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Assessment of Environmental Changes Applying GIS Indexing Technique and Remote Sensing Data, District Chandauli, State of Uttar Pradesh, India

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ASSESSMENT OF ENVIRONMENTAL CHANGES APPLYING GIS INDEXING TECHNIQUE AND REMOTE SENSING DATA, DISTRICT CHANDAULI, STATE OF UTTAR PRADESH, INDIA

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Abstract

The monitoring of the environmental changes is the very necessary aspect of today to know about the pattern of the changes and its degradation. The rapid growth of population and urbanization creates many environmental changes in several years. The remote sensing indexing techniques are used to assess and to know the changes of environmental aspects as land, water and vegetation etc. The changes of land use land cover are good indicators of the environmental change. The paper highlights the temperature variation of land surface temperature of three consecutive decadal periods of Chandauli district. NDVI is also helpful for the study of vegetation analysis while NDWI is used for the identification of water suitability zones. NDBI indicates the built up index and settlement of the study area. The result indicates that the land use land cover changes (LULC) within the year of 2000 to 2010 and 2019 by its natural and man-made activities. The water bodies decreased in 2019(2.1%) in comparison of 2000 to 2010(3%). The highest crop land is indicated in 2000(53%) it's decreased in 2010(28.6%) dew to incising order of fallow land in 2010(40%). Built up index also indicates the changes in settlement of urban and rural areas in 2019 (13.5%) in comparison of 2010(1.6%).

Keyword: NDVI, NDWI, NDBI, LST, Environmental change

1. Introduction

The word Environment is derived from the French word "environ". The meaning of the French word is related to "encompass" "encircle". It is given by biologist Jacob Van Erkul in the early 1900s. Environment is defined as the surroundings in which an organization operates including air, water, land and natural resources, flora, fauna, humans

and their relations-ISO Definition. The term Environment has been defined under section 2(a) of Environment protection Act (1986) to include water, air, land and inter-relationship between water, air, land and human beings other living creatures, plants, microorganisms and property.(Donoghue, 2002) has explain the relationship of the remote sensing and environmental change progress in physical geography. There are two types of environment 1. Physical environment 2. Cultural environment. Physical environment is the whole complex of the climatic (water, air), edaphic (land) and biotic factors (man, animal) that act upon an organism or ecological community and ultimately determine its form and survival. (McFeeters, 2013) has studied about Normalized Difference Water Index (NDWI) within a Geographic Information System to Detect Swimming Pools for Mosquito Abatement .The cultural environment is the aggregate of social and cultural conditions that influence the life of community**. (**Douglas & Lewis, 2007) recognize that land degradation has five main component soil degradation, vegetation degradation, water degradation, climate deterioration and losses of urban/industrial development. (Sekertekin & Bonafoni, 2020) has undertaken the Land Surface Temperature Retrieval from Landsat 5, 7, and 8 over Rural Area with the help of Retrieval Algorithms and Emissivity Models and Toolbox.

Environmental change detection is the process of detecting the changes in the state of an object or phenomenon by observing it at different time (Singh, 1989) In the research topic we should use the term 'change' it means physical change, climatic and vegetation change, soil change, water change, forest change and land use change of the environment .(Turner, 1994) says that land use and land cover change has been recognized as an important driver of the environmental change on all spatial and temporal scales. (Vink, 1975) says that the land is the most important natural resource which embodies soil, water and associated flora and fauna involving the total ecosystem, whereas the land use has been defined as 'the expression of man's management of ecosystem in order to meet some of his need. (Meyer et al., 2020) has undertaken the land Degradation Nexus in Mediterranean Landscapes and also described the land use land cover pattern and keys of his site. Chandauli district lies in the southwest part of Uttar Pradesh and it is situated in the upper Vindhayan range and lower plane range. (Roy et al., 2016) has described the Landsat 7 and Landsat 8 satellite character and also elaborate the use of satellite imagery in the field of NDVI. In the district there is the need to assist the environmental change of some of these important aspects. Soil, water, forest, land use. Human behaviour and responses for the environment.

