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Land Cover Change Detection Using Remote Sensing and Gis – A Case Study of Mandya District

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ABSTRACT: Image processing tool like NDVI is the beneficial process used in land cover classification, vegetation identification, finding water bodies, identifying forest, deserts, barren land, scrub area, hills, and drainage of rainwater, forestation/deforestation, agricultural fields and marine activities. Many times, more than one band combination is done to set desired output. This study uses image processing with NDVI to detect variation in vegetation cover in the selected land. Various land resources are interpreted with NDVI which obtained with the help of geospatial tools. Normalized Differential Vegetation Index and Digitally Elevated Model imageries are obtained from Landsat TM satellite resource. NDVI method is applied according to its characteristic like vegetation at different NDVI threshold values such as 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4 and 0.5. The
NDVI is highly useful in detecting the surface features of the visible area which are extremely beneficial for policy makers in decision making. The Vegetation analysis can be helpful in predicting the unfortunate natural disasters to provide humanitarian aid, damage assessment and furthermore to device new protection strategies.
KEYWORDS:NDVI, Remote Sensing, Landsat images, Change Detection, vegetation Index

I. INTRODUCTION

[1] The Multi Spectral Remote Sensing images are very efficient for obtaining a better understanding ofthe earth environment.

[2] It is the Science and Art of acquiring informationand extracting the features in form of Spectral, Spatial and Temporal about some objects, area or phenomenon, such as vegetation, land cover classification, urban area, agriculture land and water resources without coming into physical contact of these objects..

[3] The Remote Sensing data has many application areas including: land cover classification, soil moisture measurement, forest type classification, measurement of liquid water content of vegetation, snow mapping, sea ice type classification, oceanography.

[4] The multispectral remote sensing images carry essential integrating spectral and spatial features of the objects.

[5] In this article, the multispectral image of Mandya district is used to calculate the percentage of versatile features such as vegetation, water bodies, built up area, barren land, and to subsequently make these extracted features available to the public for further analysis in order to avoid any sort of natural disasters like flood.

[6] Digital image processing of satellite data provides tools for analysing the image through different algorithms and mathematical indices. Features are based on reflectance characteristics, and indices have been devised to highlight the features of interest on the image.

[7] There are several indices for highlighting vegetation bearing areas on a remote sensing scene. NDVI is a common and widely used index. . It is an important vegetation index, widely applied in research on global environmental and climaticchange.

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OBJECTIVES OF THE STUDY

Following are the main objectives of this study:

[1] To check functionalities of remote sensing and GIS capabilities in Land cover analysis with the help of NDVI at different threshold values.

[2] To classify the Landsat image into different classes such as water body, built up area, barren land, shrub and grass land, sparse vegetation, dense vegetation by using NDVI technique.

[3] To compare different periods of land cover usingLandsat image by NDVI technique.

[4] To prepare change in detection map(2015-2020) by using Arc GIS.

STUDY AREA SOFTWARE USED: The following GIS softwarepackages are used for data Analysis

• ArcGIS 10.3.1 used for NDVI classification.

• ArcGIS 10.3.1 used for preparing change indetection map.

METHODOLOGY

NDVI technique is used for extracting the various features presented in the 11-band Satelliteimage of studyarea. NDVI is calculated as

