernicus services: the Copernicus Open Access Hub and Sentinel Hub.

Accessing Copernicus Data

Copernicus Open Access Hub:

The Copernicus Open Access Hub is a primary gateway to satellite data, offering access to missions such as Sentinel-1, Sentinel-2, and Sentinel-3. Here a step-by-step guide for accessing data:

Registration/Login:

Visit the Copernicus Open Access Hub and create an account if you don’t already have one. Log in to access the data.

Searching for Your Area:

Utilize the map interface to zoom into your region of interest. You can also input coordinates directly or upload a shapefile to define your area precisely.

Defining Search Parameters:

Set the search parameters including date range, satellite mission (e.g., Sentinel-2), and cloud cover percentage. For example, you might select Sentinel-2 imagery from the last six months with a cloud cover limit of 20%.

Searching and Previewing:

Execute the search to view available images. Preview the results to identify which datasets meet your criteria.

Downloading Data:

Add your chosen products to the cart. Proceed to download by selecting the desired format and resolution.

Selecting Date and Sentinel Mission:

Define the date range and select the appropriate Sentinel mission, such as Sentinel-2, depending on your data needs.

- **IMD (Indian Meteorological Department) :- LIB**

Visit the IMD Climate Data Service Portal

Access the IMD Climate Data Service Portal by using which I can obtain a wide range of data in relation to the climate. In the website click on the "Data Services" tab which is located under the portal. It will enable to retrieve a number of climate data sheets including rainfall records over varied periods.

Login or Registration

I'll be required to fill in some basic information. After becoming a registered user, log into view the data. If I already a registered user, then I simply just log in using your credentials.

Select Preferences of Rainfall Data

After being logged in, navigate to the dashboard, then find "Rainfall Data" among the lists of datasets available, and I can opt for viewing the data according to your preference.

Time: I can choose the specific years or months you are interested in.
Region: Optionally, I can narrow down by region- either national, state, or district level.

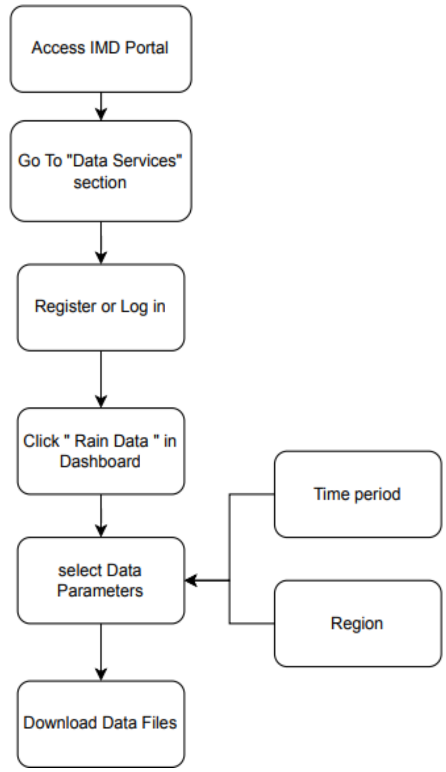
Download Data

Once I set my parameters, I should see a list of data files that match I preferences. Then I look for the download icon for each of the files and click on it to save them. The data is usually available in CSV or even Excel, so I am good to go to use analysis tools.

Document the Data

Provide that in my report details about the data source (IMD Library), type of data, date range, and the region covered. This is essential for transparency and credibility as it communicates information to sources-thereby avoiding being stripped bare by those who plagiarize.

Flowchart: -



2) NDVI CALACULATION:

Step 1: Initialization and Import of Satellite Imagery

QGIS software was launched and then added the satellite imagery from Sentinel-2 or Landsat to the project workspace. These were chosen because they provide the spectral bands needed for calculating NDVI: NIR (Near-Infrared) and Red.
The Copied Satellite Data: It has been copied using highly valued external repositories such as USGS Earth Explorer and Copernicus Open Access Hub since they deliver quality, georeferenced imagery suitable for any environmental analysis purpose.

Step 2: Calculating NDVI with Raster Calculator

To compute NDVI, the QGIS Raster Calculator tool was employed. Using the formula below,

$$\textbf{NDVI} = \frac{\textbf{(NIR Band-Red Band)}}{\textbf{(NIR Band−Red Band)}}$$

where:
Data for NIR was acquired from Band 8 of Sentinel 2 imagery.
Red data were read from Band 4 of the same dataset.

The above formula was input in the Raster Calculator using the expression:

("Band_8" - "Band_4") / ("Band_8" + "Band_4")

An appropriate file path and output format, GeoTIFF, were specified. The NDVI calculation was run, which created a new NDVI raster layer.

Step 3: Export Calculated NDVI Layer

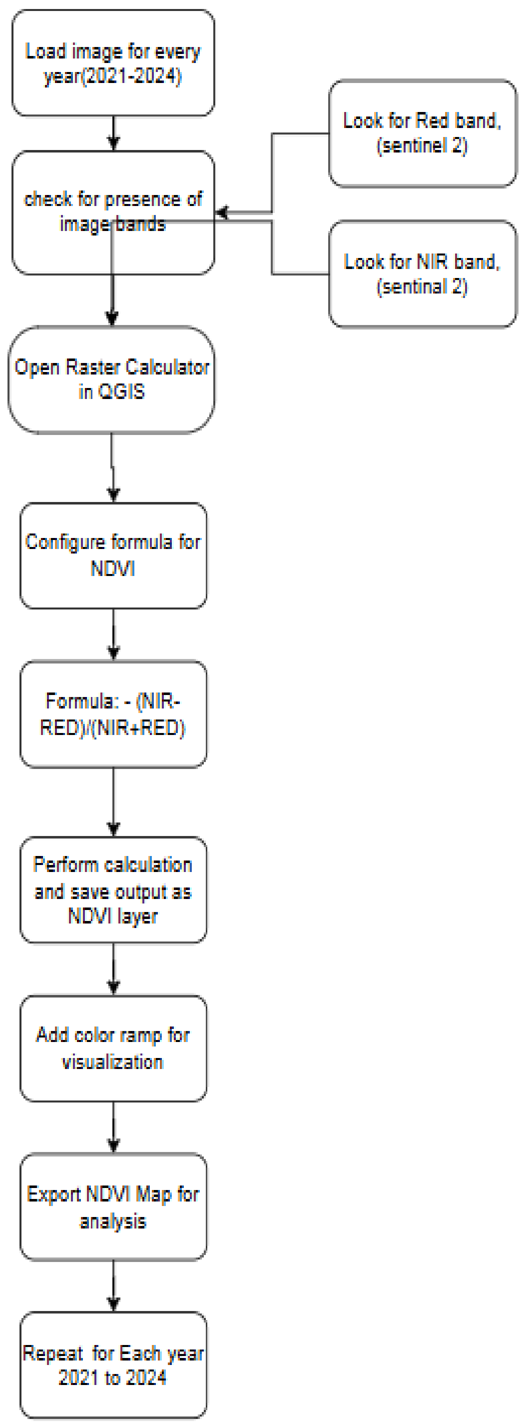
- GeoTIFF file format was specified to avoid losing geospatial data.
- An appropriate CRS aligned to the study area was selected to maintain spatial coherence.
- The file was saved to a pre-defined directory so this will easily be accessible in any future analytical stages of reporting.

