Variation detection in vegetation using remote sensing and GIS- A case study of Wadhvaan taluka, Surendranagar, Gujarat, India

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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 paper uses image processing with NDVI to detect variation in vegetation cover in the selected landscape. 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, and multisource classification is done. Different NDVI values of land cover were as cut-off values related to the reflectivity of land cover. This way variation detection is made. Outcomes decide usability of such reflective indexing techniques for landscape classification of the pictured area. It enhances the capabilities of managers to draft the related policy. Such index is also helpful to forecast unfortunate natural calamities like flood, earthquake, tsunami or storms along with available aids, damage analysis along with new policy drafting. From this study, during the gap between 2014 to 2018, it is observed that open farmland and shrubland has been reduced to 50% and 23% respectively. There is an increase in agricultural land by145% and water area by18%.*

Keywords- NDVI, Remote Sensing, Landsat 8 images, Change Detection, Vegetation Index

I. INTRODUCTION

Lithosphere can be understood in a quite better way using Multi spectrum remote sensing imagery [1]. The science and arts of getting and extracting, spatial and temporal information about some object, area or phenomenon like variation in vegetation or change in land cover, its classification, water body, urban or countryside, barren or fertile patches decided from far, is the real sense of Remote sensing [2]. The Remote Sensing or its data is used for many purposes viz. Land cover classification, deciding precipitation, deciding forest type, deciding the proportion of water/liquid present in vegetation, the study of snow cover, sea ice proportion variation, oceanography, mining, drainage of seasonal water, fishing area, etc [2]. Multi spectra remote sensing images contains special and spectral properties of an object [3]. We have used such images to calculate percentage variation in the land cover features like vegetation, scrub area agricultural area, open/active farmlands, water bodies. The outcome of such studies is helpful in many cases of disasters like famine and flood. Multispectral imagery is termed as remote sensing imagery also. The number of the spectral band varies, depending on the sources. IRS (Indian Remote Sensing) Satellite system avails three band data. It contains NIR (Near Infra-Red), Red and Green band images. While, USGS (Landsat 8) imagery contains total nine bands [5]. Image of such bands represents a reflection of specific radiation from the landscape or objects in the image. By knowing the reflectivity of the different object at different spectral ranges, the objects, their properties and variation can be analyzed. Some particular feature can be extracted by processing such bands [6]. Spectral images are examined using several mathematical formulas and particular algorithm. Then, certain features based on reflectance characteristic of surface or object, are allotted indices that highlight required attribute in the image as output. [7]. So many such indices are identified and used to analyze land cover vegetation, eg.. NDVI, RedNDVI, GreenNDVI, etc. [8]. NDVI is a remarkable one, used widely for research on global environmental and climate variation [8]. It is calculated as ratio difference in reflectance of radiation of Red and NIR bands from the canopy respectively [9]. Here we have used NDVI for identification of vegetation in a significant amount, compared to other region using multispectral imagery obtained from Landsat 8 satellite. It is used in vegetation monitoring [10, 11], identification of areas with crop cover [12], famineaffected areas[13, 14], agricultural drought assessment at national [15, 16] or global level [17]. NDVI is used to measure the land cover class regarding vegetation or crop in the selected patch with multispectral imagery [17].

II. OBJECTIVE

The primary objective of this study is to check functionalities of Remote Sensing and GIS capabilities in landscape analysis with the help of Normalized Difference Vegetation Index (NDVI) at different threshold values.

III. STUDY AREA AND RESEARCH METHODOLOG.

Selected patch is a marshy landscape of Surendra agar district located in central Gujarat. Wadhvaan is located 22° 43' N, 71° 43' E (Fig), which is selected for the detection of variation in land cover regarding vegetation as a case study.

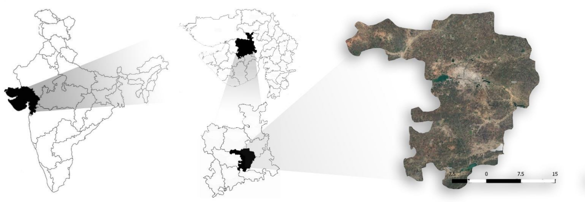

Fig.1 Study area

Landsat 8 data was downloaded from earth explorer site (earthexplorer.usgs.gov) of United States Geological Survey (USGS). TM and ETM images were orthorectified and converted into Universal Transverse Mercator (UTM). Landscape interpretation was performed with System for Automated Geoscientific Analyses (SAGA) GIS software. After image processing, a statistical analysis was performed using a confusion matrix to obtain required result. Using nine bands satellite imagery of Surendranagar district, Normalised Difference Vegetation Index (NDVI) was calculated. This biophysical indicator has been used to find soil erosion in the area also[1-5]. This index easily differentiates land cover with vegetation from land cover with bare soil as they have different reflective properties. Satellite or Arial multispectral images are processed with the mathematical formulas shown below.

$$RNDVI = \frac{NIR - RED}{NIR + RED}$$

(Where $0 < NDVI > 1$)

$$GNDVI = \frac{NIR - GREEN}{NIR + GREEN}$$

(Where $0 < NDVI < 1$)

here,
RED (Wavelength range 600nm to 700nm) - Visible red reflectance,
GREEN (Wavelength range 520 nm to 600nm) – Visible green reflectance
NIR (Wavelength range 750nm to 1300nm) - near-infrared reflectance.

