Monitoring Recent Variations Of Surface Displacement Of Forest Cover Using NDVI Calculation-Case Study Of Kheragarh Tehsil Of Agra District

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Abstract:-Remote sensing technology in combination with geographic information system (GIS) can render reliable information on vegetation cover. The analysis of the spatial extent and temporal change of vegetation cover using remotely sensed data is of critical importance to agricultural sciences.This paper investigates the Spatio- Temporal change of vegetation cover of Kheragarh taluka of Agra district. For this study, Landsat images (TM and ETM+) of 12 February, 2002 and 27February, 2015 were used. For recognition of vegetation reflectance, layer stacking of band 4, 3 and 2 (false color composite) for TM and ETM+ was performed. To cross check the vegetation cover information obtained through images, ground truth verification of certain sample locations through GPS device was done. The images were then classified into water body, forest/vegetation cover, built-up area, non-forested and agriculture. Supervised classification was done and maximum likelihood operation was performed to generate vegetation cover maps. Afterwards, vegetation cover map of 2002 and 2015 were crossed to generate the map of change of vegetation cover for the respective dates and to find out the changing pattern of vegetation cover. In addition, the use of spectral vegetation index, namely the Normalized Difference Vegetation Index (NDVI) was applied to detect areas of vegetation cover decrease. The study reveals that vegetation cover of the area has changed significantly during the study period.

Keywords: *Kheragarh taluka, Landsat images, NDVI and Vegetation & non vegetation cover*

I.   INTRODUCTION

Natural vegetation is known for its natural beauty. Forests are the green blankets that are naturallyprotecting the ecosystem and environment and preserving the natural resources.

Urban growth, a resultant factor due to population has been a major factor which has altered natural vegetation cover. Vegetation indices among other methods have been reliable in monitoring vegetation change.It is evident that the reported forest cover in our country includingdense forest, open forest and mangroves is 67.83 m.ha which is19.39% of India's geographical area (Sakthivel et al, 2010). It is observed that the state of Uttar Pradesh has1.34 m.ha, which is comparatively less forest cover than the required rate as is prescribed by National Forest Policy (Anon,1976).

Globally, every twenty minutes 1200 acres of forest are destroyed(Conservation International, 2000). Hence, it is essential to assessthe forest cover and understand the reason for the decrease in forest cover. Recent researches on assessment of forest cover change exposes the fact that due toexcessive population pressure, practice of unscientific agricultural methods and the lack of awareness about the importance of forests are the prime causesfor deforestation / degradation of forests. Forest cover change detection and analysis is a time consuming process and is quite a complicated task.Remote sensing technology can beeffectively utilized for change detection and monitoring activities(Jessica et al., 2001). Some of the researchers have identified that the increasein vegetation cover has resulted in increased rainfall (Sarma, 2001;Dengiz et al., 2009) and decrease in forest cover has directrelationship with socioeconomic status / marginal worker force (Murali,2002).

Change detection (Singh, 1989) is a process of identifying changes in the state of an object or phenomenon by observing images at different times. According to the IGBP/IHDP (Forkuo, 2012), change detection studies seek to know (i) pattern of forest cover change, (ii) processes of forest cover change, and (iii) human response to forest cover change.Hence an attempt has been made to analyze the forest coverchanges in the study area to understand its impact on local ecosystem and environmental balance. There are several indices for highlighting vegetationbearingareas on a remote sensing scene. NDVI is a common and widely used index. It is an important vegetationindex, widely applied in research on global environmental and climatic change (Bhandari et al, 2012). NDVI is calculated as a ratiodifference between measured canopy reflectance in the red

and near infrared bands respectively (Gandhi et al, 2015). In this article we have used NDVI values to understand the changes in vegetation cover.

II.   MATERIALS AND METHODS

In the present study, for assessing the temporal changes inthe forest cover, satellite images used include Landsat TM and Landsat ETM. Landsat TM and ETM were taken on 12 February, 2002 and 27 February, 2015 respectively. Both sensors have spatial resolution of 30. A supervised classification of the satellite imagery was used to produce the vegetation cover maps. Maximum likelihood classification technique was performed using all spectral bands in each satellite image. Many measurements have been proposed to improve the interpretation of the error matrix, among which the Kappa coefficient is one of the most popular measures. It is a discrete multivariate technique used in accuracy assessment (Congalton, 1988). An overall classification accuracy of 75.53% was achieved.