Step 4 (Optional) – Improving NDVI Layer Visualization

The NDVI values ranging between -1 and 1 in the color ramp (usually red to green) under the Symbology tab of the Layer Properties was selected.

- Red hues indicated the presence of minimum or no vegetation.
- Green hues indicated the presence of healthy, dense vegetation.

FLOWCHART:-


Load image for every year(2021-2024)
check for presence of image bands
Look for Red band, (sentinel 2)
Look for NIR band, (sentinal 2)
Open Raster Calculator in QGIS
Configure formula for NDVI
Formula: - (NIR-RED)/(NIR+RED)
Perform calculation and save output as NDVI layer
Add color ramp for visualization
Export NDVI Map for analysis
Repeat for Each year 2021 to 2024

3) CHAGE DETECTION AND IMAGE ENHANCEMENT:

Application of Reclassify by Table Tool Upload Your Raster Layer:

Start by uploading my raster layer, that is, NDVI data to QGIS.

Reclassify Tool:

Move through Raster > Analysis > Reclassify by Table

Input and Reclassification Parameters:

Input Raster Layer: Input the raster layer that I want to work with.
Reclassification Table: Input the range and the output values here;
0 - 0.25 → 0
0.25 - 0.45 → 1
0.45 - 0.75 → 2
0.75 -1 → 3

Reclassify steps:-

Step 1 : Import the Raster File

Open QGIS
Layer > Add Layer > Add Raster Layer
Browse to my raster file

Step 2 : Open the Reclassification Tool

Search for Reclassify by Table under Raster Analysis or GDAL > Raster Miscellaneous.

Step 3 : Setting up the Reclassification Tool

Input Layer: Select the raster layer my wish to reclassify.

Reclassification Table:

Click on the "." button in the table input field to bring up the dialog.
Lower Bound : This is the starting value of the range I wish to reclassify.
Upper Bound: This is the ending value of the range I wish to reclassify.
New Value: This is the value to be assigned to all cells in that range.

Output Nodata Value (optional) : Enter in my value for the nodata cells
Output Layer: Select where I want to output the reclassified raster, such as save as file or as a temporary layer.

Step 4: Run the Reclassification

When it is complete, look in the Layers panel for the newly reclassified raster layer

Step 5: Check the Reclassified Layer

Right-click on the reclassified layer and then click Properties
Under the Symbology tab:
Change the render type to Singleband pseudocolor for visualization.
Add classes with color assignment on the newly reclassified values.

Step 6: Save the Reclassified Raster (Optional)

Right-click on the reclassified layer from the Layers panel.
Export > Save As.
Save it under some format, such as GeoTIFF, specifying the name of the file and CRS.
Click OK to save

Step 7: Validation

Validate the reclassification by comparing the original raster with the reclassified raster.
Now we will use the Identify Features tool to see what the pixel values are.

Visualize the Reclassified Raster:

After reclassification, open Layer Properties > Symbology to assign colors and labels to each class.

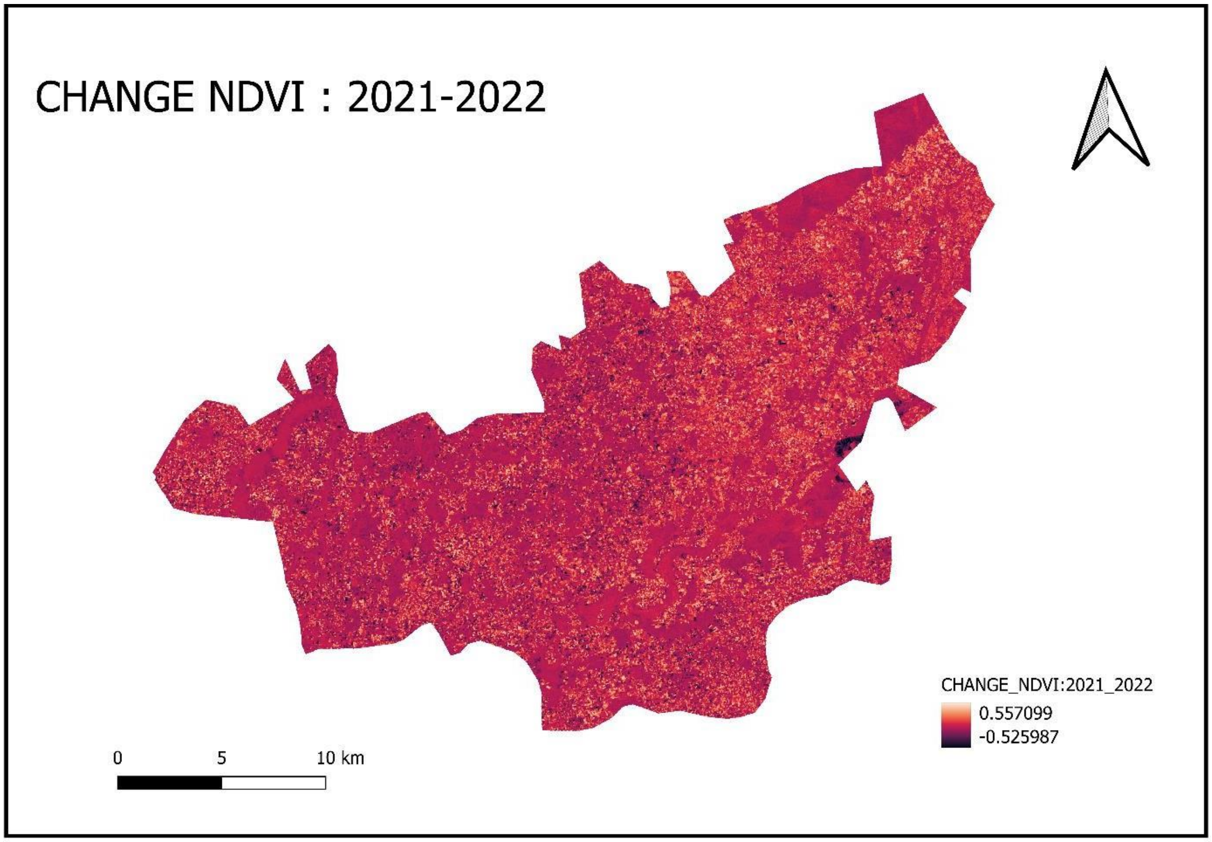


Figure. No. 8. CHANGE NDVI 2021-2022

4) PYTHON SCRIPT:-

Rasterio: It manipulates raster data, for example GeoTIFFs, as a means of reading, writing, and manipulating spatial data.
NumPy: Package for array and matrix operations-this is central to doing any manipulation on raster data.
matplotlib. pyplot: plots data, in this case, plots of NDVI changes.

Function to Crop or Pad Rasters to a Fixed Shape:

Function to Crop or Pad Rasters to a Fixed Shape crop_to_fixed_shape() crop or pad each raster into one with a target shape, target_shape
Parameters:
raster paths. File paths to NDVI or rainfall raster images.
target shape. Fixed shape (height, width) to which each raster will be resized; default is (2714, 4023).