Table 1 indicates wavelengths and difference in reflectance characteristics of different types of objects.The formulae detect the maximum difference between NIR and Red reflectance as chlorophyll has, it is normalized to overcome the effect of shadows due to clouds, hills or buildings. Results of this formula allot definite indices by subtracting NIR and Red band effect pixel by pixel to the whole image. Hence vegetation is decided from GNDVI as it has greener band reflectance.

Table: 1 Thematic Bands and the wavelength of radiation of Lansat satellites.

Band	Name of Band	Wavelength	Characteristics and Usage
1	Visible Blue	0.45 – 0.52	Max. Water Penetration
2	Visible Green	0.52 – 0.60	Plant vigor measure
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 – 1.756	The moisture content of the soil
6	Thermal Infrared	10.4 – 12.5	Soil Moisture and thermal mapping
7	Middle Thermal IR	2.08 – 2.35	Mineral Mapping

Typically, NDVI < 0.1 indicates the barren areas of rock, sand, or snow. Values 0.2 < NDVI < 0.3 indicates shrub and grassland while 0.6 < NDVI < 0.8 indicate temperate and tropical rainforests and agricultural landscape. NDVI around 0 represents. Bare soil Negative values of NDVI represent water bodies. [4-7].

The water of cells reflects NIR while chlorophyll of cells absorbs red with great extent hence NDVI has a variation with the greenness of plant leaves. Different feature and characteristics are obtained by performing indexing test on it. Filtration for any band in the visible spectrum can be performed with appropriate technique. The full work process has indicated in Fig.2. Different bands occupy a range of different wavelength, and different methods are designed with different feature extraction. For this, more bands are required in the imagery. Different options are available for band selection at the time of obtaining imagery. For now, only three bands are required those are Red, NIR, and Green.

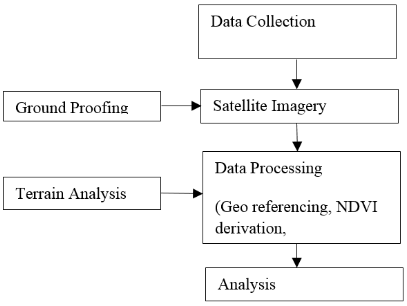

Figure 2 Flow Chart of Research Methodology

IV. RESULTS AND DISCUSSION

In this study, variation in the greenness or vegetation has been determined with vegetation index of satellite images. With this, crop standing in the field can also be estimated in the given time span. The Difference in the land use in Wadhwan taluka of Surendranagar district region between 2014 and 2018 is derived and indicated in Table.2.

Comparing these images with visible band images obtained from Bhuvan portal, the result provides extensive information about variation in vegetation and land use between 2014 to 2018. After the analysis of first image [Fig.3], it is found that the multispectral images are giving the best result for all the features at all NDVI with second image [Fig. 4], giving a good result for land use comparison, between the years 2014 to 2018. In this work, the NDVI value is varied from (0.1 to 0.5) so that best features can be extracted from Wadhwaan taluka and the classes discrimination are depicted in Fig 5. NDVI variations between 2014 to 2018 is presented in Fig.6. The lowest values are found on the less vegetated soils and presumably because the 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.

Due to various reasons when water in the soil reduces, green vegetation starts disappearing, reducing NDVI. From Fig.7, The change detection analysis in selected land cover shows approx. 50% reduction in bare (uncultivated) farms, 23% in shrublands, but 145% increment in farming activity and 51% increase in a concrete structure or urbanization. The result implies that NDVI extracts superior results for vegetation monitoring of selected areas. Fig.5 represents the area which observed changes from one class to the other. Monitoring such areas can answer the causes for the sudden boost in agriculture activity. The area had come with the availability of water through Narmada canal (increase in the water body by 18%). People started using the water for irrigation legally or illegally for their seasonal farmland. Shrubland also suffered for the occupation of working farms instead of dry farms. GIS classification along with the ground proofing has enhanced overall accuracy in remote sensing image interpretation.