NDVIis used to distinguish healthy vegetation from others or from non-vegetated areas(Manandhar et al, 2009) using red and near-infrared reflectance values and this technique was used in the post-classification analysis to delineate between the intensity of green cover and barren land. This was derived using the following equation (Tuxen et al, 2008).

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

Study area:

The present study has been focused on Kheragarh (Fig 1& 2), which is a tehsil/block/nagar panchayat in Agra District. The area is located between $26^0 75'N$ to $27^0 06'N$ and $77^0 44''E$ to $78^011'E$. Its population is 117,859(2013). There are about 154 villages in Kheragarh block. It is situated on the banks of Utangan River with an altitude of 169meters above MSL. Utangan river merges with River Parvati and river Chambal.
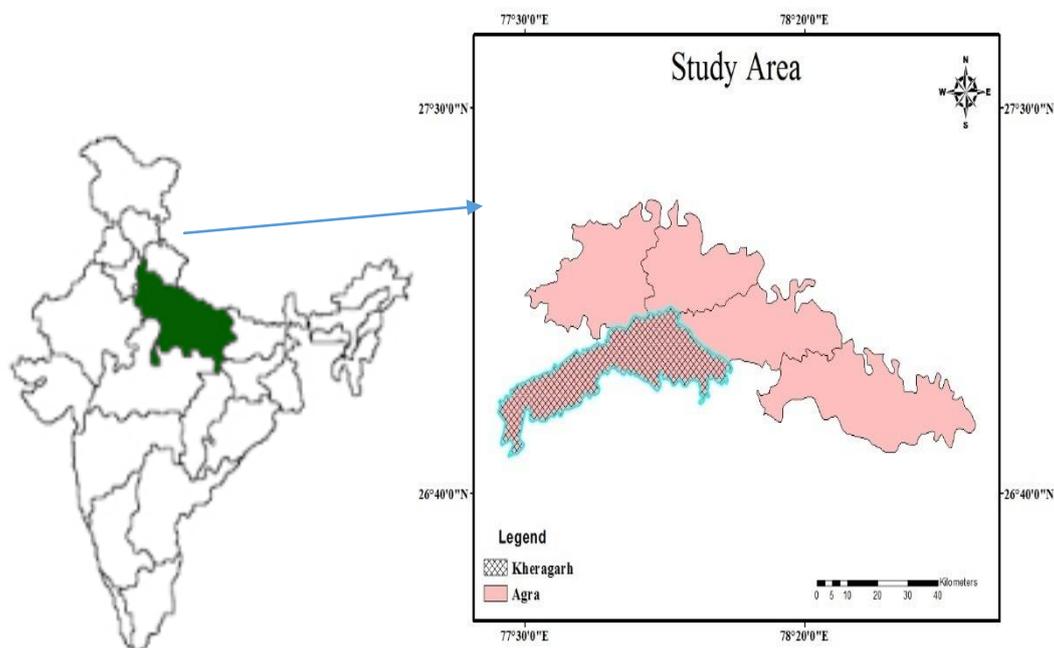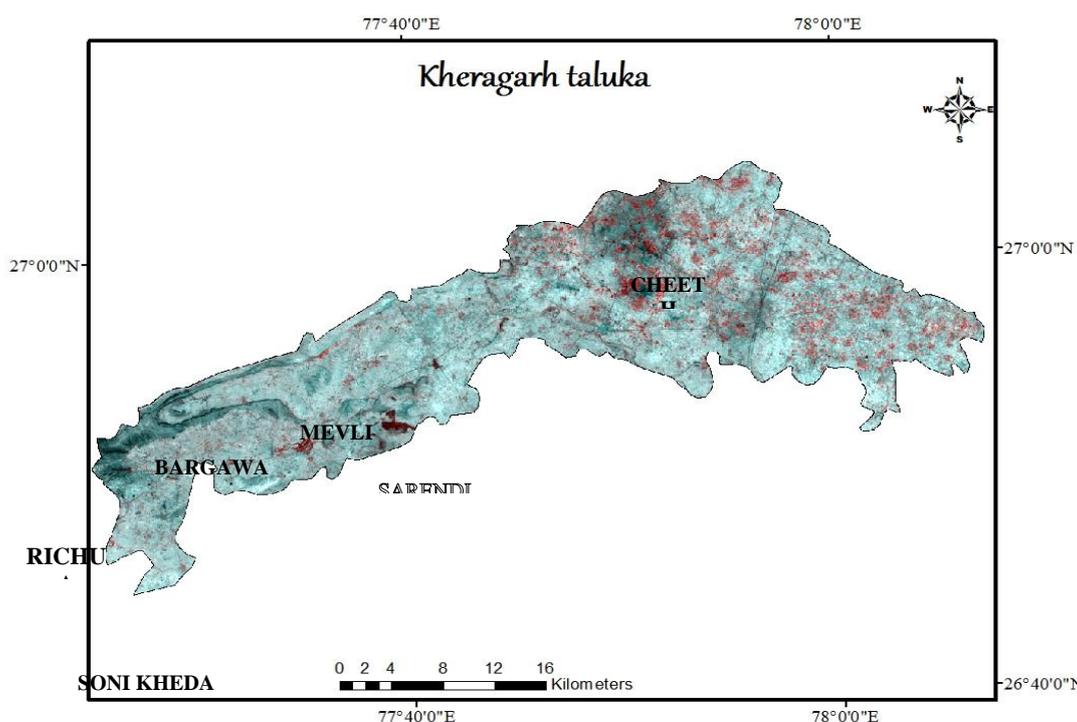