$$\text{NDVI}=\frac{NIR-RED}{NIR+RED} \longrightarrow (1)$$

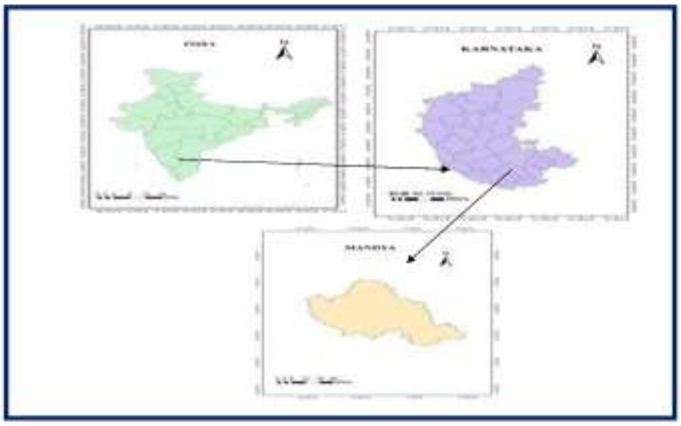

Fig 1. Location of study area

The investigations were performed as a case study on Mandya district, which is located in south India. Mandya district is located between north latitude 12°13' to 13°04' N and east longitude 76°19' to 77°20' E. It is bounded by Mysore district to the west and southwest, Tumkur district to the northeast, Chamrajnagar district to the south, Hassan district to the northwest, and Ramanagar district to the east.Mandya district consists of Seven taluks grouped under two sub divisions. The Mandya sub division comprises Mandya , Maddur and Malavalli taluks , while the Pandavapura subdivision comprises Pandavapura , Srirangapatna, Nagamangala and Krishnarajpet Taluks. Mandya District has five rivers such as Kaveri River and fourtributaries main Hemavathi , Shimsha , Lokapavani, Veeravaishnavi. It has an area of 4,961 square kilometres (1,915 sq mi).

MATERIALS

DATA AVAILABILITY: In this study LANDSAT-8 OLI (Operational Land Imager) with a 30m spatial resolution and ground surveyed data is used. The Operational Land Imager (OLI) measures the near infrared, visible and short wave infrared portions of the spectrum. In LANDSAT 8 (OLI) data available from 2013 to 2021 December. To achieve the objective of the present study the following satellite data for different year are used the Satellite data used for the study was that of LANDSAT 8 OLI , the specifications are given in table.

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Remote sensing data	Path/row	Date
Landsat- 8(OLI)	144/51	January 2020
Landsat- 8(OLI)	144/51	August 2015

Table 1. Data source and acquisition

Where RED is visible red reflectance, and NIR is near infrared reflectance. The wavelength range of NIR band is (750-1300 nm), Red band is (600-700 nm), and Green band is (550 nm).The NDVI is motivated by the observation vegetation, which is the difference between the NIR and red band. Very low value of NDVI (0.1 and <0.1) coincide to barren areas of rock, sand, or snow. Moderate values describe shrub and grassland (0.2 to 0.3), while high value indicates temperate and tropical rainforests (0.4 to 0.8). Bare soil is represented withNDVI values, which are closest to 0 and water bodies, are represented with negative NDVI values. The main objective to calculate NDVI is toquantifying the healthy green vegetation (Green Cover, Grass land, vegetation) on the basis of satellite images. The value of NDVI varies between -1 to 1. High values of NDVI show dense vegetation and low values show deep water of the area.

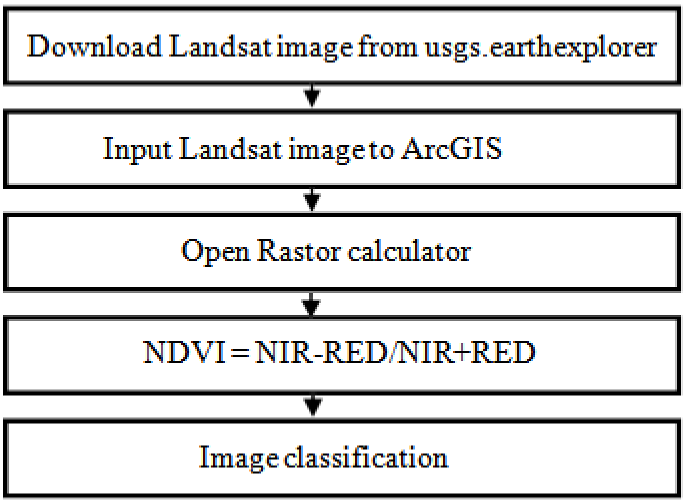

Fig 2. NDVI Image processing flow chart

Steps to Calculate NDVI:

1. Open ArcMap and add the NIR and RED band by using the add button.
2. Now open Arc Toolbox select Spatial Analysis Tool.
3. In the Spatial Analysis tool select Map Algebra and inside this select raster calculator.
4. Now in raster calculator assign the formula of NDVI and select the location where you want to save the file and click ok.
5. NDVI will be generated.