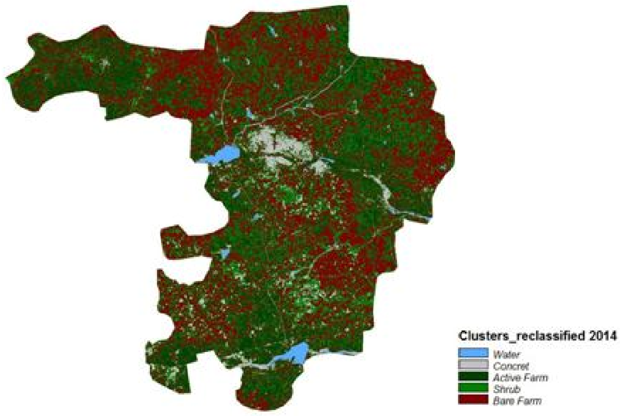

Fig. 3 Wadhvaan Taluka NDVI classification 2014

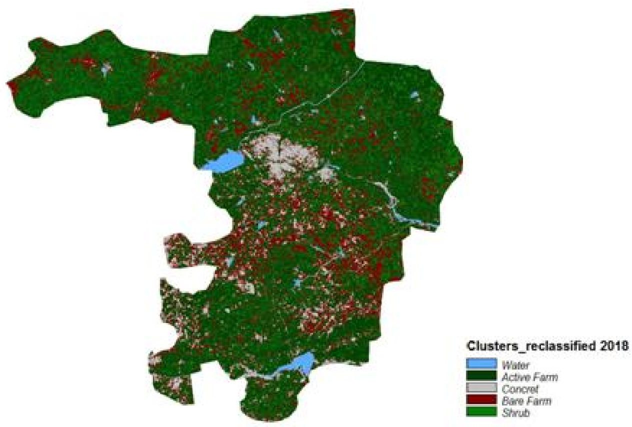

Fig. 4 Wadhvaan Taluka NDVI classification 2018

Availability of high-resolution images would doubtlessly improve the accuracy of results for the land classification. NDVI with different threshold values is widely used for landcover feature extraction. At the different threshold of NDVI classification do not differ the result to the remarkable extent. It indicates that this method of classification of land cover is a superior and reliable method for vegetation or land classification.

NAME	Area (2014)	Area (2018)
Bare Farm	167.4693	84.4065
Shrub	125.7885	101.5191
Active Farm	73.1484	169.3305
Concret	20.475	30.6153
Water	5.6034	6.6114

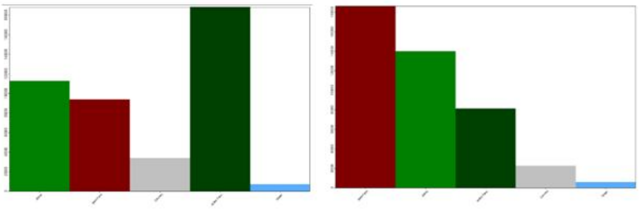

Fig. 5 Classes discrimination for entire landscape of Wadhvaan taluka between 2014 and 2018

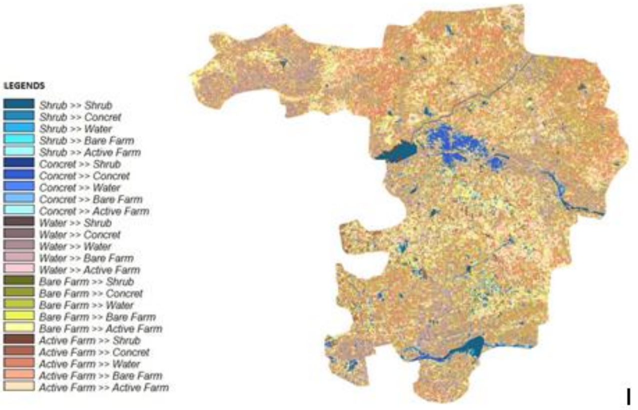

Fig. 5 Change observed in the land used between 2014 to 2018

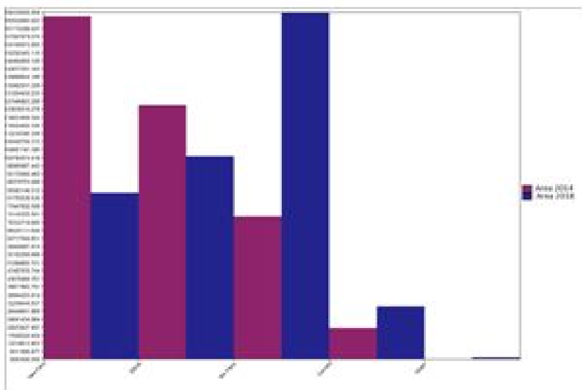

Fig. 6 Variation in different classes of land observed (in m2) between the years 2014 to 2018

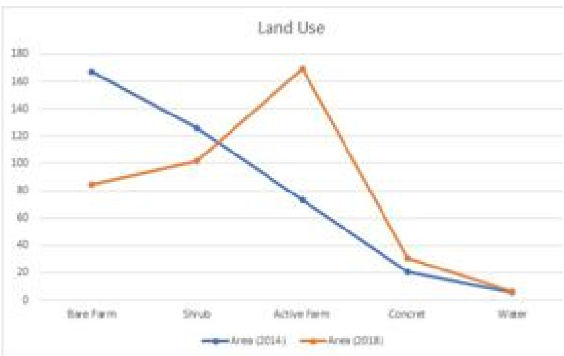

Fig. 7 Variation in different classes of land observed (in km2) between the years 2014 to 2018

V. CONCLUSION

Above study has introduced the capability of remote sensing and GIS in the identification of various features of land cover. Further, application of enhanced tools like RADARs and LIDAR, landscape analysis will become more versatile. High-resolution satellite imagery is an essential requirement which is not possible for individual patches of landform at this ease aerial remote sensing imagery using drones should be encouraged

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