Fig 1: Location of Kheragarh in India.

Fig 2: Study area

Objectives:
Identification of vegetation and non -vegetation cover and their spatial distribution during 2002 to 2015.
- To analyze the Spatio- Temporal change of vegetation and non -vegetation cover during 2002 to 2015.
- Distinguishing of healthy green vegetation from others and non-vegetation cover using NDVI calculation.

Table 1: Reserved Forest areas of Kheragarh tehsil

FOREST NAME	AREA	SOURCE OF VILLAGE AREA
Soni Khera	1061.50 acre	Vested and Resumed area
Richoa	503.60 acre	Vested and Resumed area
Barigawa khurd	441.00 acre	Vested area
Mevli	348.33 acre	Resumed area
Sarendi	83.00 acre	Resumed area
Cheeth	170.00 acre	Vested area

III. DISCUSSION

The study area has 06 reserved forest areas (Table 1). According to official records the total area encompassed by these RF is 2607.43 acres. The spatial distribution of forests cover along with other land use cover in 2002 is shown in Fig 3. The area under built up and non-agricultural was 386 km^2 i.e.about 48.33% of the study area. Agriculture and water bodies constituted 285 and 12 km^2 respectively, which is about 35.66 and 1.50 % respectively of the study area. Forests occupied about 116 km^2, which is about 14.51 % of the total study area.

In the present study, built-up and non-agricultural class include settlement, scattered settlement, commercial/industrial zones, educational, governmental offices, roads, barren land, hospital and religious categories. In general it has been observed that the settlements having scattered/dispersed built up area in 2002 has been converted to moderate to nucleated settlement areas whereas the settlements having already dense built up area has been converted to large semi-urbanized to urbanized nucleated zones in 2015. The general trend of settlement distribution was observed in western, central and central western part along with southern part of the study area at the expense of forested land, barren, fallow, scrub land, agricultural land and small waterbodies. Major built up in 2002 is seen in and around the town of Kheragarh and Cheeth which are locatedtowards the central and central western part of the study area. Scattered built up is seen throughout the study area, especially in the form of villages/towns. Barren land, fallow land, waste land, degraded lands are found in plenty in the

study region. These are included in the category of non-agricultural. This is more prominent in the south central and south western part of the study region.