Process :

- Iterate over raster file paths.
- Reads the first band of each raster, extracting its data array.
- Gets the data array's current shape.
- Fills a new array - cropped data - of target shape, manage any padding:
- Copies data from the original raster into the new array, cropping or padding as necessary.
- Adds the modified raster to cropped_rasters.

Computing Year-to-Year NDVI Changes Weighted by Rainfall Effect:

The function calculate_weighted_changes() computes the NDVI change between two sequential years and scales it to rainfall changes.

Parameters:

- ndvi_rasters, rainfall_rasters: Lists of cropped NDVI and rainfall rasters, respectively.
- **threshold**: The minimum threshold value of rainfall effect change; changes in rainfall below this value do not affect the NDVI.
- **epsilon:** Tolerance value to avoid division by zero

Process:

- Iterates over years, calculating year-over-year change in NDVI and rainfall.
- Normalizes rainfall changes relative to the maximum absolute change for each year.
- Applies the threshold to filter out insignificant rainfall impacts, setting them to zero.
- Adjusts the NDVI change by the rainfall impact factor, storing results in weighted_changes.

Analyze Weighted NDVI Changes

The function call NDVI change for each year and the average of all.
parameters:

ndvi_changes: List of weighted arrays holding ndvi changes

Process
Loops over ndvi_changes to print the mean NDVI change for each year.
Computes the average NDVI change over all the years and returns it for further computation.

Saving Raster Data as a GeoTIFFs

Function save raster() Saves processed data to a new GeoTIFFs based on a reference raster to set metadata.

parameters
data: The array of processed raster data to be saved
filename: A file path for saving the new raster
reference_path: Path to the reference raster to get metadata.

Process

Open the reference raster and retrieves all the metadata it had copied it into a new Raster
Updates metadata as appropriate for the new raster-data type, height, and width.
It writes data to a new GeoTIFF file with an updated profile.

Plotting Year-over-Year Weighted NDVI Changes

plot_weighted_changes () generates a line plot of the average change in NDVI over time.

Parameters
years: a vector of years, such as [2021, 2022, 2023, 2024].
weighted_ndvi_changes: vector of arrays of weighted NDVI change.

Process:
It plots the average of each year's weighted changes in NDVI vs. time as lines.

Main Script Execution

NDVI and Rainfall File Paths: Provide paths for NDVI and rainfall rasters for all years.
Crop Rasters Crop or pad NDVI and rainfall rasters to a fixed shape.
Calculate Weighted Changes: Calculate weighted NDVI changes with rain.
Analyze and Save Results: Print mean changes, save average change as GeoTIFF, and plot year- to-year changes