In environmental change assessment remote sensing plays an important role to know about the present scenario of any area. (Kumar, 2015) has studied Remote Sensing based Vegetation Indices Analysis to Improve Water Resources Management in Urban Environment. We should use the remotely sensed data for analysing purpose, assessment purpose and visualization purpose of the given real world features in the data. Remote sensing is the collection of information about earth surface and phenomenon using sensor not in physical contact with surface and phenomenon of interest. (Akinyemi, et al., 2019) has carried Land cover change effects on land surface temperature trends in an African urbanizing dry land region and also determine the relationship in between Lu/Lc and LST. Remote sensing includes the mission plan and choice of sensors, the reception recording and processing of signal data and finally the analysis of the resultant data. The remote sensing image are analysed frequently for a variety of application ranging from land cover classification, change detection, water quality monitoring, measurement of sea surface temperature, snow survey, monitoring of atmospheric constituents of geological interpretation, among these applications. (Lv & Zhoua, 2011) has studied about Utility of Landsat Image in the Study of Land Cover and Land Surface Temperature Change with the advent of high spatial resolution satellite images, the change detection using multispectral multi temporal land set images has been an important field of research. Remote sensing is defined as collection and interpretation of information about the environment and the surface of the earth from distance, primarily by sensing radiation that is naturally emitted or refracted by the earth's surface or from the atmospheric, or by sending signals transmitted from a satellite and refracted back to it (ESRI Press Dictionary of GIS Terminology, 2000). Remote sensing and GIS has been used for analysis and measurement of potential of surface water resource. (Jianga, & Tiana, 2010) has studied about the Analysis of the impact of Land use/Land cover change on Land Surface Temperature with Remote Sensing. It has been used for soil and mineral characterization. Remote sensing has also been used for the analysis and assessment of the land use land cover change for the past three decades in the study of geography.

2. MATERIAL AND METHODS

2.1 Study Area

Chandauli district is situated in the eastern most part of the state of Uttar Pradesh. Chandauli was a tehsil of Varanasi district but it was created on newly constituted May 1997

district. It stretches from 24°44’56”N to 25°38’44”N latitudes and 83°104” E to 83°33’19” E longitudes. The northern limit of the chandauli is Ghazipur district. Whereas the north-western part of the Chandauli district made by Varanasi and Mirzapur district. Southern boundary of study area delineated by Sonbhadra and in the eastern boundary is division of Bihar and Uttar Pradesh. The district north-south length is 82.5 km and west-east length is the 50 km. whereas area of the district is 2541 sq. km. The district consist the plane and hills plateau area. In the district Ganga is the main river flows in the northern and western part and Kermanshah River make a boundary of the south eastern part of the district. Garai and Chandraprabha River is also a part of the hill plateau region of the district. There is the four tehsil in the district Sakaldiha, Chandauli, Mugalsarai, Naugarh which is further divided into nine development blocks in the district i.e. Dhanapur, Sakaldiha, Barahani, Chandauli, Niyamtabad, Chakia, Chahniya, Sahabganj and Naugarh. Total population of district is 1,952,756 rural population is the 1,710,203 and urban population is the 242,553.