From Fig. 3it evident that the forestcover was found to be restricted to open reserved forest. Forest class includes the moderate mixeddeciduous vegetation cover and open scrub land in the study area.The southern and south western part of the study area has major lineaments and escarpment zones. There is scattered natural vegetation here.
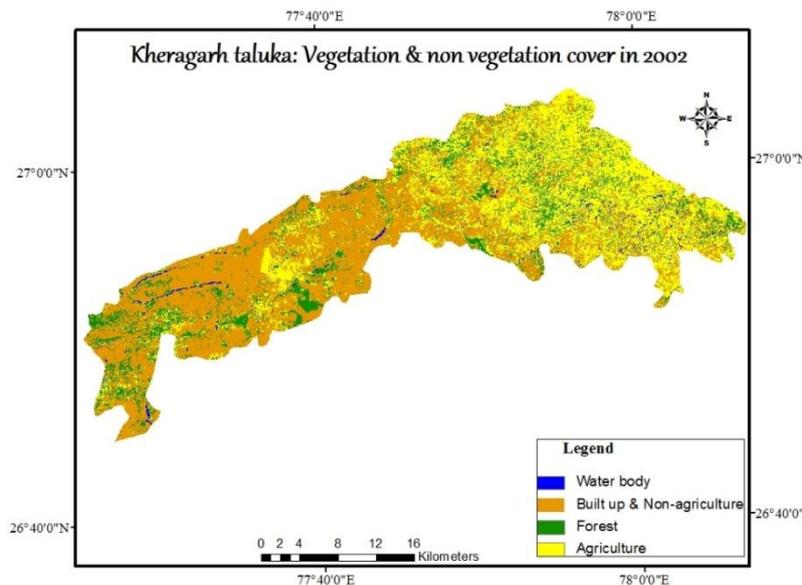

Fig 3: Vegetation & non vegetation cover in 2002

The spatial distribution of forests cover along with other land use cover in 2015 is shown in Fig. 4. In the year 2015, forests/natural vegetation occupied only 24 km^2(2.99%), which is a reduction of about 40 km^2 over a period of 13 years. Major deforestation is observed throughout the study area, particularly in the southern and northern part of the study area due to advent of human intervention (agriculture, development of built-up area, pasture land etc.). Decline in the density of reserved forest cover is also observed in the southern part of the study area due to human encroachment. Along with overall cover of natural vegetation in the study area, there has been shrinkage in the area of reserved forest (official data on this could not be obtained from forest department). Ground truth and satellite image proves this fact, although official records do not collaborate this. Further the nature of forest has also undergone change which is evident from NDVI value. Moderate mixed natural vegetation cover has been changed to sparse vegetation cover along with scrub land almost throughout the study area specially Richua (RF), Cheeth and Soni Kheda forest area. Major reduction of natural vegetation is also observed in the rugged/degraded terrain in the southern part of the study area near Tarsooma and Ban Kookra village. Lack of afforestation measures was observed in this area which falls under reserved forest zone. Generally ravine thorn forest is predominant in these forests with the species being local *Babool, Semul, Khejri, Phulai, Dhanja, Neem* and other shrubs. Blue bull, Wild boar, porcupine, spotted dear, squirrel, rabbit, nevla, jackal, various snakes and birds etc are found here in small numbers. Rapid deforestation due to anthropogenic cause and climatic factors like semi –arid condition have provided the impetus for loss of natural vegetation and biotic life.

The area under built up and non-agricultural has increased by 148 km^2 to 534 km^2 i.eabout 66.58 % of the study area. Visible reduction in natural vegetation particularly in the northern part of the study area near Kukandai, Pahari Kalan, Dungarwalaetc has led to the increase in area of built up category. An increase in size of all the towns (Khairagarh, Cheet, Tarbeejpuretc) and big villages in general has been observed due to assimilation and accreditation of the areas adjoining them or in their vicinity. Major removal of natural vegetation over the years has also led into the increase of barren and fallow topography. Considerable decrease in agriculture and water bodies is seen over a period of 13 years and they constituted 239km^2 and 05 km^2 respectively, which is about 29.80% and 0.62% respectively of the study area. Land lost in this category has been accredited in the built up and non-agricultural category.
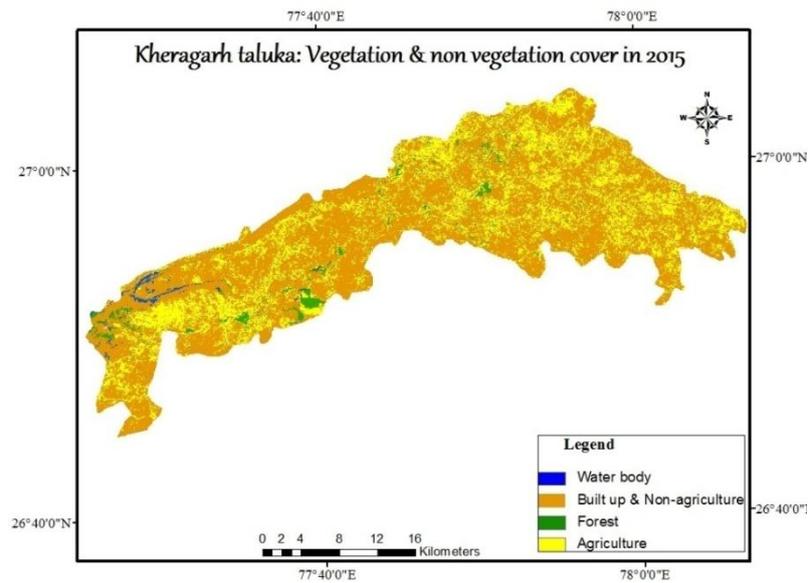
Fig 4: Vegetation & non vegetation cover in 2015