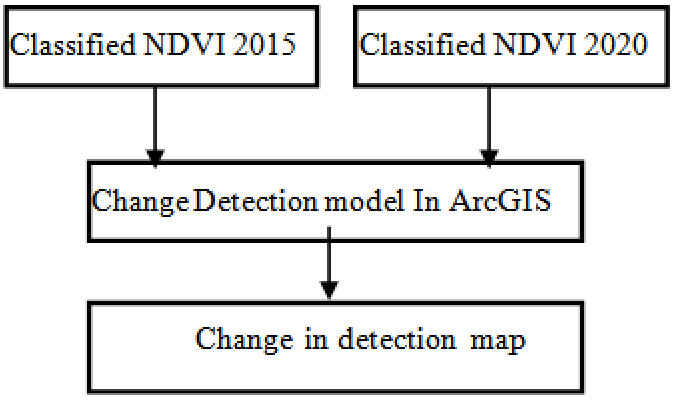

Fig 3. Land Cover Change Detection MethodologyFlow chart

II. RESULTS AND DISCUSSION

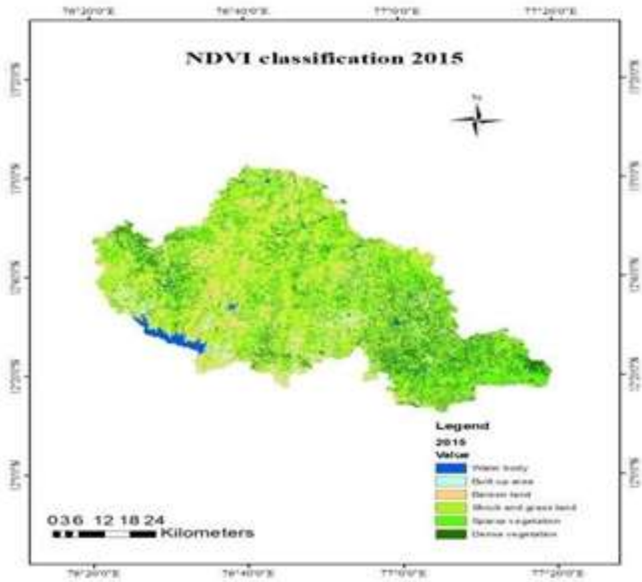

Fig 4. NDVI classification 2015

From the above Map the percentage of vegetation is found to be 41.24% at NDVI value 0.57, Water bodies and rivers found to be 2.22%, built up area is 6.32%, and barren land is 23.50% And shrub and grass land is 25.08%. In the above map the NDVI value varies from -1 to 0.57.

OBJECT ID	AREA (Sq km)	CLASSIFICATION
1	109.582	Water body
2	313.9479	Built up area
3	1200.68	Barren land
4	1244.301	Shrub and grass land
5	1416.899	Sparse vegetation
6	630.1431	Dense vegetation