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CHAPTER V

RESULTS AND DISCUSSION

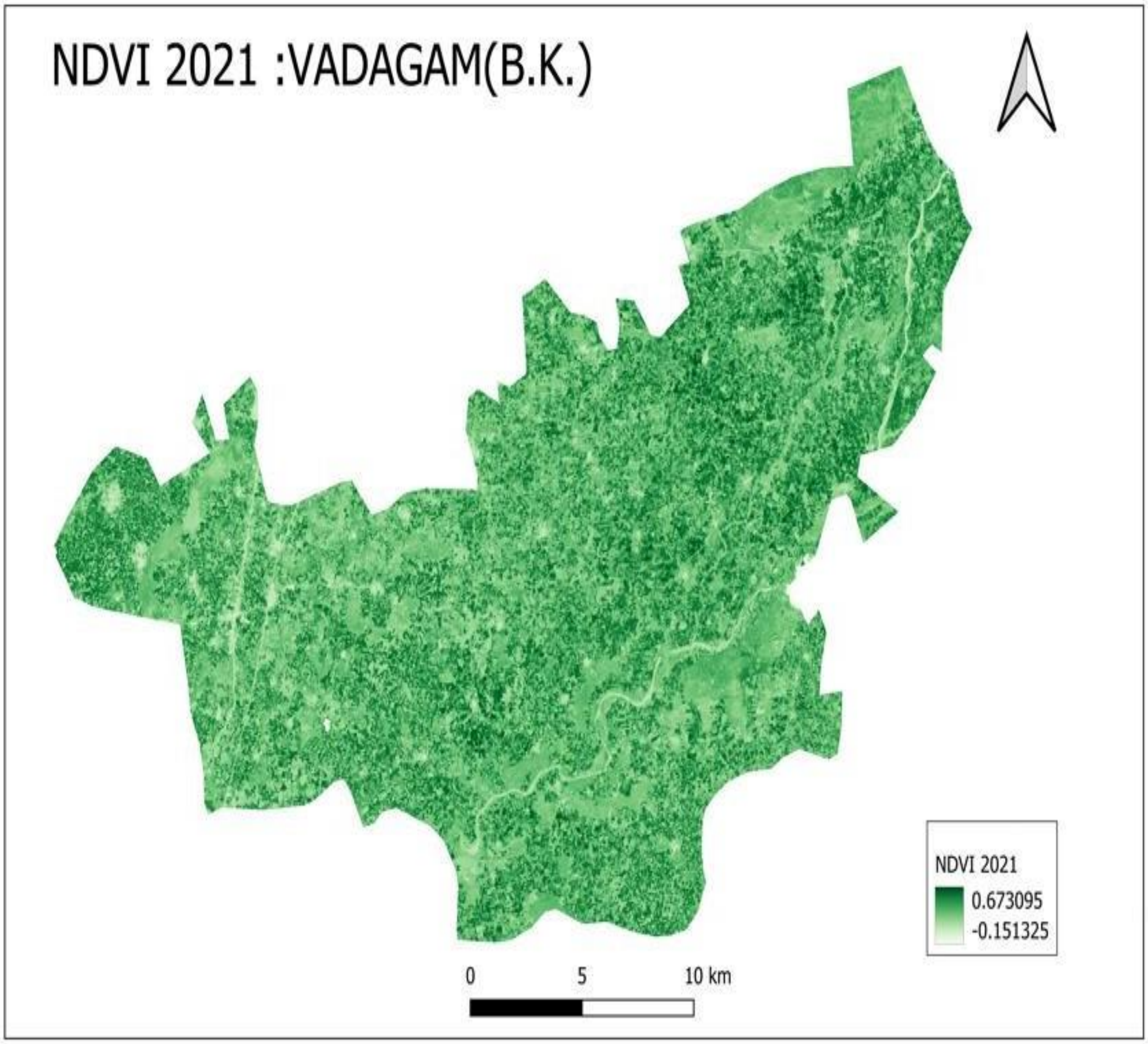

Figure. No. 9. NDVI 2021: VADAGAM

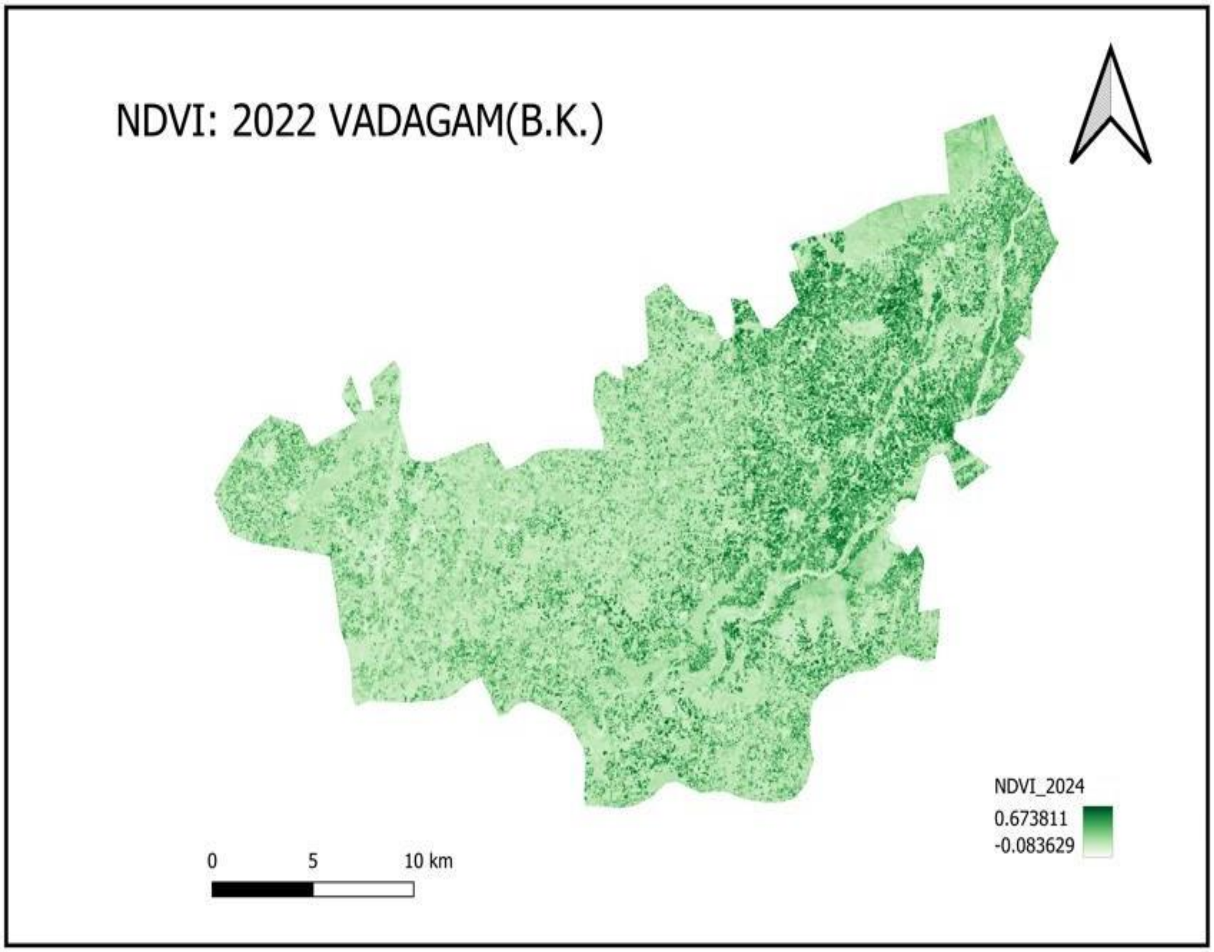

Figure. No. 10. CHANGE NDVI 2022: VADGAM

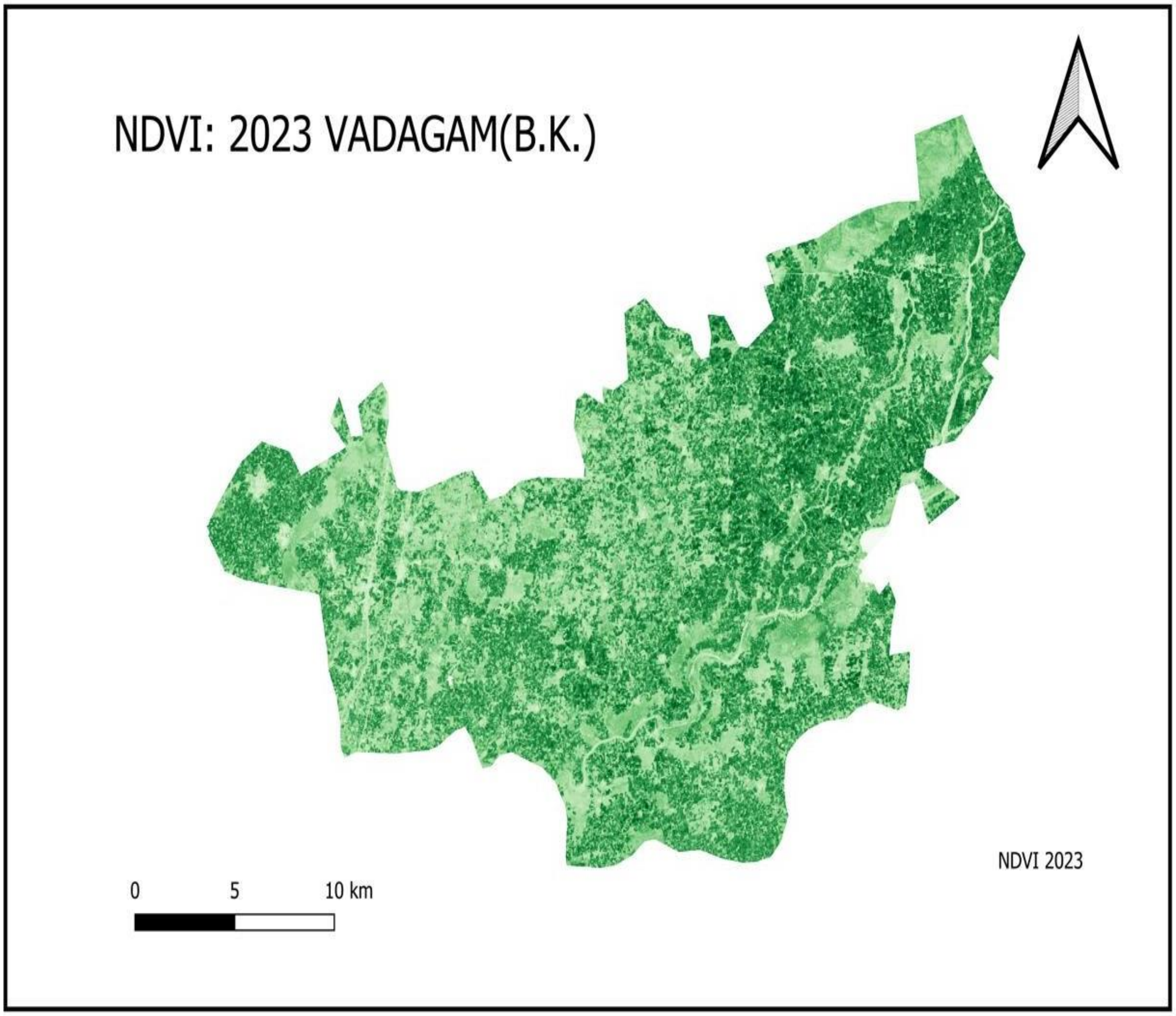

Figure. No. 11. CHANGE NDVI: 2023 VADGAM

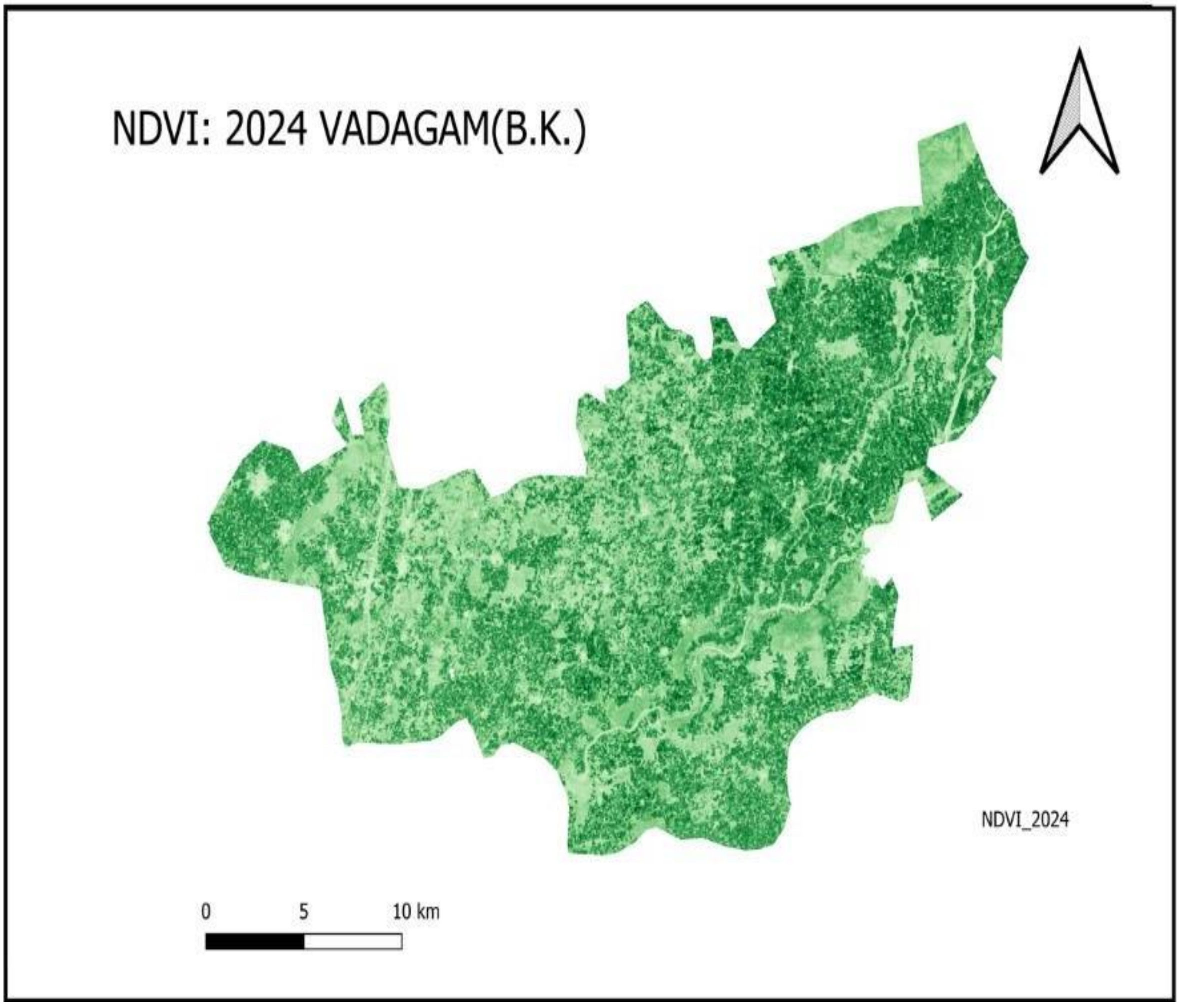

Figure. No. 12. CHANGE NDVI: 2024 VADGAM

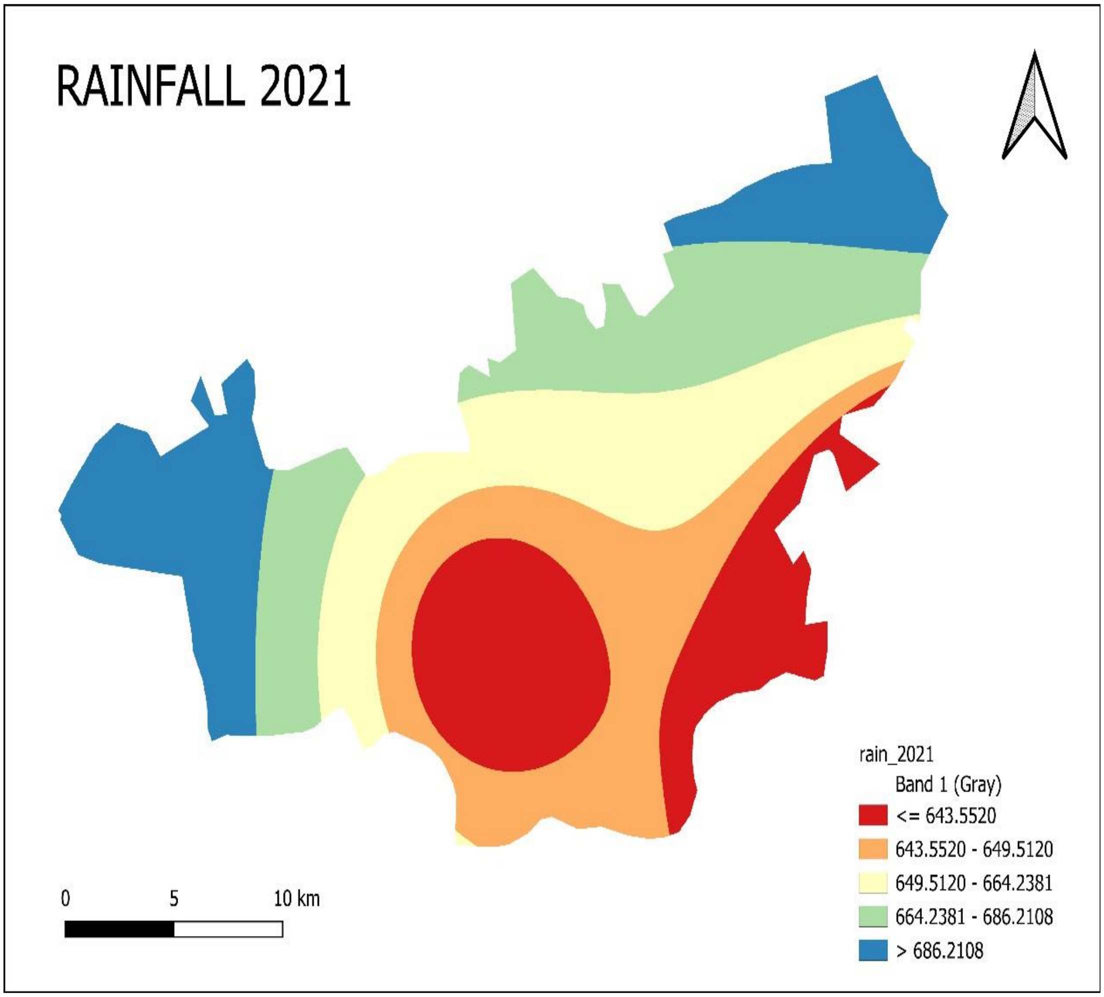

Figure. No. 13. RAINFALL: 2021

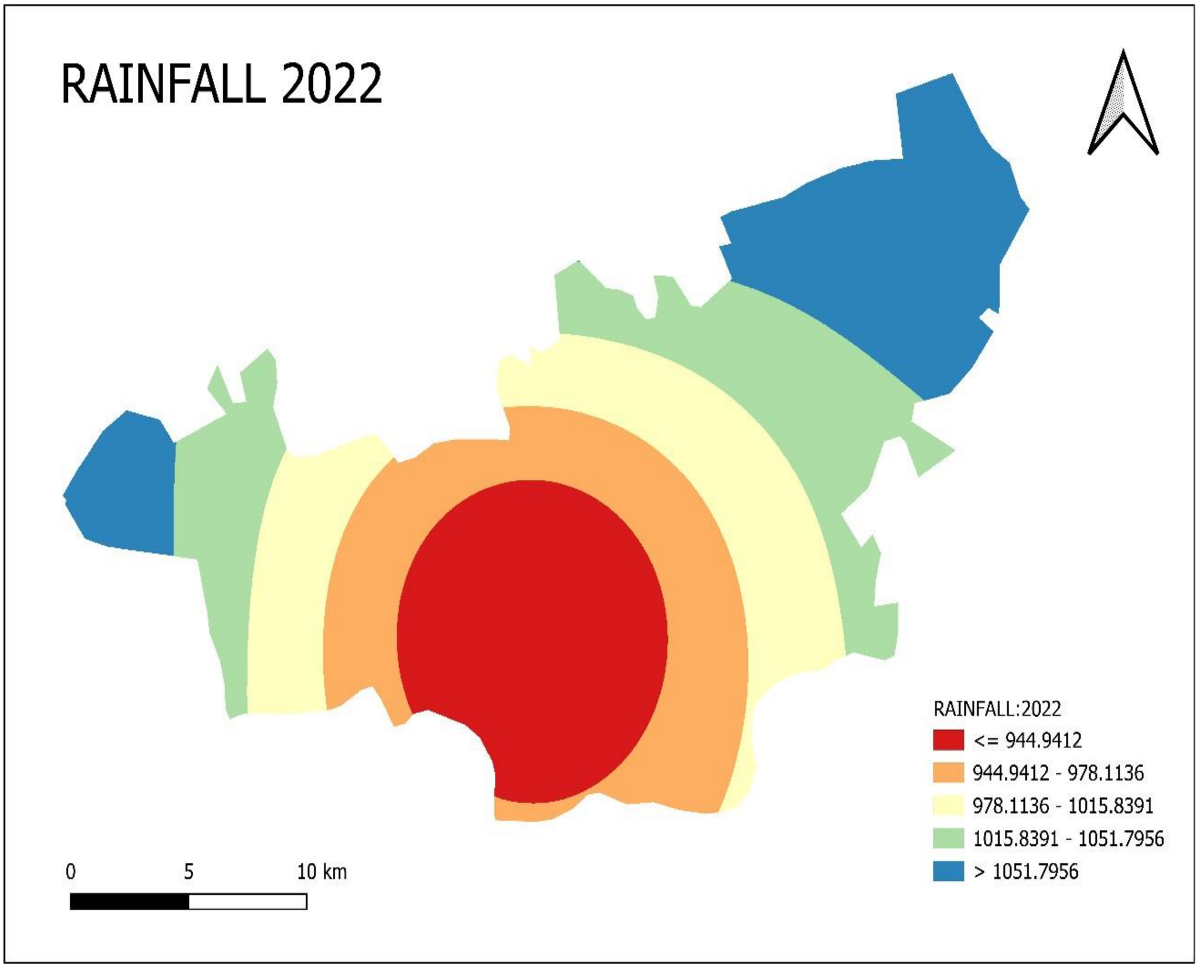

Figure. No. 14. RAINFALL: 2022

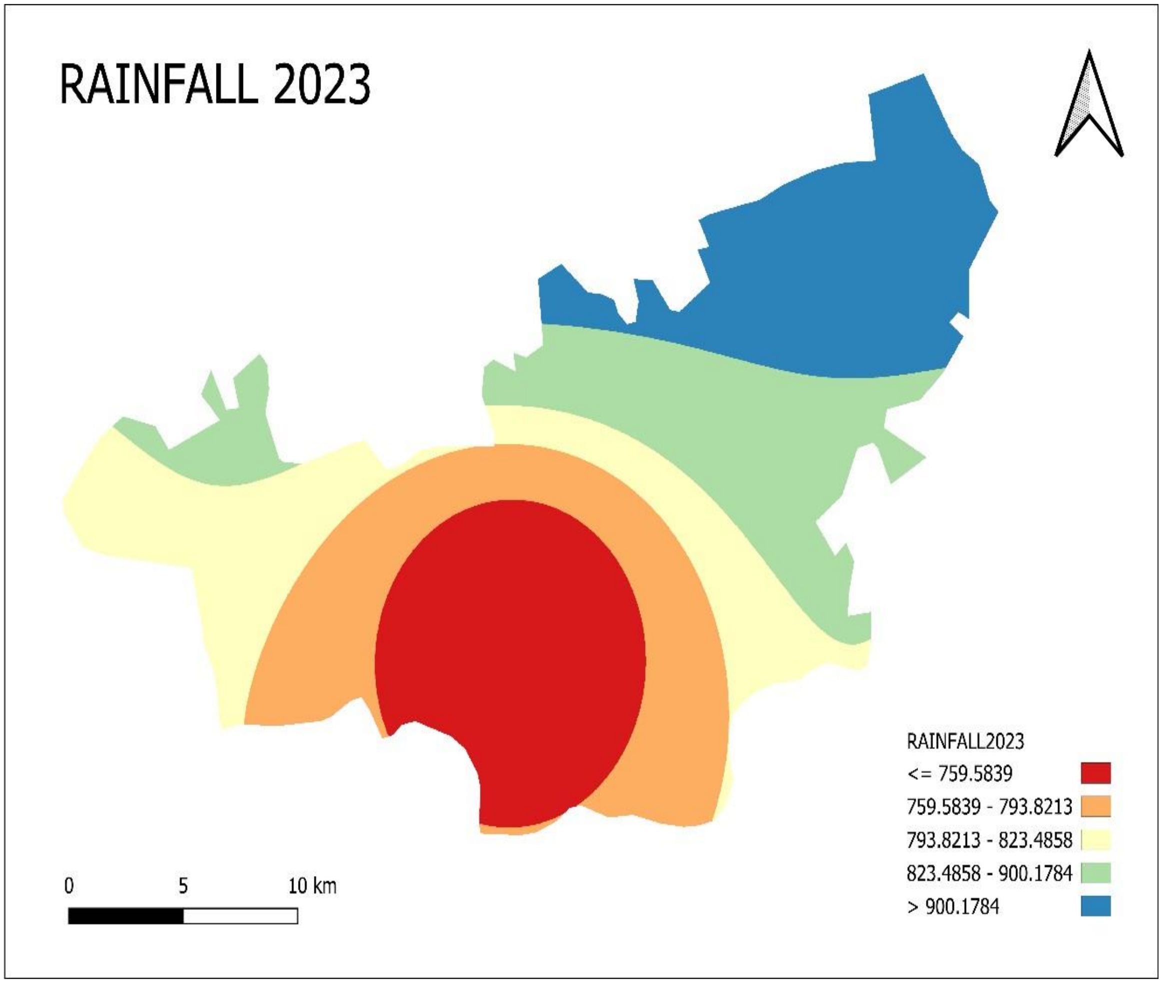

Figure. No. 15. RAINFALL: 2023

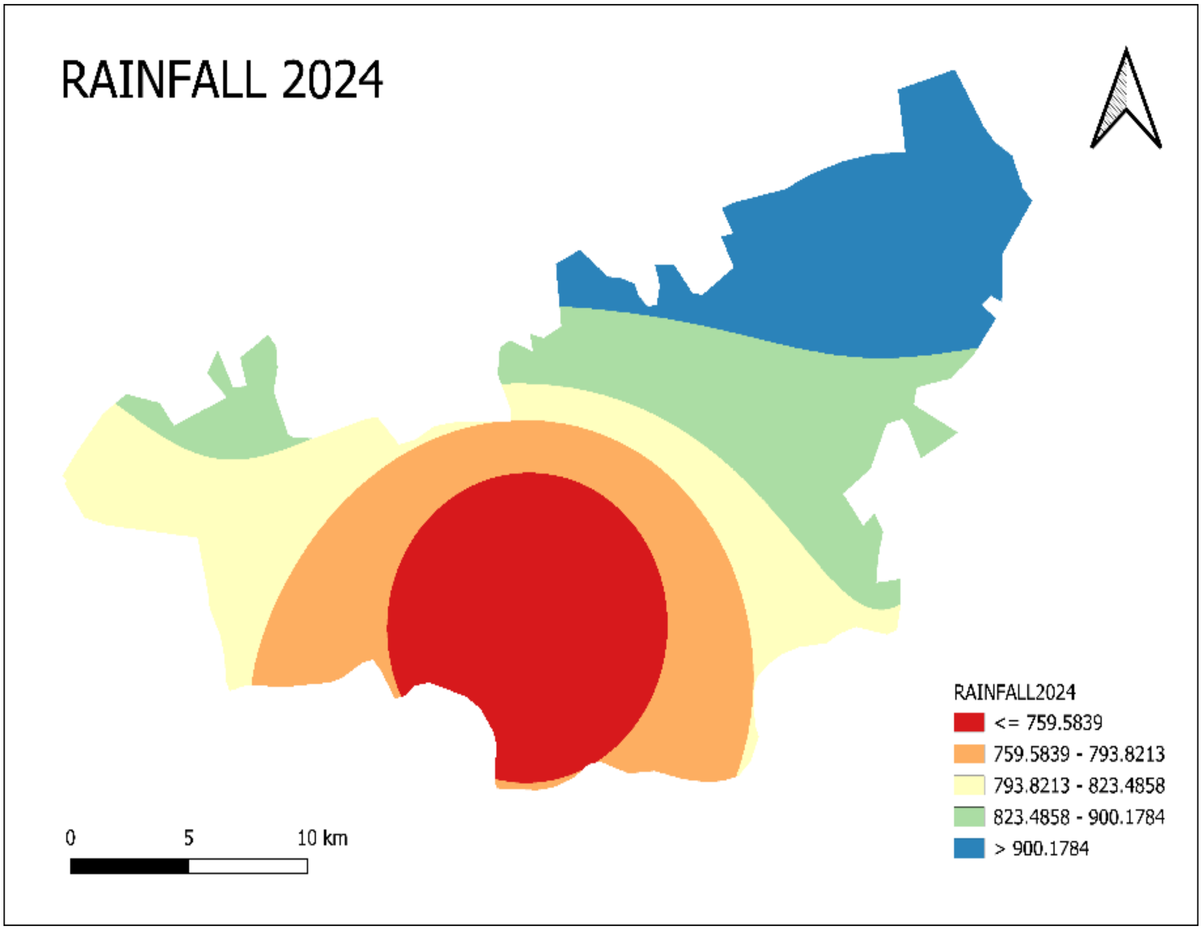

Figure. No. 16. RAINFALL: 2024

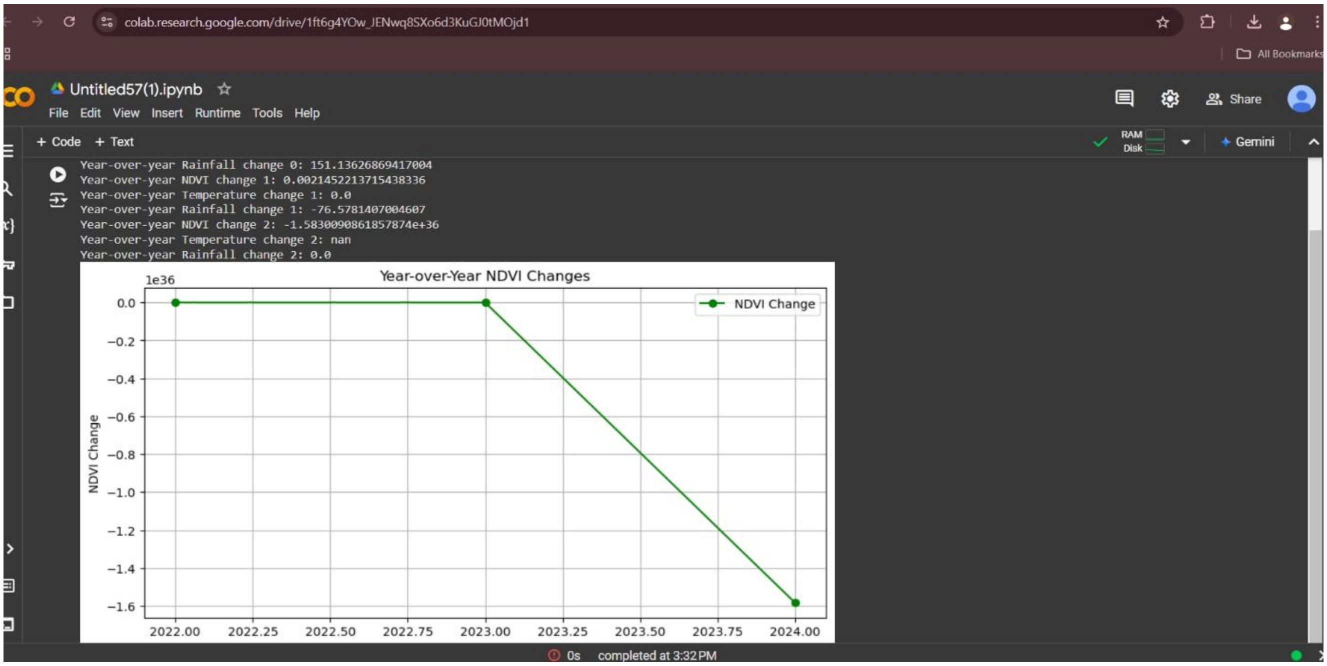

Figure. No. 17. YEAR-OVER-YEAR NDVI CHANGES

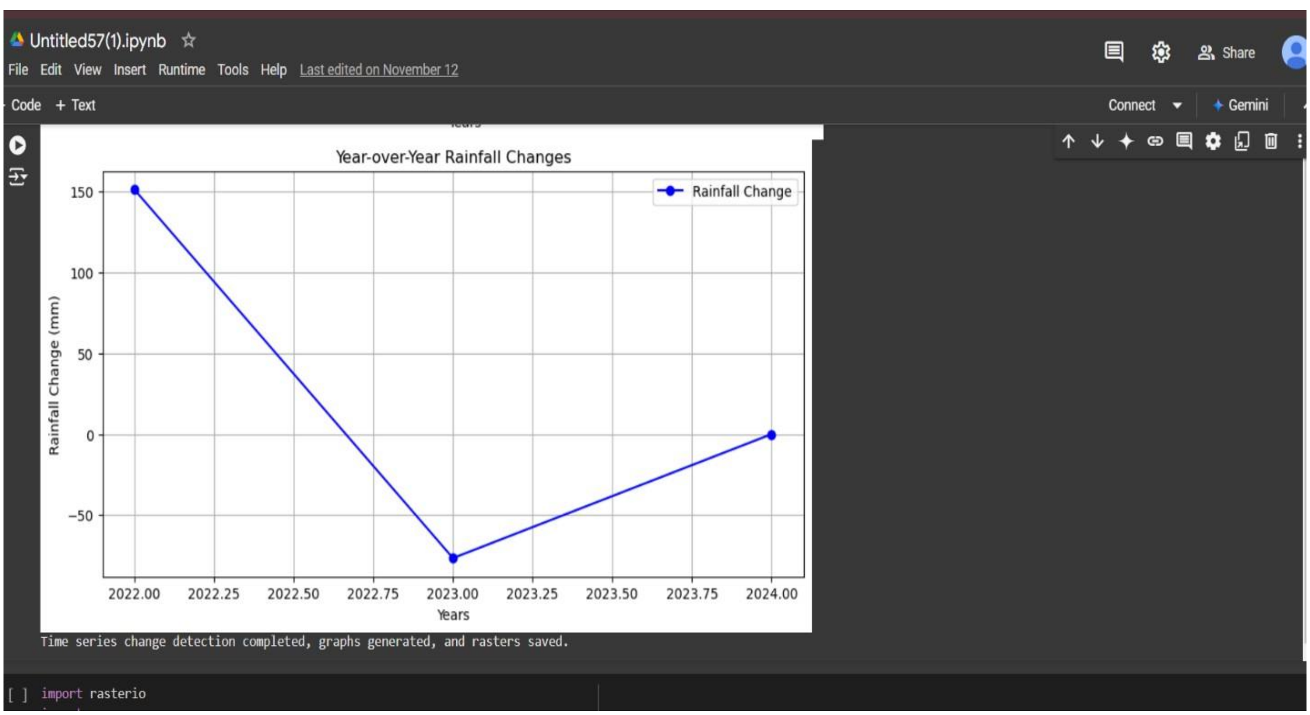

Figure. No. 18. YEAR-OVER-YEAR RAINFALL CHANGES

