

## **MAPPING AND MONITORING OF DESSERTIFICATION AND LAND DEGRADATION USING REMOTE SENSING AND GIS TECHNIQUES**

<sup>1</sup>Prabhakar Tripathi, <sup>2</sup>Mohd Muzzammil Ansari, <sup>3</sup>Vashi Ahmad, <sup>4</sup>Dr M.S Yadav

<sup>1</sup> M.Tech. (RS & GIS) Remote Sensing Application Centre, UP, India.

<sup>2</sup> M.Tech. (RS & GIS) Remote Sensing Application Centre, UP, India,

<sup>3</sup> M.Tech. (RS & GIS) Remote Sensing Application Centre, UP, India,

<sup>4</sup> Scientist S.E, Head (Soil Resources Division), Remote Sensing Application Centre, UP, India,

**Abstract:** *-The objective of this study is to develop techniques for assessing and analyzing land desertification in Chitrakoot, a city in the state of Uttar Pradesh, as a typical monitoring the area through the application of remotely sensed data and geographic information systems. The methodology included the use of LISS-III data, topographic maps, field work and use of other existing data. From this, land cover, the Normalized Difference Vegetation Index (NDVI), farmland, woodland and grassland maps at 1:50,000 were prepared for land desertification monitoring in the area. In the study all data was entered into a GIS using ArcGIS software to perform land desertification monitoring. The results indicate that land desertification in the area has been increasing. Although land desertification has to some extent been controlled in the area by planting grasses and trees, the issue of land desertification is still serious problem. The analysis also establish an example of why the summation of remote sensing with GIS is decisive for the monitoring of environmental changes in arid and semi-arid regions, e.g. in land desertification monitoring in the Chitrakoot area. However, land desertification monitoring using remote sensing and GIS still requires to be retain, refined for the purpose of long-term monitoring and the management of fragile ecosystems in the area. Modeling and monitoring desertification processes are of prime importance for the preservation of the ecosystem and human society. The desertification process involves many typical phenomena which must be diagnosed and monitored through multi-disciplinary approaches of physical, biological and social indicators.*

**Keywords:** - NDVI; GIS ; Desertification; Ecosystem

### **1. INTRODUCTION**

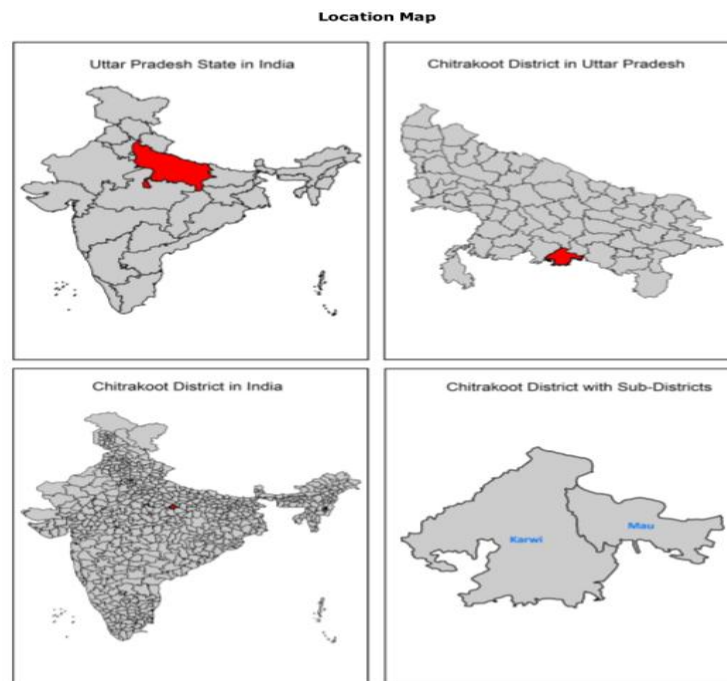
For humans, land is important because they not only live but also perform all economic activities, natural vegetation, and supports wildlife. Land is a limited resource as the degradation of land is taking place in various areas of the world at a higher rate. Exploitation and mismanagement of the earth's resources has led to land degradation, which is a serious environmental problem in our time. Deforestation, overgrazing, agricultural practices, industrialization and urbanization are the causes behind land degradation. It is a known fact that Desertification/land degradation is a preeminent economic, social and environmental problem of global problem. In general, land degradation is reduction in productivity of soil. Loss of soil productivity means loss of ecology and economy. Increasing population (both human and cattle), over exploitation of natural resources, un-sustainable land use practices, frequent natural hazards, extreme weather conditions and climate changes are accelerating the processes of land degradation. In India, initially aerial photographs were used in deriving information on degraded lands. Amidst the new technologies developed for studying natural resources, remote sensing and GIS are effective technologies for detecting, assessing, mapping, and observation of the land degradation. One of the key requirement is inventory and monitoring desertification and land degradation of the country using satellite data in Geographical Information System (GIS) environment for providing baseline data to be used for prioritizing areas, carrying out desertification vulnerability and risk assessment and preparing action plans for combating desertification and land degradation. The present study is based on the mapping and monitoring of degraded land/desertification using remote sensing and GIS.