Table 2. Area of classified map

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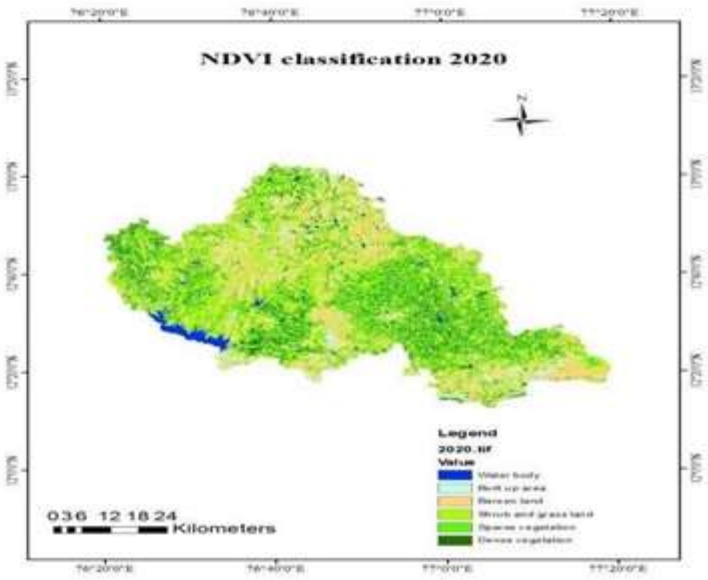

Fig 5. NDVI classification 2020

From the above Map the percentage of vegetation is found to be 35.4% at NDVI value 0.57, Water bodies and rivers found to be 2.31%, built up area is 6.9%, and barren land is 26.7% And shrub and grass land is 27.7%. In the above map the NDVI value varies from -1 to 0.58.

OBJECT ID	AREA(Sq km)	CLASSIFICATION
1	114.969	Water body
2	344.0475	Built up area
3	1326.2361	Barren land
4	1381.6775	Shrub and grass land
5	1143.63	Sparse vegetation
6	612.9876	Dense vegetation

Table 3. Area of classified map

The NDVI have been used widely to examine the relation between Spectral variability and the changes in vegetation growth rate. It is also useful to determine the production of green vegetation as well as detect vegetation changes. The results, included in Table 2 and 3, represent the various features, which have been extracted from the satellite image of mandya district. After the analysis of first image [Fig.4], it has been found that the multispectral images are giving best result for all the features at NDVI value of -1 to 0.57 in the year 2015, whereas second image [Fig. 5], giving good result for all the features at NDVI value of -1 to 0.58 in the year 2020. In this work, the NDVI value is varied from (0.1 to 0.58). The lowest values are found on the less vegetated soils and presumably because reflection from the soil is high, and produce low values in NIR band and high values in red band; hence the NDVI values are low. When soil water availability decreases, due to any environmental reason (stress by water deficit); the green vegetation tends to disappear, then the values of NDVI decreases. In some part Vegetation remains green (high NDVI values) due to availability of water in the soil. The major reason for depletion of the vegetation in general and natural forests in particular is due to high deforestation rate, and high population pressure.

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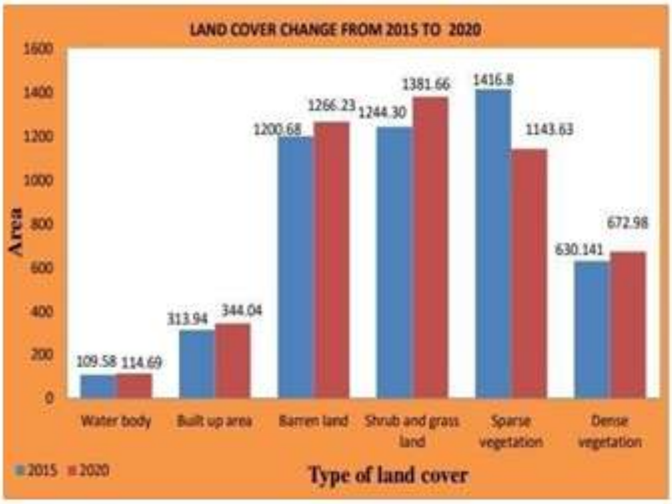

Fig 6. Land cover change from 2015 to 2020

The above graph shows the total area of vegetation is found to be 2092.0421 Sq km, water bodies & river are found to be 109.582 Sq km, built up 313.9479 sq km, barren area is found to be 1200.68 Sq km in 2015. In the year 2020, total area of vegetation is found to be 1756.61Sq km, water bodies & river are found to be 114.96 Sq km, built up 344.075 sq km, barren area is found to be 1326.2361Sq km in 2020.

