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Change detection of NDVI in Sangareddy district using Google Earth Engine (GEE)

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Abstract
Global environmental change, along with the development of Earth observation equipment, have caused significant developments in Earth system science. In order to monitor, measure, analyse, evaluate, and simulate Earth observation data, new instruments are required. The cloud-based Google Earth Engine (GEE) technology has powerful computing capabilities. Thousands of open geospatial and remote sensing datasets can be found on Earth Engine. There are now additional chances for more precise Normalized Difference Vegetation Index (NDVI) classification thanks to cloud computing platforms, time series feature extraction methods, and machine learning classifiers. Using Sentinel-2 photos, the goal of this study was to track the NDVI development in the Sangareddy district over time. Data for the four-year period from 2018 to 2021 is extracted. Often obtained from a space platform, the Normalised Difference Vegetation Index (NDVI) is a straightforward graphical indication that may be used to interpret remote sensing information and determine whether or not the target being observed includes live, green vegetation. Water is represented by NDVI values that are negative (values close to -1). Values close to zero (-0.1 to 0.1) typically represent rocky, sandy, or snowy deserts. Finally, low, positive values (between 0.2 and 0.4) reflect shrub and grassland, whereas high values (values close to 1) represent temperate and tropical rainforests. According to the results of our study, between 2018 and 2021, the vegetation area significantly grew in 2019 and 2020 compared to 2018.Additionally, it somewhat decreased in 2021, further decreasing in 2022.

Keywords: Google earth engine, normalized difference vegetation index (NDVI), sentinel, Sangareddy

Introduction

Based on radiation reflected or emitted from objects at or near the surface of the earth and the atmosphere, remote sensing offers information about those items. The information is normally recorded as visual data at a distance from above. By using these data, we may analyse photos taken at various points in time to analyse changes and identify the composition and nature of the earth's surface and atmosphere on a local to global scale. In this way, remote sensing is helpful in supplying spatial data that would otherwise be difficult or impossible to gather, such as data on land surface features. Remote sensing has thus developed into a useful research and application tool in a variety of fields, including engineering, geology, geography, urban planning, forestry, and agriculture. For planetary- scale geospatial analysis, Google Earth Engine is a free cloud-based platform with supercomputing power for difficult calculations or large-scale processing issues. Two web- based platforms, GEE Explorer and Code Editor, are currently available to registered users as GEE. While users of the GEE Code Editor may perform analysis and customization using programming (JavaScript or Python) code, the GEE Explorer only allowed users to view a small portion of the satellite imagery. Users can apply mathematical and spatial operations to the picture independently or in combination, and they can adjust their use to the study objectives, thanks to the built-in capabilities of the Code Editor environment.

The most widely used index for evaluating vegetation is called the Normalized Difference Vegetation Index (NDVI), which was one of the first remote sensing analytical products to employ multi-spectral imagery to simplify difficult concepts. Because every multispectral sensor having a visible and a near-IR band can calculate an NDVI, it is popular and widely used. Multispectral sensors are becoming more affordable and lightweight, allowing them to be mounted on satellites, aircraft, and increasingly Unmanned Aerial Systems (UAS). The use of NDVI improves remote sensing applications in part because it corresponds with the status of a wide range of vegetation attributes, simplifying the complex.

In addition, the widespread adoption of remote sensing technologies has encouraged the production of low-cost image data that is beneficial for a wider range of NDVI applications. The way that land resources are perceived, utilized, and managed has altered as a result of remote sensing. The same holds true for the relationship between NDVI and vegetation status, patterns, and health.

