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Vegetation Cover Change Detection Using Remote Sensing and GIS Based on NDVI Methods: A Case Study in Seethampeta Mandal, Srikakulam District, Andhra Pradesh, India

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A B S T R A C T

Vegetation loss has been an ongoing practice since the dawn of human space exploration. The loss of natural forest as a result of human activity is becoming a major concern for the environment. Damming a river by restricting its natural flow results in a loss of greenery. For both upper and lower catchment, it has an impact. Vegetation Index (VI) and Remote Sensing (RS) and Geographical Information System (GIS) techniques may be used to investigate this disruption. In terms of determining vegetation cover, the Normalized Difference Vegetation Index (NDVI) is a useful tool. Visual and near infrared electromagnetic spectrum is used to generate a numerical indication. Plant cover changes may be tracked using the index of NDVI, which is linked to the amount of photosynthesis-inducing radiation (PAR). NDVI differencing was used to detect changes in the environment. In various NDVI threshold values, such as 0, 1, 2, 5, 10, 15, 20, 25, 30, 35, and 40, the NDVI technique is used based on its characteristic like vegetation. For policy makers, the simulation results show that the NDVI is very accurate in estimating surface properties of the viewable region. Vegetation analysis may be used to predict natural disasters, provide humanitarian aid, evaluate damage, and develop new defence methods. Waterbodies and Barren land cover categories have decreased by roughly 2.37% and 17.13%, respectively, from 2017 to 2020; Shrubs/sparse vegetation has decreased by 7.86%, built-up by 3.71%, and vegetation areas have increased by 13.65%. There is also an examination of the regions of curvature, plan curvature, profile curvature and the Wetness Index (WI). The primary goal of this article is to use the NDVI approach to spot changes in plant patterns and the disappearance of green cover.

Key words: NDVI, Landuse/Landcover, GIS, Remote Sensing, Change detection

Earth's ecosystem may be studied more effectively with Multi Spectral Remote Sensing images [1-5]. Information on items, areas, or phenomena, such as vegetation, land cover classification, urban area(s), agricultural land, and water resources, may be collected scientifically and artistically without ever coming into direct touch with such objects. Land cover classification, soil moisture measurement, forest type classification, measurement of plant liquid water content, and snow mapping are only few of the uses for Remote Sensing data [6-8]. The spectral and spatial properties of the objects may be seen in the multispectral remote sensing images. Using a multispectral image of Vellore district, this article aims to determine the proportion of different types of land cover, such as vegetation and hills, as well as water bodies, open space, scrub land, agricultural land, and thick versus thin forest, in order to better prepare for natural disasters like floods. Satellite imagery from the United States' National Aeronautics and Space Administration, or NASA, is known as LANDSAT [9-15]. The National Remote Sensing Centre (NRSC) provided the multispectral remote sensing data used to create this NDVI of Seethampeta mandal, Srikakulam District, Andhra Pradesh. Near-infrared band, red band, and green band are the three bands that make up the data in this signal. The properties of each band may be accessed with the help of these three bands, which each contain unique information. Remote sensing may be classified into three types based on wavelength: visible and reflective infrared, thermal infrared, and microwave. A variety of methods and mathematical indices may be used to decipher the image utilizing digital image processing techniques from satellite data. Reflectance qualities are the basis for aspects, and indices have been created to highlight the most important aspects of the image [16-20]. On a remote sensing landscape, there are several indices that may be used to identify vegetation-bearing areas. It's not uncommon to see the NDVI in use. When it comes to global environmental and climatic change research,

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it's an important plant indicator. The red-to-near-infrared reflectance ratio difference is used to calculate the NDVI. These differences between the visible red and near-infrared bands of a quick image may be used to identify areas with a lot of vegetation and other distinctive features. At a national and global level there are several studies documenting how NDVI may be used for vegetation monitoring as well as crop cover measurements and drought monitoring. Earth surface vegetation and crop growth condition may be assessed using the Vegetation Index (VI), a quick and easy-to-use statistic for remote sensing [21-23].