CHAPTER VI

CONCLUSIONS

Conclusion

The "Spatiotemporal Analysis of NDVI Changes with Rainfall" in Vadagam, Banaskantha, Gujarat shows that NDVI values which describe the health of vegetation have a strong control of rainfall variability. This shows that the semi-arid region's vegetation has a high dependency on seasonal rainfall. Therefore, agricultural and ecological planning should be customized considering rainfall variability. The presented findings can help in climate change mitigation and adaptation by supporting climate-resilient sustainable land management practices.

Future Work

Expansion of the study to encompass all climatic variables, such as temperature and soil moisture.

Incorporate machine learning models to predict other climate change scenarios with a view to forecasting NDVI changes.

Analysis to explore the impact of extreme weather, for instance, drought on trends in vegetation.

The same will be carried out in other parts of the region in order to establish comparison among different climatic zones.

USE OF NDVI

1. **Vegetation Health Monitoring**: It monitors plant health and photosynthetic activities for agriculture and forestry applications.
2. **Agricultural Applications**: It helps monitor crops, and precision farming is conducted so that water, fertilizer, or pesticide use is optimized.
3. **Environmental Change Detection**: Changes such as deforestation, desertification, or land degradation are detected.
4. **Drought and Disaster Monitoring**: Assesses drought stress and evaluates the recovery of vegetation after a disaster.
5. **Carbon Cycle and Climate Studies**: Biomass and carbon sequestration are estimated to understand vegetation's role in climate.