In this study, all the maps are very helpful in monitoring and understanding environmental and climate changes such as deforestation and desertification. vegetation index was used to measure biomass, amount of vegetative cover, and vegetation condition and also NDVI is use full for drought monitoring. NDVI is a significant technique to measure the evolution of land use land cover (LULC) especially change detection of vegetation pattern and its area. Result of the NDVI study shows that the vegetation of medium and low density is rapidly reduced by the various anthropogenic causes.

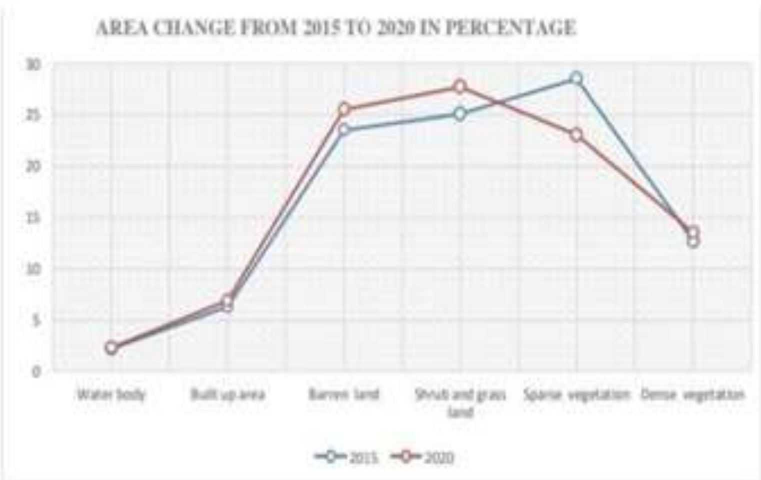

Fig7. Percentage of area change

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Classification	2015	2020
Water body	2.22	2.31
Built up area	6.32	6.9
Barren land	23.5	25.5
Shrub and grass land	25.08	27.7
Sparse vegetation	28.5	23.05
Dense vegetation	12.7	13.54

Table 4. Percentage of area change

ACCURACY ASSESSMENT

Generally, no land cover classification would be complete without an accuracy assessment. A variety of factors influence the classification accuracy. The classification accuracy mainly depends on sampling theory, but practical considerations regarding accessibility and resources constrain the desirable (Cihlar, 2000). The error matrix (confusion matrix) and kappa coefficient have become a standard means for assessment of classificat__ion accuracy. Error matrices compare, on a class-by-class basis, the relationship between known reference data (ground truth) and the corresponding results of the classification procedure. Individual class accuracy was calculated by dividing the number of correctly classified points for each class by either the total number of points in the corresponding column (producer accuracy) or row (user's accuracy). Overall accuracy was computed by dividing the totalnumber of correctly classified points (i.e., the sum of the elements along the major diagonal) by the total number of reference points.

Accuracy assessment is an important part of any classification project. It compares the classified image to another data source that is considered to be accurate or ground truth data. Ground truth can be collected in the field.

Total accuracy: The total accuracy is calculated by "summing the number of correctly classified pixel and dividing by the total number of pixel".

Kappa Statistics (Kappa coefficient): kappa statistic is a measure of how closely the instances classified by the machine learning classifier matched the data labeled as ground truth, controlling for the accuracy of a random classifier as measured by the expected accuracy.

$$K=\frac{N\sum_{i=1}^{r} xii-\sum_{i=1}^{r}(x_{i+}*x_{+i})}{N^2-\sum_{i=1}^{r}(x_{I+}*x_{+i})} \longrightarrow \quad (2)$$

r= No. of rows in the error matrix
xii= The no. of observations in low i and column i(on the major diagonal)
xi+= Total of observation in row i (shown as marginal total to right of the matrix)
x+i= Total of observation in column i