MATERIALS AND METHODS

The study was conducted in the Seethampeta Mandal, Srikakulam district, Andhra Pradesh, India, which covers an area of 446.26 km^2. To put it simply, it is located between north latitudes 18° 32′00″ to 18° 32′30″ N and eastern longitudes of 83° 32′00″ E, as seen in (Fig 1). The research area's climate is semi-arid. The average yearly temperature fluctuates between 200 and 250 degrees Celsius in the winter and 350 and 400 degrees Celsius in the summer. The average yearly rainfall in this area is 950 mm. The chranokites, granulites, migmatites, and quartzites are all studied geologically in this region (Fig 2). Pediment and Pedi plain dominate the study area's geomorphology, which is mostly composed of moderately dissected hills and valleys with a structural basis (Fig 3).

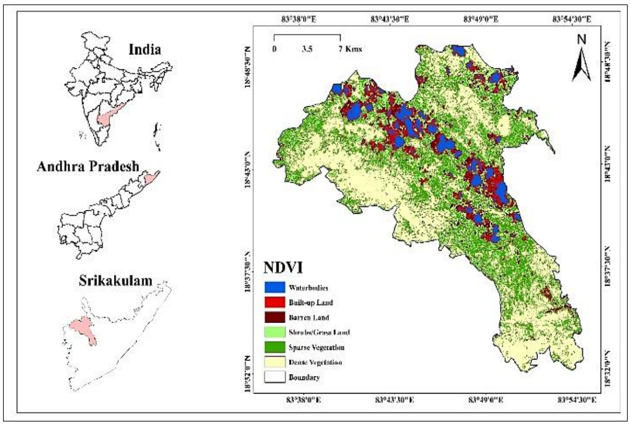

Fig 1 Location map of Seethampeta Mandal, Srikakulam District, Andhra Pradesh, India

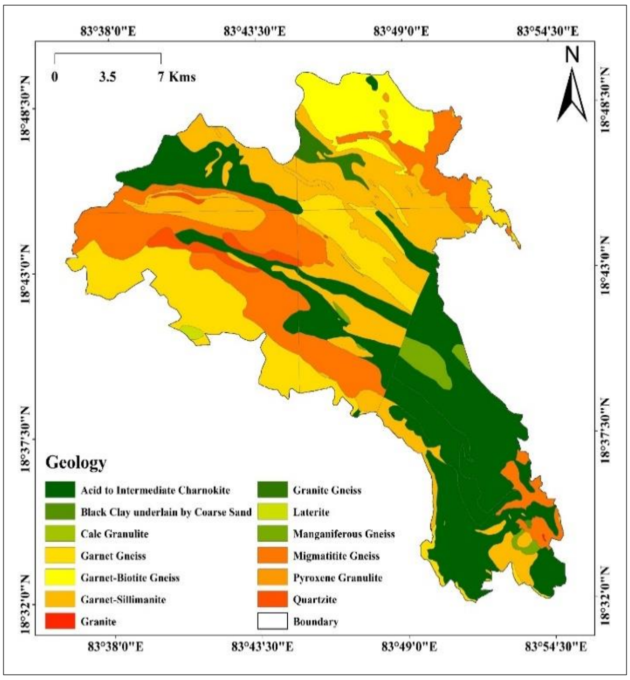

Fig 2 Geology map of the study area

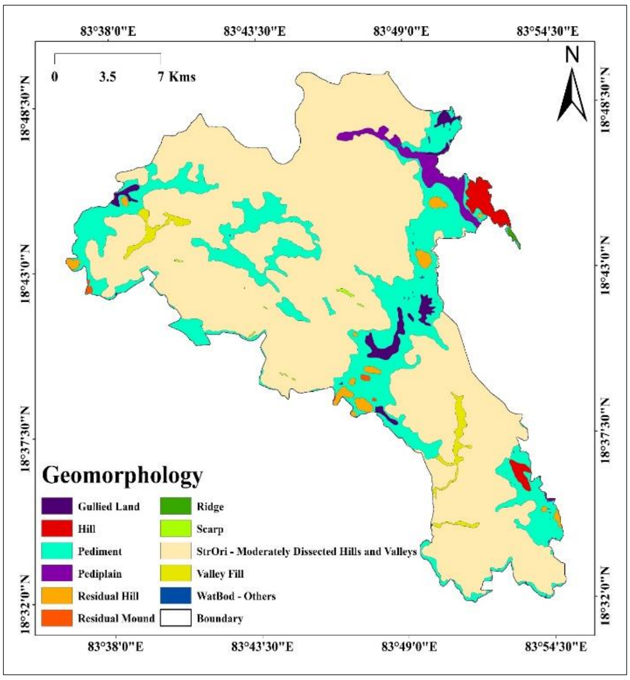

Fig 3 Geomorphology map of the study area

Soil erosion is an important biophysical indicator that may be gauged using vegetation indices generated from satellite pictures in this section [24-26]. The Vegetation indices approach is utilized in this section to extract different characteristics from the three-band satellite image of Srikakulam district. Based on the distinctive reflectance patterns of green vegetation, we can distinguish the spread of plant and soil. Based on the NDVI value, a remote sensing platform may determine whether or not the target or item being seen contains any living green vegetation. The NDVI may be calculated using the provided equation as follows:

$$\text{NDVI} = \frac{NIR-RED}{NIR+RED}$$

where RED denotes reflectance in the visible red range and NIR denotes reflectance in the near infrared range. It is within the (750-1300 nm) range of the NIR band, (600-700 nm) for the red band, and (550 nm). It is the difference between the NIR and red bands that determines how much chlorophyll is present in the observed plant. As a result, it normalises the (NIR - red) differential in order to compensate for shadows cast by clouds or hills [27-31].

Table 1 Thematic bands of LANDSAT 8 satellite image

Name of the band	Wavelength	Characteristics and usage
Visible blue	0.45-0.52	Maximum water penetration
Visible green	0.52-0.60	Good for measuring plant vigour
Visible red	0.63-0.69	Vegetation discrimination
Near infrared	0.76-0.90	Biomass and shoreline mapping
Middle infrared	1.55-1.76	Moisture content of soil
Thermal infrared	10.4-12.5	Soil moisture and thermal mapping
Middle infrared	2.08-2.35	Mineral mapping

For many features (Table 1), which lists the wavelength range and characteristic values. That is to say, on a pixel-by-pixel basis, subtract the red band value from the NIR band value and divide by their total. Low Normalized Difference Vegetation Index (NDVI) values (0.1 and lower) indicate regions of rock, sand, or snow that lack vegetation. Moderate levels imply shrub and grassland (0.2 to 0.3), whereas high values indicate temperate and tropical rainforests (0.6 to 0.8). Normalized Difference Vegetation Index (NDVI) values closest to 0 are used to represent bare soil, whereas NDVI values opposite to 0 are used to depict water bodies [32-34].

In other words, the chlorophyll concentration is directly proportional to the greenness of the plant. Red light absorption by plant chlorophyll and infrared radiation reflection by water-filled leaf cells affect Normalized Difference Vegetation Index (NDVI) values. The Satellite camera gathers all visible ranges in the form of NDVI bands, from which various properties may be obtained after utilizing the NDVI technique. Using wavelengths of about 1 m, each band is depicted. These visible ranges (visible blue, thermal infrared and mid-IR) may all be used to extract various properties, but just three visible bands (visible red and visible green) are used in this work for feature extraction.

To determine the vegetation index from a Multi Spectral Remote Sensing picture included in a satellite image, the Normalized Difference Vegetation Index (NDVI) process necessitates the separation of each band. A series of Normalized Difference Vegetation Index (NDVI) threshold values, such as 0.1, 0, 15, 0, 25, 0, 30, 35, 0, 4, 5, 6, and 8, are used to differentiate between the various bands once the discrete bands have been separated. Satellite images of Seethampeta Mandal, Srikakulam District, Andhra Pradesh, India are analyzed using a variety of Normalized Difference Vegetation Index (NDVI) threshold settings [35-36].

RESULTS AND DISCUSSION

The relationship between spectral variability and variations in vegetation growth rate has been studied repeatedly using the Normalized Difference Vegetation Index (NDVI). The production of green vegetation, as well as changes in vegetation, may also be assessed. (Table 2) shows the many features of the study area that have been determined from the satellite image. The results are contrasted to the Google Earth image, which clearly shows the improvement. (Fig 4) shows that the multispectral pictures are producing the best results for all features at the Normalized Difference Vegetation Index (NDVI) value of 0.2, with modifications in the year 2017 providing outstanding results for all features. The Normalized Difference Vegetation Index (NDVI)value has been modified from (-0.1 to 0.7) in this research in order to get the best features from the Srikakulam district and the discriminating between classes is shown in (Fig 5) also shows the Normalized Difference Vegetation Index (NDVI) 2018 fluctuation data [37-40]. NIR and red band Normalized Difference Vegetation Index (NDVI) values are lower on the less vegetated soils, which is likely due to the significant reflection off the soil, which results in low NIR and high red band values (Fig 6-7).