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CHAPTER VII

SUMMARY

"Spatiotemporal Analysis of NDVI Changes with Rainfall" at Vadagam, Banaskantha, Gujarat to assess how the response of vegetation varies at different time scales to rainfalls. Through analyzing NDVI from 2021 through 2025, the present study identifies trends in the health of vegetation and observes the relationship of variability in rainfall with changes in vegetation. Insights obtained could be used to enhance the prediction of local agricultural productivity, inform land management decisions, and assist in developing strategies in the semi-arid region to reduce the impacts of climate variability and change on vegetation.

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CHAPTER VIII

REFERENCES

1. https://www.mdpi.com/2072-4292/15/12/2967
2. https://www.mdpi.com/2072-4292/15/12/2965
3. 5. Cohen, J.; Agel, L.; Barlow, M.; Garfinkel, C.I.; White, I. Linking Arctic Variability and Change with Extreme Winter Weather in the United States. *Science* **2021**, *373*, 1116–1121. [**Google Scholar**] [**CrossRef**] [**PubMed**]
4. https://www.mdpi.com/2071-1050/15/5/4375/review_report
5. Schlegel, R.W.; Darmaraki, S.; Benthuysen, J.A.; Filbee-Dexter, K.; Oliver, E.C.J. Marine Cold-Spells. *Prog. Oceanogr.* **2021**, *198*, 102684. [**Google Scholar**] [**CrossRef**]
6. 3. https://iwaponline.com/wst/article/88/2/430/96113/NDVI-based-spatial-and-temporal-vegetation-trends
7. Doss-Gollin, J.; Farnham, D.J.; Lall, U.; Modi, V. How Unprecedented Was the February 2021 Texas Cold Snap? *Environ. Res. Lett.* **2021**, *16*, 064056. [**Google Scholar**] [**CrossRef**]
8. 4. https://www.mdpi.com/2072-4292/15/12/2967

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