## 2. STUDY AREA

The study area is a district of Uttar Pradesh with its administrative headquarters located at Chitrakoot town. The term 'Chitrakoot' means the 'Hill of many wonders'. Chitrakoot lies in the Northern Vindhya Range of mountains. Geographically, it is bounded by 25°18'N latitude, 80°87'E longitude and 207 m altitude. The district covers a geographical area of 3,216 sq.km. and it is bounded by Fatehpur district on the North, Kaushambi district on the North-East, Banda district on the North-West and Madhya Pradesh on the South, South-East and South-West. The climate of the study area remains extremely hot during the summer. The Average rainfall occurs in the district was 917 mm. According to 2011 census, the district has a population of 9,91,730 (persons) out of which 5,27,721 (males) and 4,64,009 (females). The district has a sex ratio of 879 females for every 1000 males.

### **PROCESS OF DESERTIFICATION/ LAND DEGRADATION**

- i) Vegetation degradation** - Decrease in biomass and/or decline in the vegetative ground cover, as a result of deforestation or overgrazing.
- ii) Water erosion** - Water Erosion is referred as loss of soil cover mainly due to rainfall and/ or surface runoff water.
- iii) Wind erosion** - Wind erosion removes the topsoil, which is rich in all plant nutrients and bacterial activities.
- iv) Water logging** - Water logging refers to the saturation of soil with water
- v) Salinity / Alkalinity** - Salinity or Alkalinity is fundamentally the chemical property of the soils. It occurs mostly in cultivated lands, especially in the irrigated areas.
- vi) Man Made-** It involves sliding, rolling and flowage of masses of soil, overburden and bedrock.
- vii) Barren / Rocky area** - Barren / rocky areas are kind of wastelands which do not have productive capacity.



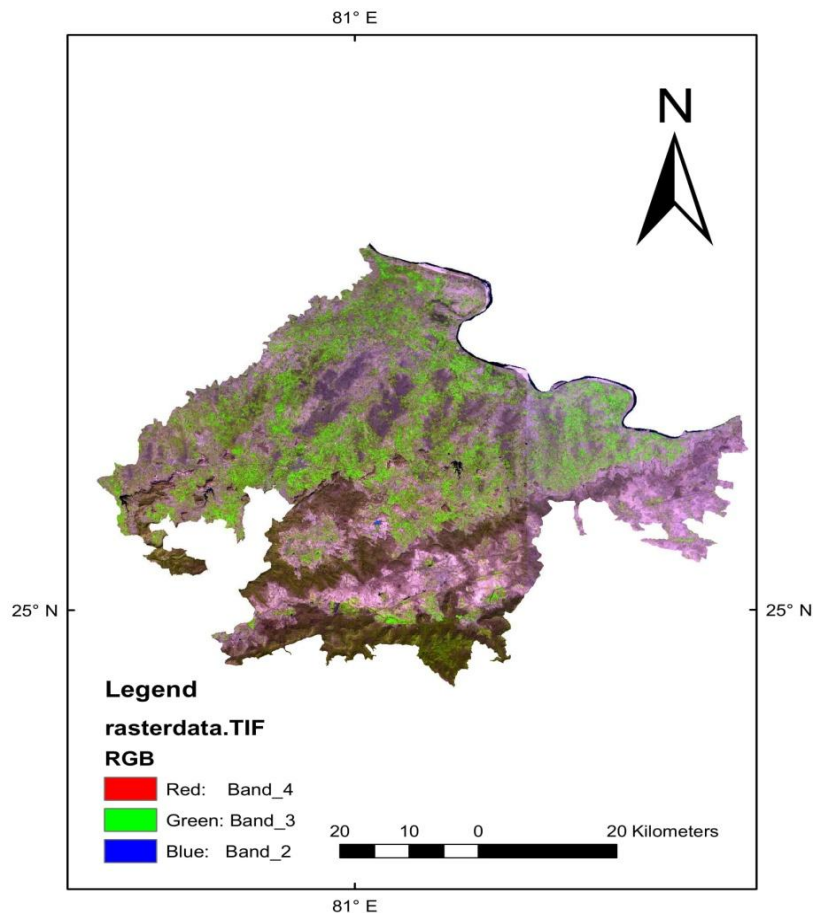
## 3. MATERIALS AND METHODOLOGY.