Table 2 Change detection analysis from 2017 to 2020 through Normalized Difference Vegetation Index (NDVI) analysis

NDVI	2017		2018		2019		2020	
	Percent	Km^2	Percent	Km^2	Percent	Km^2	Percent	Km^2
Waterbodies	11.92	53.21	3.62	16.15	2.41	10.74	9.55	42.60
Built-up land	3.85	17.19	3.74	16.70	7.11	31.74	7.56	33.74
Barren land	25.04	111.73	9.42	42.03	8.48	37.85	7.91	35.29
Shrubs/Grass land	20.27	90.46	14.26	63.65	20.54	91.68	12.41	55.38
Sparse vegetation	17.58	78.44	31.70	141.46	29.15	130.08	27.58	123.08
Desne vegetation	21.34	95.23	37.26	166.27	32.31	144.17	34.99	156.16

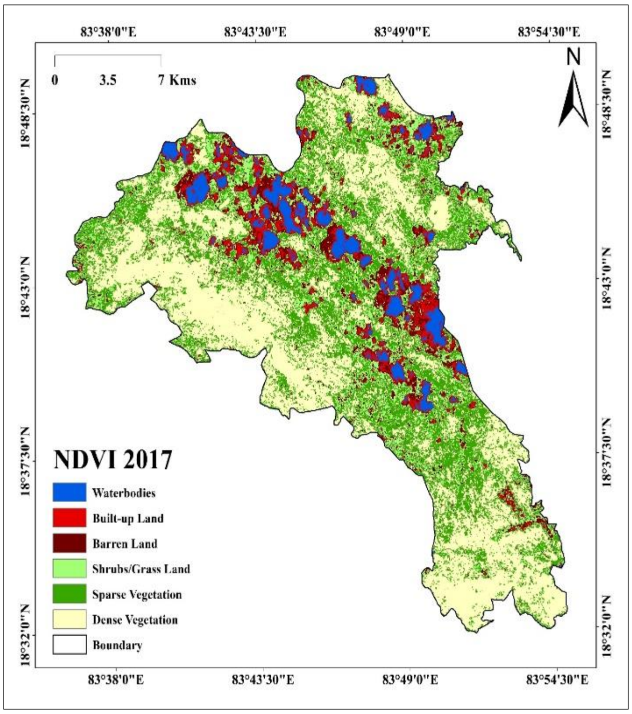

Fig 4 NDVI map of the study area in the year 2017

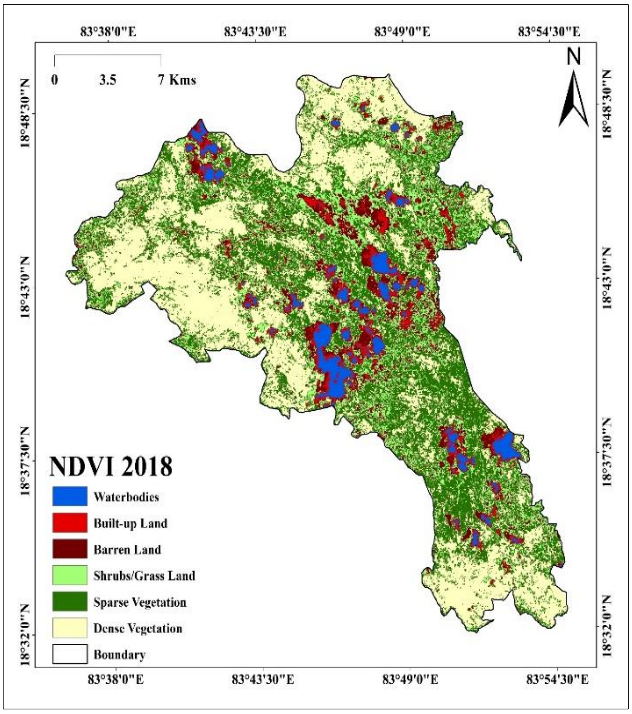

Fig 5 NDVI map of the study area in the year 2018

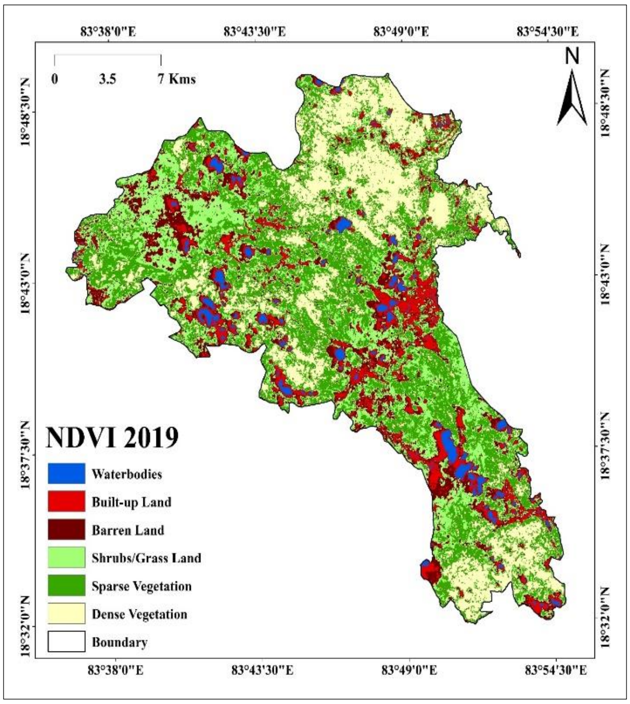

Fig 6 NDVI map of the study area in the year 2019

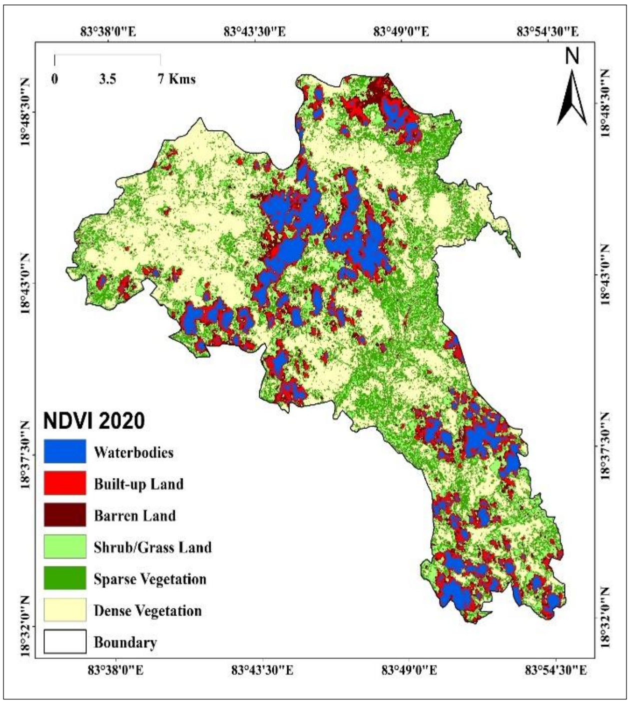

Fig 7 NDVI map of the study area in the year 2020

The NDVI starts to decline as the green foliage fades. Because of the abundance of water in the soil, Change Detection study for Vegetation shows that the vegetation remains green (high NDVI values). According to this, vegetation coverage at different cutoff points is almost identical. Vegetation analysis may be used to predict natural disasters, provide humanitarian aid, evaluate damage, and develop new defence methods. Waterbodies and Barren land cover categories have decreased by roughly 2.37% and 17.13%, respectively, from 2017 to 2020; Shrubs/sparse vegetation has decreased by 7.86%, built-up by 3.71%, and vegetation areas have increased by 13.65%. There is also an examination of the regions of curvature, plan curvature, profile curvature and the Wetness Index (WI) [41-46]. The primary goal of this article is to use the NDVI approach to spot changes in plant patterns and the disappearance of green cover. When plant density changes, the NDVI technique provides better results from a multispectral remote sensing picture than when the vegetation is spread.

Since 2017, forest or shrub land and open area cover categories have decreased by roughly 6% and 23%, respectively, while agricultural land has grown by 19%; built-up areas have grown by 4%; and water areas have increased by 7%. Land cover change detection analysis is shown in (Fig 8, Table 2).