The **Change Detection analysis** is an efficient way of describing the changes observed in each land use category. Major decrease or change from vegetative class is observed from Fig 5.
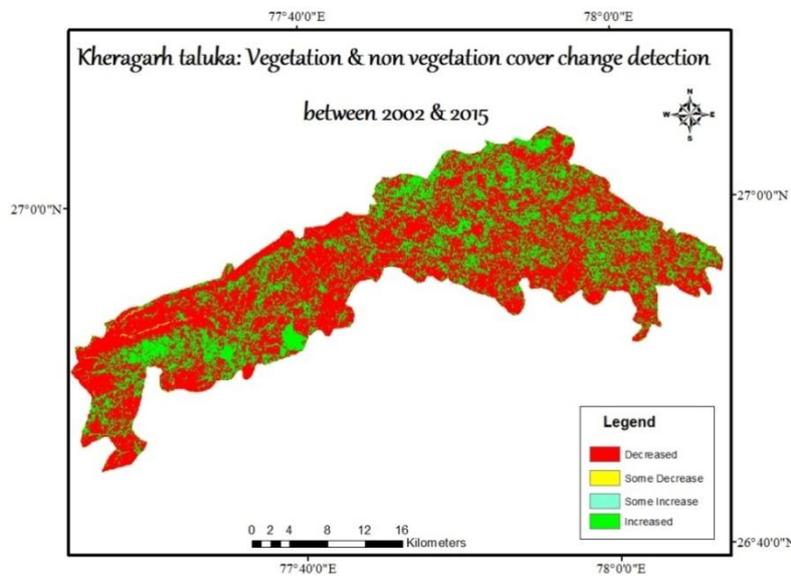

Fig 5:Vegetation and non vegetation cover change detection between 2002 & 2015

Normalized Difference Vegetation Index (NDVI)

Theoretically, NDVI threshold value ranges between -1 to +1. Measured value range from -0.35 (water) through zero (soil) to +0.6 (dense green vegetation). This research used NDVI based on the red band and near-infrared band of Landsat. The NDVI gave very good results in identifying forest areas for subsequent investigation and data collection during fieldwork (Fig 6 & 7). The result obtained through NDVI analysis only corroborates the result obtained from the supervised classification regarding substantial reduction in area of green vegetation/forest cover.Very low values of NDVI (0.1 and below) correspond to barren areas of rock, sand, or snow. Moderate values represent shrub and grassland (0.2 to 0.3), while high values indicate temperate and tropical rainforests (0.6 to 0.8) (John Weier et al, 1999).A marked reduction in the area having value >0.20 is observed during the study period as is evident from Table 2. In the study area, the NDVI value varies from 0.1 to 0.4.

Table 2: NDVI derived change statistics of the study area

NDVI Value based category	NDVI Value threshold	NDVI Value 2002 acres of category	NDVI Value 2015 acres of category
NIL to scanty Vegetation	<0.20	64,445	73,974
Low to Moderate Vegetation	0.20-0.40	11,055	5075
Moderate vegetation	>0.40	4564	1015