Materials and Methods

Study area

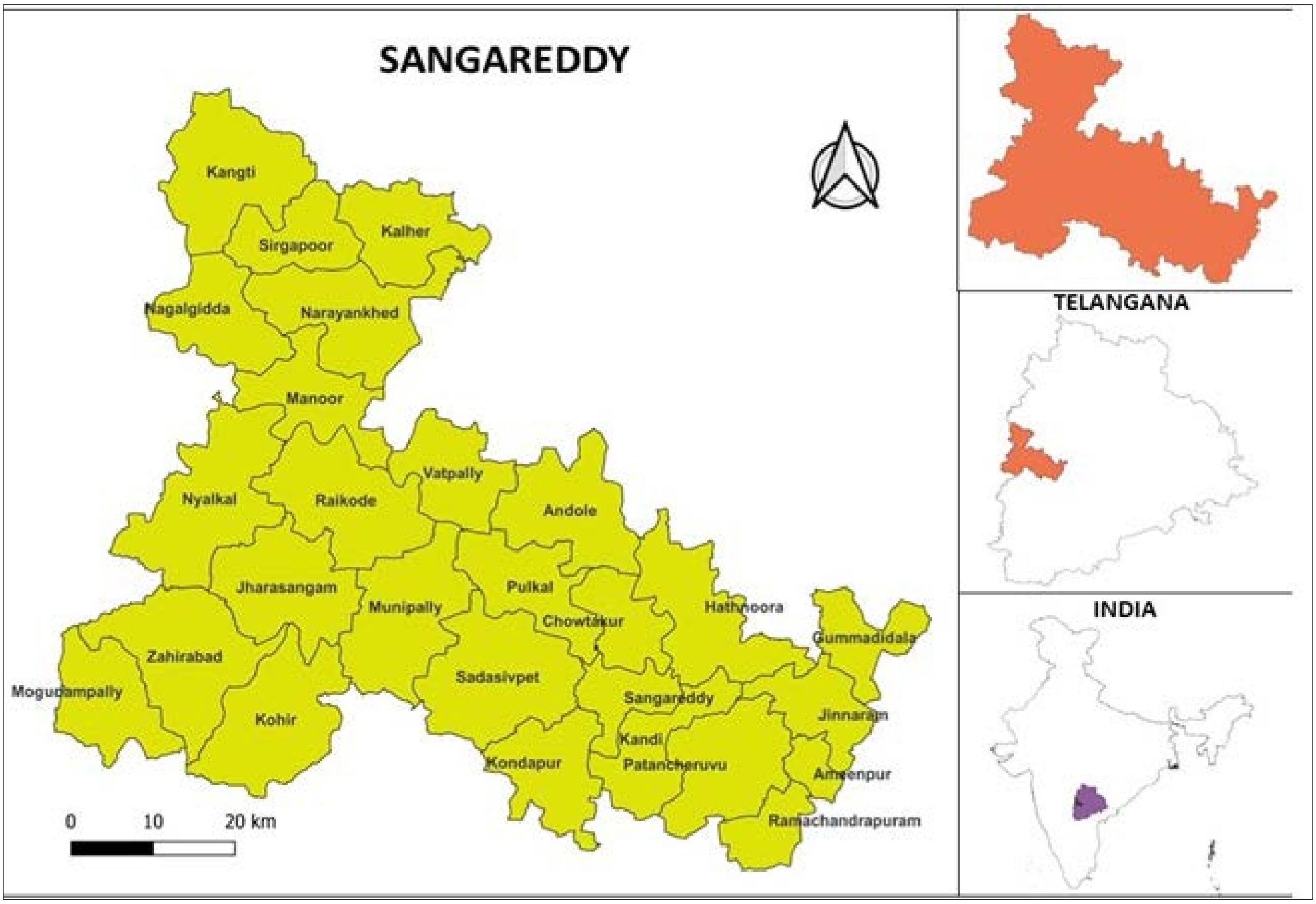


Fig 1: Location map of Sangareddy study area

The Study area was carried out in the Sangareddy district covering an area of 4996km2 with a population of 1,97,860 and located in the northern region of the Indian state of Telangana (fig.3.1) with 17◦31'50.4"N and 78◦1'6.96"E. The district is one of the most industrialized regions in Telangana state. This province is characterized by an arid climate being cold and semi-humid in the northern areas and cold with long winters in the higher regions. The boundary of the study area was chosen in a way that could well represent a complex landscape and involved densely built-up area, wet lands, forests, water bodies, croplands, shrubs, and barren lands.

Database

The Copernicus Sentinel-2 mission comprises a constellation of two polar-orbiting satellites placed in the same sun-synchronous orbit, phased at 180° to each other. It aims at monitoring variability in land surface conditions, and its wide swath width (290 km) and high revisit will support monitoring of Earth's surface changes

Normalized Difference Vegetation Index (NDVI)

Normalized Difference Vegetation Index (NDVI) is a reliable measure of the amount of green biomass, the index of leaf area, and the pattern of production. The idea behind this index is that healthy, green leaves' internal mesophyll structure strongly reflects NIR (near infrared) radiation, while chlorophyll and other pigments in the leaves absorb a significant amount of red VIS (visible red) radiation. When vegetation is unhealthy or under water stress, this turns around. The difference between reflectance in the electromagnetic spectrum's NIR and VIS band is used to calculate NDVI. The NDVI value ranges from -1.0 to +1.0. Plant leaves primarily absorb light in the red spectrum, using chlorophyll to synthesis glucose from carbon dioxide and water during photosynthesis, while their cell walls strongly reflect light in the NIR spectrum. The pixel is likely to be vegetated with healthy leaves if there is lighter reflected in the NIR than in VIS wavelengths because light from the visible spectrum (VIS) has already been absorbed by the plants.