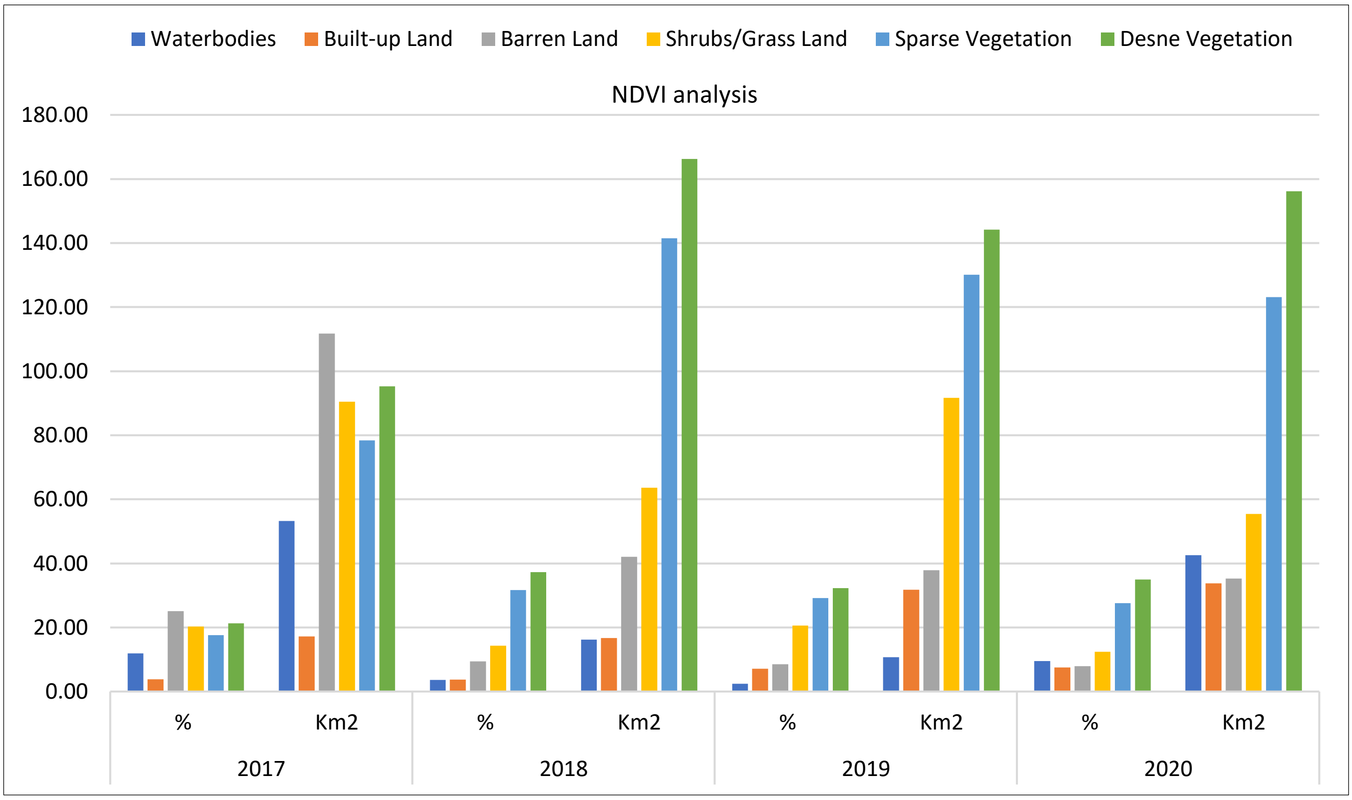

Fig 8 Change detection analysis from 2017 to 2020 through NDVI analysis

CONCLUSION

Change detection analysis is an efficient way to summarize the changes discovered in each land use category. Agricultural area, mountainous terrain with flora, and dry farming all changed dramatically over the course of a decade. Ground truth traverse and supervised Landsat image classification have both improved the overall accuracy of image interpretation classes. The classification of land use might benefit greatly from the use of high-resolution satellite data. We used the normalized difference vegetation index with varied thresholds for feature extraction. According to this, vegetation coverage at different cut off points is almost identical. Vegetation analysis may be used to predict natural disasters, provide humanitarian aid, evaluate damage, and develop new defence methods. Waterbodies and Barren land cover categories have decreased by roughly 2.37% and 17.13%, respectively, from 2017 to 2020; Shrubs/sparse vegetation has decreased by 7.86%, built-up by 3.71%, and vegetation areas have increased by 13.65%. There is also an examination of the regions of curvature, plan curvature, profile curvature and the Wetness Index (WI). Multispectral remote sensing imagery provides better findings for NDVI analysis of variable plant densities and for scattered vegetation.

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