Source:Computed by the authors

NDVI 2002 & 2015 variations arepresented respectively in Fig. 6 & 7. The lowest values (<0.20) are found on the less vegetated soils, barren soils and uncovered soil, presumably because reflection fromthe soil is high, and produce low values in NIR band and high values in red band; hence the NDVI values are low. Medium values (0.2-0.3) indicate degraded grassland, shrub and scanty to low vegetation. Moderate values of 0.35-0.5 represents open mixed vegetation cover in the study area. NDVI of >0.50 has not been recorded in the study area proving the absence of moderately thick dense vegetation.
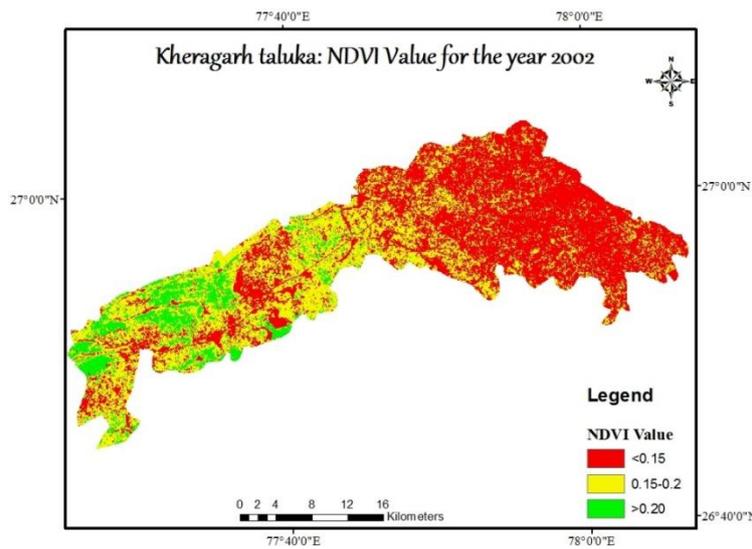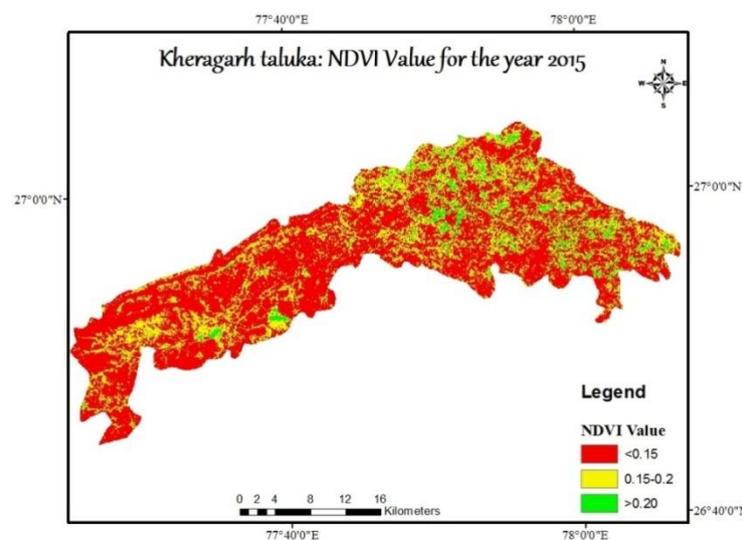

Fig 6:NDVI Value for the year 2002

Fig 7:NDVI Value for the year 2015

IV.   CONCLUSION

Change in forest cover of Kheragarh taluka of Agra district during 2002 to 2015 has been attempted in the present paper. The forest cover type in the study area generally includes open reserved forest, moderate mixed deciduous and open scrub land. Blue bull, Wild boar, porcupine, spotted dear, squirrel, rabbit, nevla, jackal, various snakes and birds etc are found in these forests. Through Supervised classification of Landsat TM and ETM, taken on 12 February, 2002 and 27 February, 2015 respectively, the area under forest cover in 2002 came at 116 Km^2 which drastically reduced to 24 Km^2 in 2015, i.e. a reduction of 92 Km^2 in 13 years. Through the change detection analysis, the area and extent of change was also observed. Major deforestation has occurred throughout the study area including the reserved forest zones. This research used NDVI based on the red band and near-infrared band of Landsat. The result obtained through NDVI analysis only corroborates the result obtained from the supervised classification regarding substantial reduction in area of green vegetation/forest cover. Three NDVI value threshold of <0.20, 0.20-0.40 and >0.40 were undertaken. A marked reduction in the area having value 0.20- 0.40 is observed during the study period along with minor reduction in area of the threshold of >0.40. However owing to increase in scanty and thorny vegetation, there is an increase in the area in the threshold category of <0.20. Thus widespread deforestation and shrinkage in forest area of Kheragarh taluka along with change of forest class is evident from this study.

This study examines the scientific basis for the use of remotely sensed data, particularly NDVI, in land degradation assessments at different scales and for a range of applications.

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