	Water body	Built up area	Barren land	Shrub and grass land	Sparse vegetation	Dense vegetation	Total
Water body	5	0	0	0	0	0	5
Built up area	0	3	1	1	0	0	5
Barren land	0	0	4	0	1	0	5
Shrub and grass land	0	0	0	5	0	0	5
Sparse vegetation	0	0	0	0	5	0	5
Dense Vegetation	0	0	0	0	0	5	5
Total	5	3	5	6	6	5	30

Table 5. Error matrix method(2015)

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Over all accuracy = 90%
Kappa coefficient = 0.89

	Waterbody	Built up area	Barren land	Shrub and grass land	Sparse vegetation	Dense vegetation	Total
Water body	5	0	0	0	0	0	5
Built up area	0	4	1	0	0	0	5
Barren land	0	0	4	0	1	0	5
Shru band grass land	0	0	0	5	0	0	5
Sparse vegetation	0	0	0	0	5	0	5
Dense Vegetation	0	0	0	0	0	5	5
Total	5	4	5	5	6	5	30

Table 6. Error matrix method(2020)

Over all accuracy = 92%
Kappa coefficient = 0.9

CHANGE DETECTION MAP

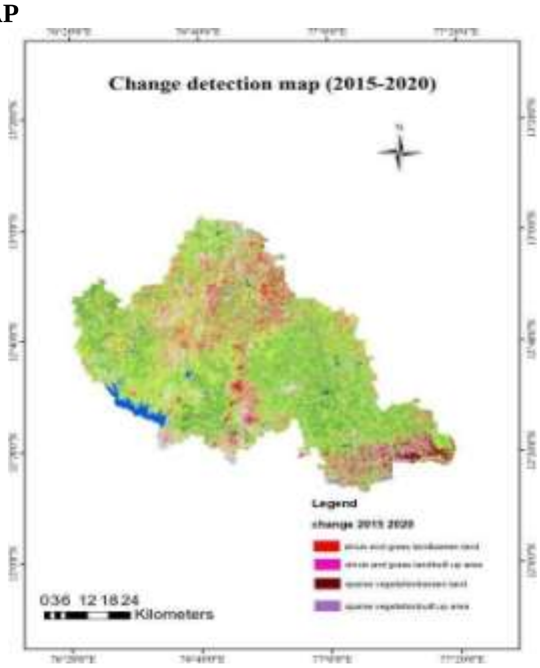

Fig 8.Change detection map

Change (2015-2020)	Area
barren land-Water body	3.925585
built up area-Water body	10.85431
dense vegetation-Water body	1.305578
shrub and grass land-bareen land	474.0058

shrub and grass land-built up area	59.80884
shrub and grass land-Water body	2.098756
sparse vegetation-bareen land	240.3791
sparse vegetation-built up area	42.05068
sparse vegetation-Water body	2.155678
water body-bareen land	2.414596
water body-built up area	9.329589
water body-Dense vegetation	0.72179
water body-shrub and grass land	1.165508
water body-sparse vegetation	1.061941
water body-Water body	94.85297

Table 7. Major change areas

III. CONCLUSION

The normalized difference vegetation index technique with different threshold values has been employed for land cover extraction of Mandya district as a case study. The results show that in the year 2015 the percentage of vegetation is found to be 41.24%, Water bodies and rivers found to be 2.22%, built up area is 6.32%, barren land is 23.50%And shrub and grass land is 25.08%. In 2020 the percentage of vegetation is found to be 35.4% , Water bodies and rivers found to be 2.31%, built up area is 6.9%,and barren land is 26.7% And shrub and grass land is 27.7%. Vegetation has declined in the lower part of Malavalli and some part in Nagamangala district due to water scarcity and also some part of vegetation area is converted into built up area. Built up area has increases due to development activity. NDVI classification of Landsat images and cross verification by ground truth traverse has results an overall accuracy of the image interpretation classes. A high-resolution satellite data would suitably improve the land use classification

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