### **3.1 DATA ACQUISITION AND PROCESSING**

Multi-temporal digital IRS LISS III data, ancillary information, collateral data and Survey of India Topographic map were used. IRS LISS III is 10 bits data with 23.5 meters spatial resolution, 24 day repeativity, swath of 141 km in four spectral channels, i.e. 520-590 nm (Green), 620-680 nm (Red), 770-860 nm (NIR) and 1550-1700 nm (SWIR). False Color Composite (FCC) is prepared using first three bands.

Resourcesat Sensor Specifications	
Sensor	LISS-3
Number Of Bands	4
Spectral Band 2( $\mu$ )	0.52 - 0.59 (Green)
Spectral Band 3( $\mu$ )	0.62 - 0.68 (Red)
Spectral Band 4( $\mu$ )	0.77 - 0.86(NIR)
Spectral Band 5( $\mu$ )	1.55 - 1.70 (SWIR)
Resolution(m)	24
Swath(km)	140
Revisit Period(Days)	24

The digital LISS III data is downloaded from Bhuvan Portal ([https://bhuvan.nrsc.gov.in/bhuvan\\_links.php#](https://bhuvan.nrsc.gov.in/bhuvan_links.php#)) . The Toposheet numbers of the data are G44O11, G44O12, G44O08, G44U13, G44O16, G44O03, G44P11, G44P12, G44P07, G44P08, G44V01, G44P02, G44O15, G44P03 and G44P04. The LISS III data is of date January 2016. ArcGIS software version 10.3 is used to elaborate pre-processing, processing , Normalized Difference Vegetation Index(NDVI) and Normalized Difference Water Index(NDWI) and classification of the satellite images. LISS III images were taken as they are free of cost and easily available. Mosaicing is done of all the tiles of the image and composite band is created using 4 bands.