This study aims to process images and return the Normalized Difference Vegetation Index (NDVI) using sentinel 2 satellite images. NDVI is an index commonly used in satellite image analysis to get basic information on vegetation distribution. Sentinel 2 images, just like other images, consist of pixels. Each pixel contains values. While the colourful image has 3 bands, usually red, green, and blue, sentinel 2 has 13 bands. Two of these bands used to generate NDVI are band 8 (NIR) and band 4 (Red). When you have negative values, it's highly likely that it's water. On the other hand, if you have an NDVI value close to +1, there's a high possibility that its dense green leaves. But when NDVI is close to zero, there are likely no green leaves and it could even be an urbanized area. Soils typically produce low NDVI values (0.1-0.2). Moderate NDVI values may be produced by sparse vegetation, such as shrubs and grasslands (0.2-0.5).

NDVI was calculated by using the following formula:

$$NDVI = \frac{1111111}{11111}$$

Here, NIR and RED stands for the spectral reflectance attained in the near infrared regions and red (visible) regions respectively.

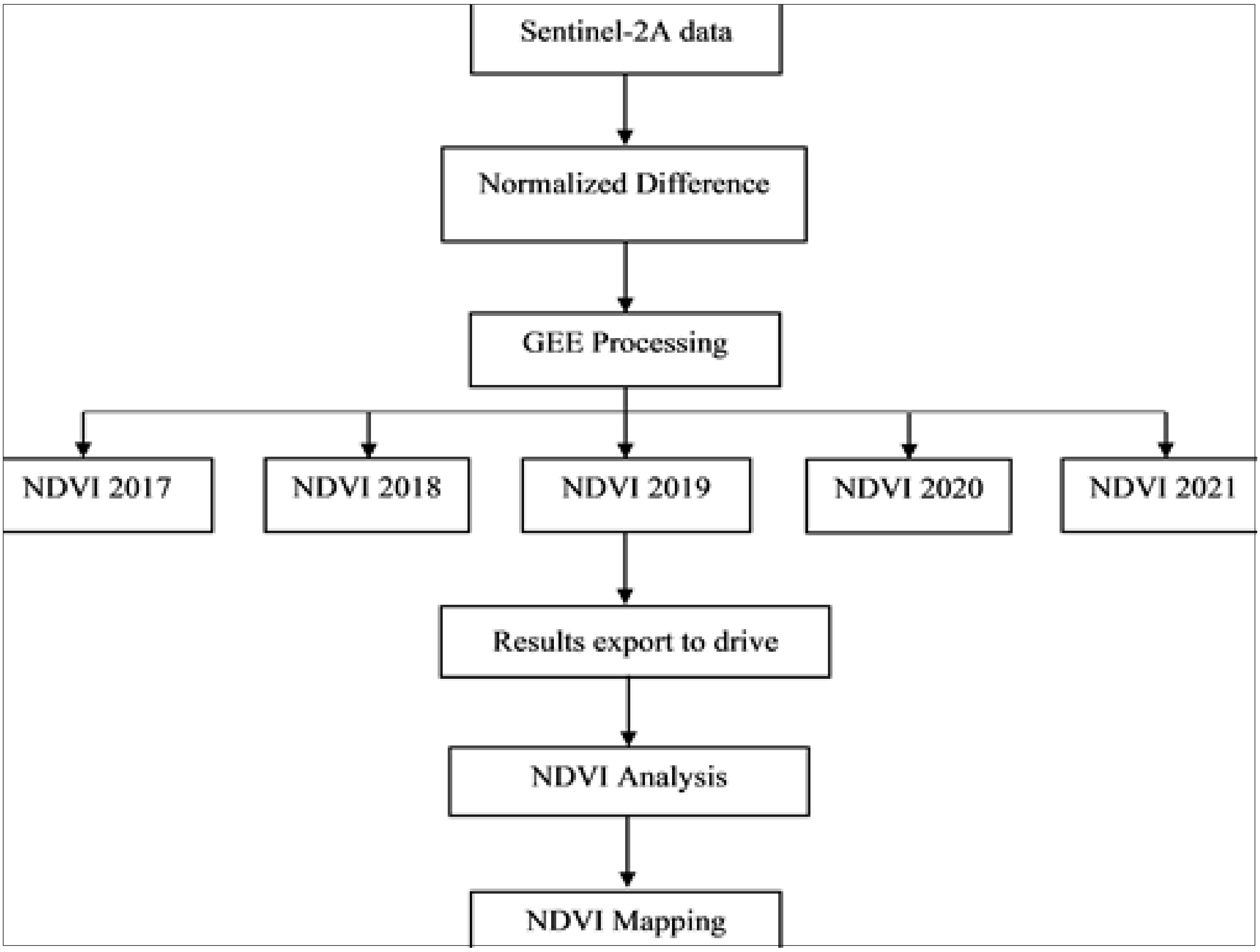


Fig 2: Flowchart for NDVI extraction using GEE

Google Earth Engine

Google Earth Engine combines planetary-scale analysis tools with a multi-petabyte collection of geospatial datasets and satellite imagery. Earth Engine is used by scientists, researchers, and developers to identify changes on the surface of the Earth, map trends, and measure differences. Earth Engine is still free to use for educational and research purposes but is now available for commercial use. The daily updated and expanded public data archive contains scientific datasets and historical imagery spanning more than thirty years. It has instantaneous analysis access to more than 40 petabytes of geospatial data. The Earth Engine API is available in Python and JavaScript, making it easy to harness the power of Google's cloud for your own geospatial analysis. For the first time ever, Google Earth Engine has made it possible to quickly and accurately process enormous amounts of satellite imagery, pinpointing the precise locations and timing of tree cover change. Without it, Global Forest Watch would not exist. The Earth Engine (EE) Code Editor is a web-based IDE for the Earth Engine JavaScript API, and it can be found at code.earthengine.google.com. Complex geospatial workflows can be created quickly and easily with the help of Code Editor features.

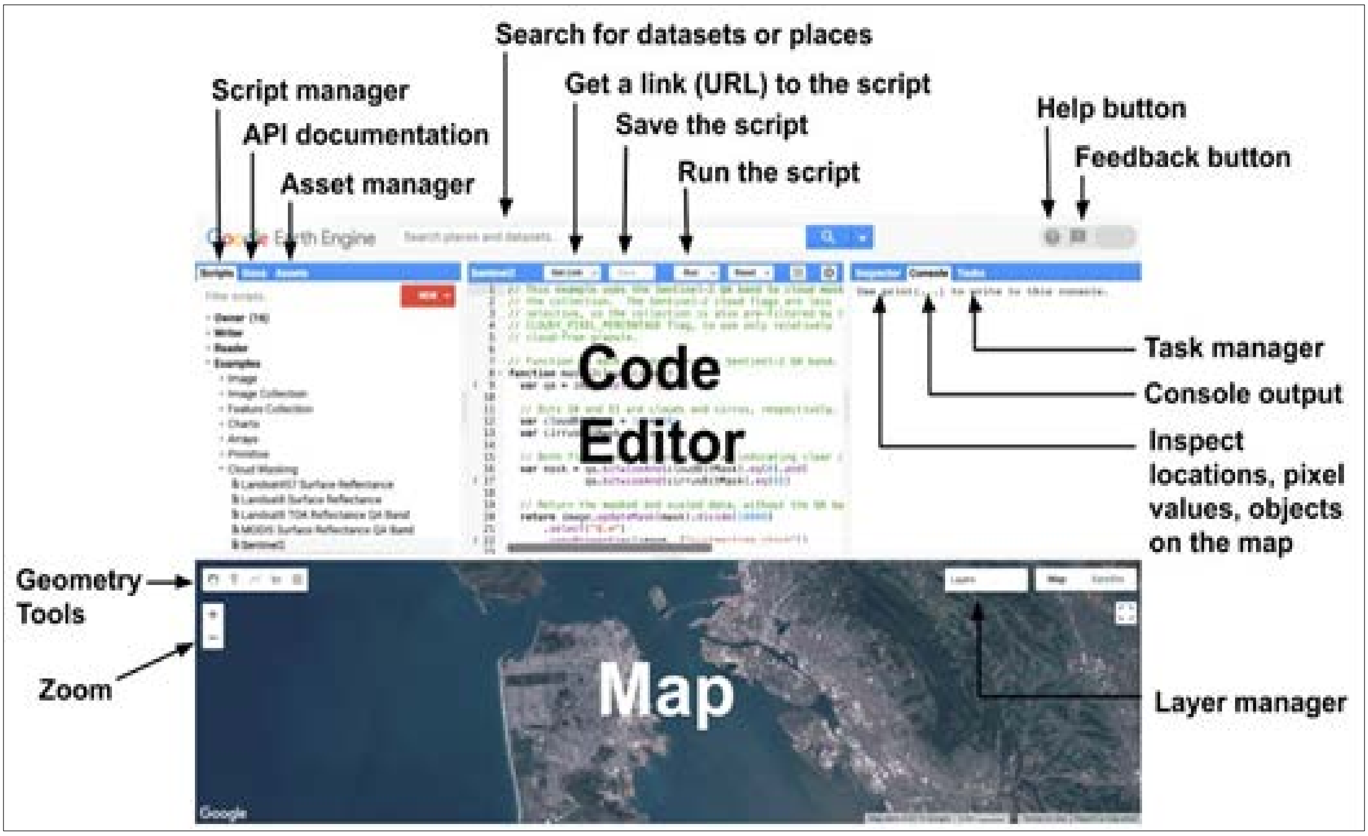


Fig 3: Components of the Earth Engine Code Editor

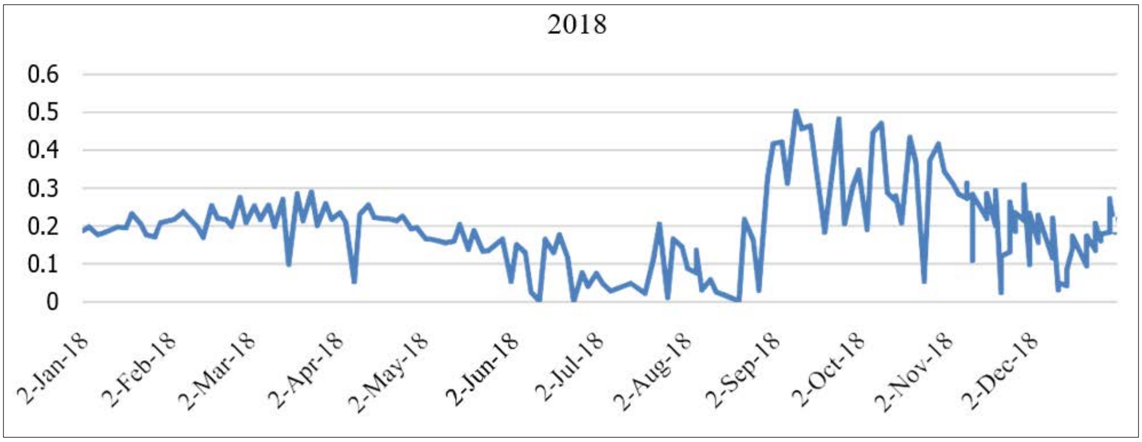
Results and Discussion

Normalized Difference Vegetation Index (NDVI) Analysis

In this study variation of vegetation in the study area has been assessed from 2018-2021, And maps of months February, May, November are extracted.

Depending on their characteristics, various surfaces will reflect, transmit, and absorb a different quantity of radiation. The index makes use of the red and NIR bands' contrast, as well as the red band's absorption of chlorophyll pigment and the NIR band's high reflection of plant components. In other words, vegetation that is healthy or has a high level of greenness typically has a high NDVI mean. Green dense vegetation reflects very small amount of red light, while bare land and water reflects a bigger amount. Bare soil NDVI values usually assumed close to zero and generally chosen from the lowest observed NDVI values, while water will give negative values. The NDVI values actually indicate the vegetation health where it is highly related with water variability for the region.

The graphs below show how the mean NDVI values in the Sangareddy district have varied over time. According to the study, greater NDVI values are observed from August through December during the karif seasons. It demonstrates that the majority of farmers plant crops during the karif season. Since it has been raining and there is water available, the bulk of farmers are farming now. The NDVI measurement peaks at 0.6. The data gathered indicates that 2021 is the year with the second-highest overall amount of vegetation, followed by 2020.