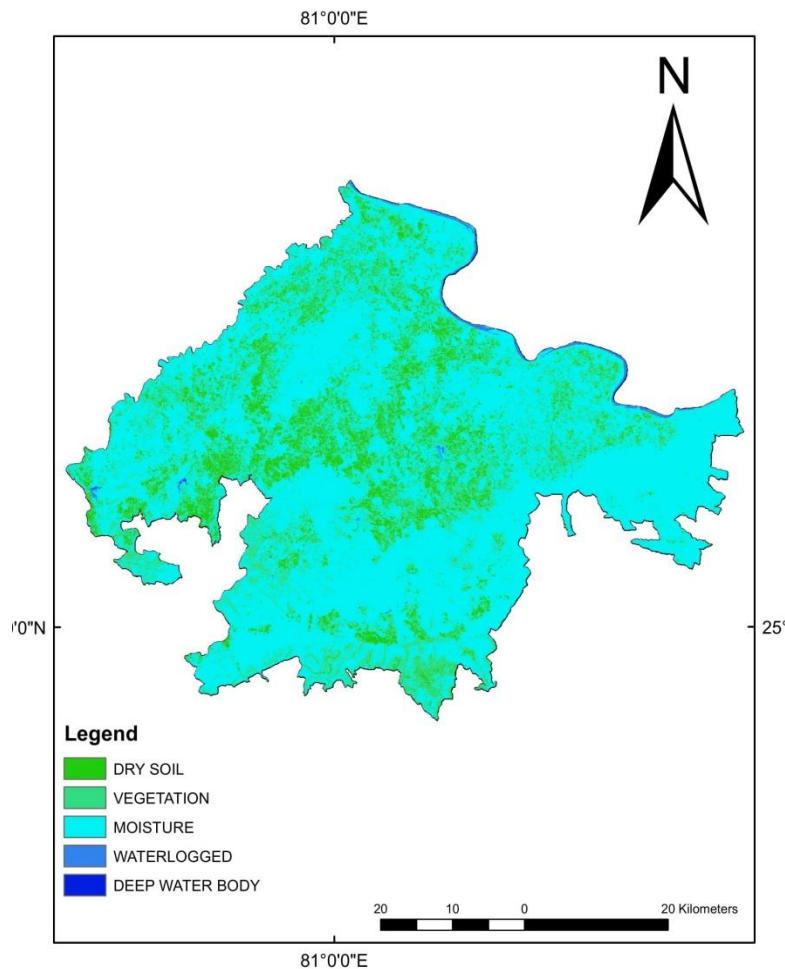
**Fig.1** Geomorphology of study area

### 3.2 NORMALIZED DIFFERENCE WATER INDEX(NDWI)

The Normalized Difference Water Index(NDWI) is used in remote sensing which hints in the change in the content of water in plantation. Monitoring & detection of moisture content in vegetation over huge areas can be done using NDWI. It is found that NDWI values displayed a quicker response to land degradation/desertification than NDVI. NDWI uses green and near infra-red bands of remote sensing images. The NDWI can be easily calculated by using the following equations-

$$NDWI = \frac{(X_{green} - X_{nir})}{(X_{green} + X_{nir})}$$

In LISS-III digital image, band 2 is for green and band 4 is for near infra-red.



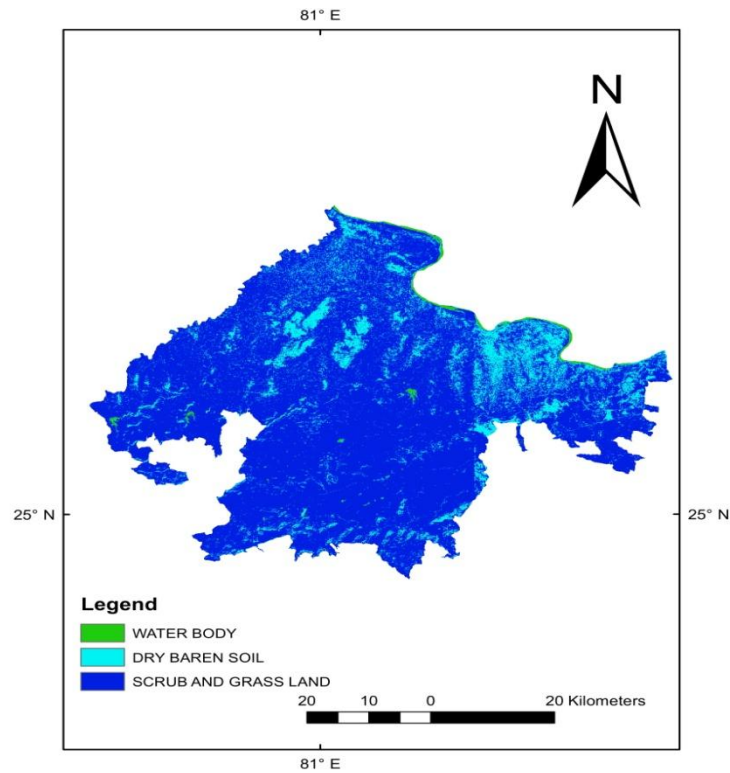
**Fig. 2** NDWI of study Area

### 3.3 NORMALIZED DIFFERENCE VEGETATION INDEX(NDVI)

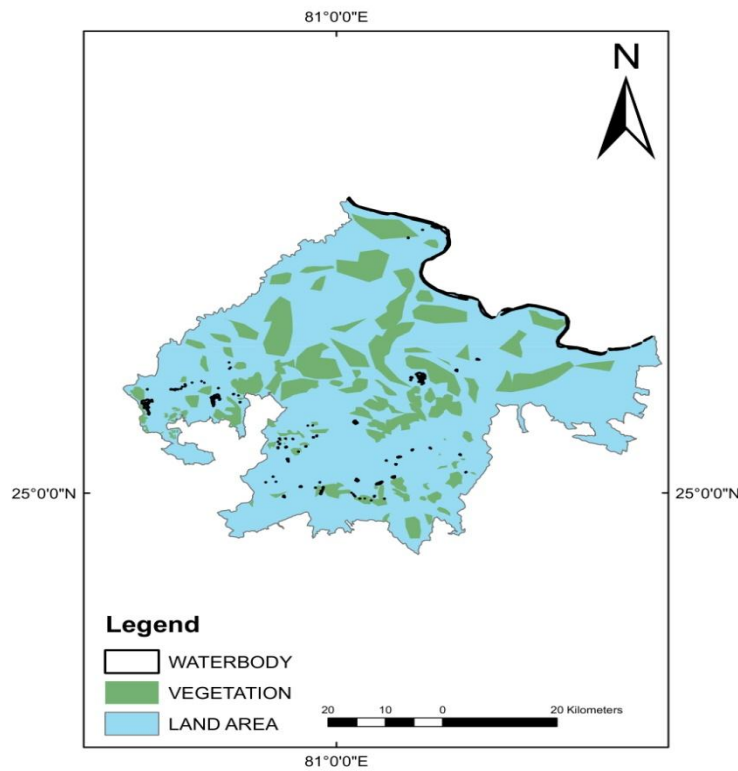
NDVI in remote sensing is used to compute the vegetation by measuring the change between near Infra-red and red light band. Healthy vegetation shows the value of NDVI in +1. NDVI is used in the research on land-use and land-cover change, drought, soil erosion, desertification, vegetation fires, and soil organic carbon (SOC) etc. NDVI uses red and near infra-red bands of remote sensing images. The NDVI can be easily calculated by using the following equation-

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

In LISS-III digital image, band 3 is for green and band 4 is for near infra-red.



**Fig.3** NDVI of Study Area



**Fig. 4** Land Specifications



#### 4. RESULTS AND DISCUSSION

The soil of the study area includes hilly soil, black soil and alluvial soil. Geomorphology, the study area has an influence on the ground water.

##### *Assessment of Land degradation*

Analysis and observation have been made using ArcGIS 10.3 for the identification of land degradation in the study area. Some of the important components of the operation are-

- 1) Topography, NDVI maps with the entire raster layer is classified.
- 2) NDWI of the study area is classified to analyze the moisture content.
- 3) Water bodies, vegetation and land area has been categorized and calculated.

##### *NDVI of Study area*

In this study, NDVI of the area of interest is calculated and observed that river is flowing in the north-east area. Some other water bodies are also available in the central and west region of study area. Less number of water bodies can result into water scarcity if no proper water management is done.

Dry barren soils exist in the eastern and western areas mostly. It also exists in the outer parts of water bodies. Scrub and grass lands cover the maximum area in the study.

##### *NDWI of Study area*

The water level is declining very fast in the study area and it is strongly recommended that exploitation of ground water should be stopped. The declining water level can cause adverse effect on ecological balance as minor drainage ways which used to have water are almost dry. Below is the results obtained from the study area.

Vegetation Degradation = 711.22 sq. km Total Geographic Area = 3250.67 sq. km Water Erosion = 131.1 sq. km Total Area under Land Degradation = 21.87 %
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There is no water logged area in the study area. Lake beds and water bodies have high risk with physical degradation and moderate risk with salinization. The study shows that the water bodies in the area of interest are very less in number and the quality of soil is deteriorating which can result in soil degradation.

#### 5. CONCLUSION

Remote sensing & GIS plays a crucial role in the elaboration of land degradation. GIS is a helpful tool to store, alter and quantify in evaluating land degradation. One of the most important factors affecting land degradation is human activities. The human activities exploit the natural resources on a regular and extreme manner until the process of desertification is irreversible.

#### 6. REFERENCES

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