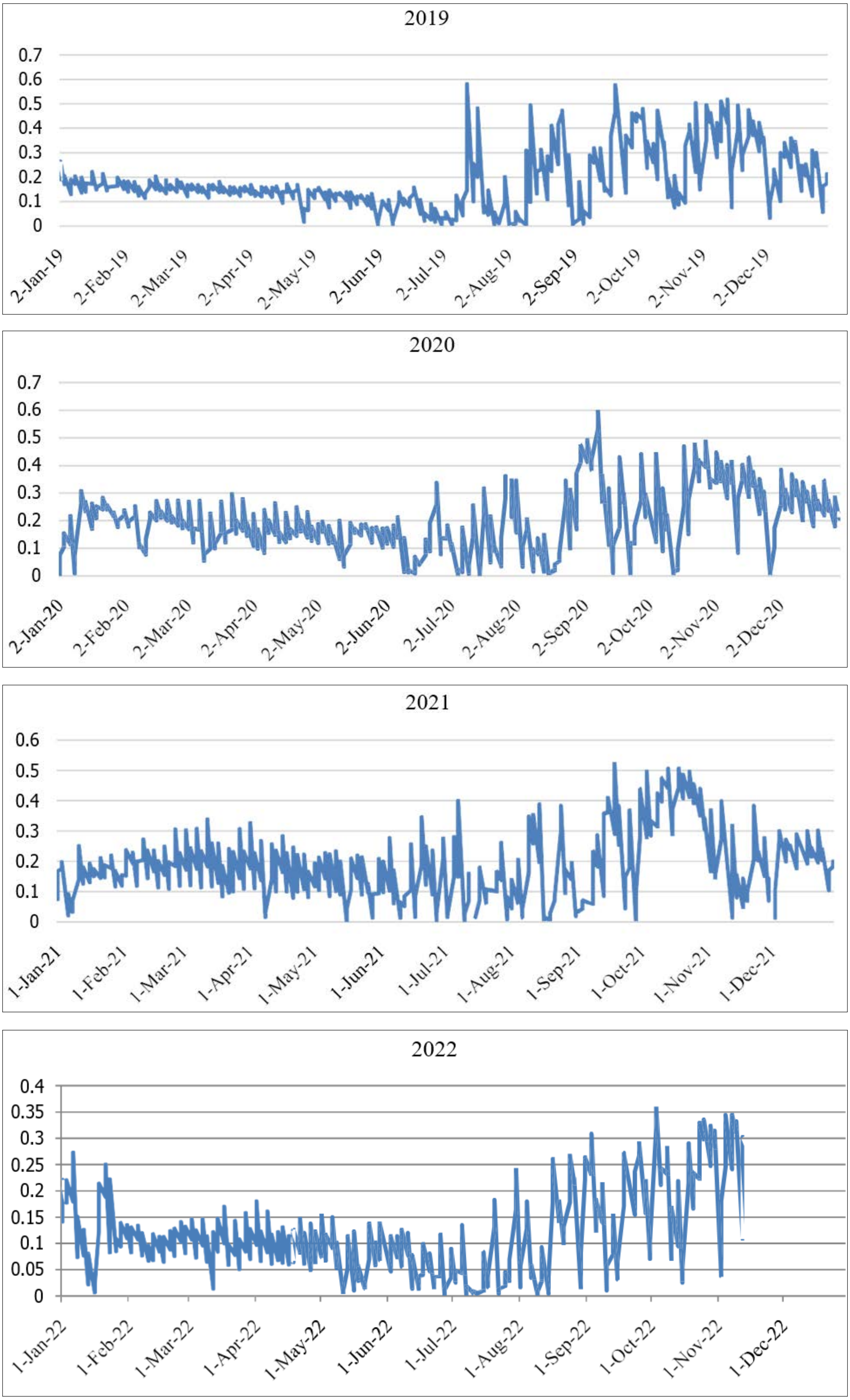


Fig 4: These are the NDVI maps extracted for the particular years

Fig 5: NDVI maps

Summary and Conclusion

These are the outcomes we have seen in the change deduction of NDVI study. When compared to prior years, the Normalized Difference Vegetation Index readings for 2018 are modest. The Normalized Difference Vegetation Index (NDVI) value was too high in August 2020, at 0.6, with July 2019 recording the second-highest NDVI value at 0.58.November 2020 sees the lowest NDVI levels. The second-lowest NDVI values, at -0.3, were recorded in October 2021.

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