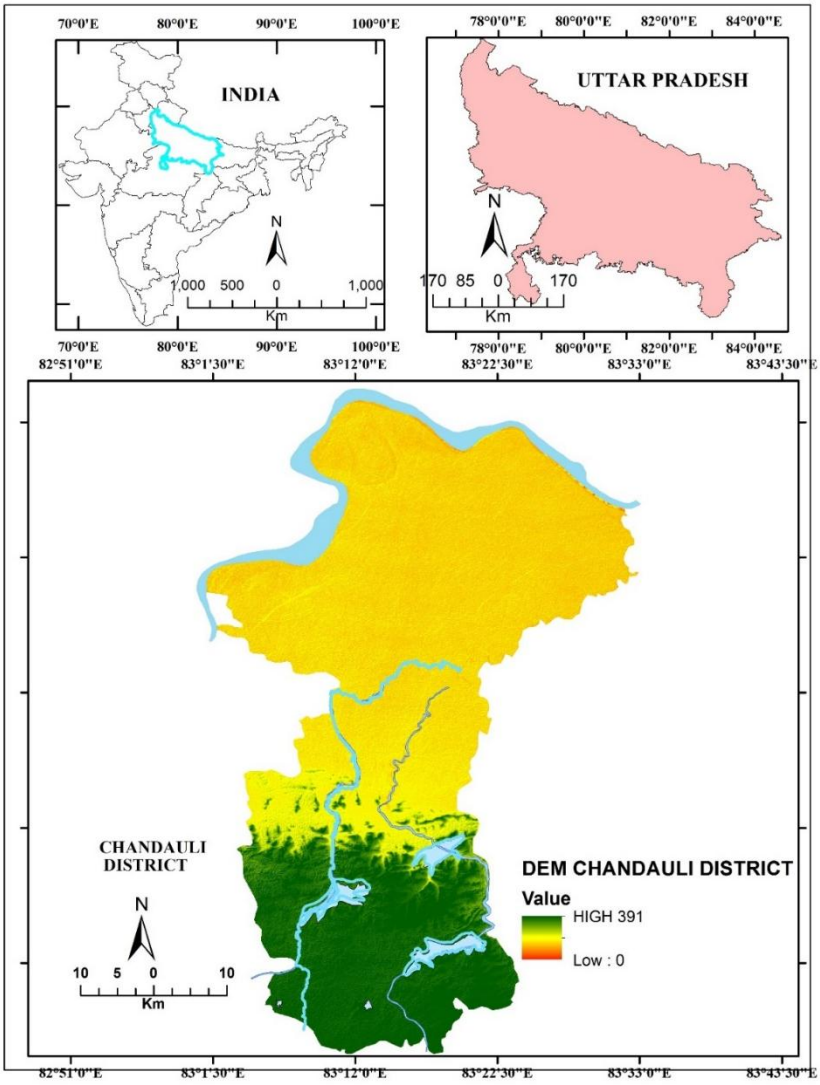

Figure 1. Location Map of Study area

2.2 Methodology

Remote sensing and geographical information system is very good and simple handling software to analyse and assessment the environmental monitoring. To know about the changes, the Landsat 5 TM and Landsat 8 operational Landsat imagery of 2000, 2010 and 2019 has been downloaded from the USGS (United States geological survey). Landsat path 143 and row 42, 43 cover the chandauli district. The UTM universal transvers Mercator projection and WGS 82 datum has been used for the satellite data. The Landsat data also cloud and distortion free and the pixel size of the image is 30×30 m. supervised maximum likelihood methods has been used for the analysis of the land use land cover changes of the present and previous patterns of its 9 categories. After the supervised methods NDVI normalized difference vegetation index, NDWI normalized difference water index, NDBI

normalized difference built up index and LST land surface temperature has been used for the analysis and know about the changes of these categories.

3. **Analysis and Finding**

Assessment of environmental changes by the help of remote sensing technique is very help full for the mapping and monitoring the environment of its deferent aspects like NDVI, NDBI, NDWI and LST. The changes of NDVI is direct relationship in between land surface temperature and normalized deference built up index. LST and built up index have strong positive relationship in compression of NDWI. The Landsat data series land sat 5 and Landsat, 8 has been play an important role to identify and analysis the current patterns of land use and also helpful in the mapping of environmental changes. In this study Landsat 5 data of 2000, 2010 and Landsat 8 data of 2019 ware used for the analysis of environmental changes.

3.1 Land Use Land Cover Change Detection

Land use land cover mapping is use full for to know about the current pattern of the land use of chandauli district. Maximum likelihood supervised methods ware used to produce the land use land cover map of the year of 2000, 2010 and 2019.The result from classified map indicated that in 2000 (Figure.2) are occupied by different classes such as water bodies 2.1%, sand 0.66%, crop land covered by 53.0% built up land 0.12%, fallow land 6.9%, waste land 12.87%, and dense forest 3.2%, open forest that is the largest part of occupied land as a forest 17.2% and scrub forest 3.7%. in the other hand in 2010 (Figure.3) the result from occupied supervised classes such as water bodies 3.0% sand 0.9% crop land 28.67% built up land 1.06% fallow land is the largest occupied land 40.45% waste land 4.0% dense forest 4.1% open forest11.58% and scrub forest 6.05% (Shown in Table 1).

The images of supervised land use and land cover of the year 2000 and 2010 are clearly shown the changes of built up land that is 0.12% in the year of 2000 and its increases to 2010 in 1.06% due to rapid growth of population whereas crop land is decreases in compression of the year 2000(53%) to the year of 2010(28.67%) due to sessional variations of cropping pattern and sessional variation also indicate the changes of fallow land in 2010(40.45%). The changes of forest dense, forest open, and forest scrub in the year of 2000 to 2010 are 3.2%, 17.2%, 3.7%, forest dense increases as 4.1%, open forest decreases to the compression of 2000 satellite data as 11.5%, scrub forest increases in 2010 in compression of 2000 data 6.05%.

3.2 Land use land cover change for the 2010 to 2019

The major changes of 2010 to 2019 , water bodies 3.0% to 2.1% it's indicate that water bodies decreases in 2019. Built up land is the highest land occupied categories in 2019, 13.5% in compression of 2010 and open forest also increasing 11.5% to 19.55 % in 2019. Sand , crop land , fallow land , waste land , dense forest , and scrub forest decreases 4.9 %, 26.5,% 25.2%, 0.27 %, 2.5 % , 5.07% respectively. Table 1. Show the total changes of land use from 2000 to 2019 in percent.

The Total changes of the land use land cover categories from the year of 2000 to 2019 in the chandauli district according to the satellite data water bodies 0.04%, sand 4.32%, crop land 26.48%, built up land 13.43%, fallow land 18.31%, waste land 12.59%, dense forest 0.67%, open forest 2.33% , scrub forest 1.32 % respectively.

Table 1: Total Changes of Land use from the year of 2000 to 2019

Class	Area_2000 (%)	Area 2010 (%)	Area 2019 (%)	Changes From 2000_2019 (%)
Water bodies	2.10	3.00	2.15	0.04
Sand	0.66	0.98	4.96	4.30
Crop Land	53.05	28.67	26.57	26.48
Built Up Land	0.12	1.06	13.55	13.43
Fallow Land	6.95	40.45	25.27	18.31
Waste Land	12.87	4.05	0.27	12.59
Dense Forest	3.22	4.11	2.55	0.67
Open Forest	17.24	11.58	19.57	2.33
Scrub Forest	3.74	6.05	5.07	1.32

Source: Calculated by the Author Based on Land use map 2000, 2010 and 2019

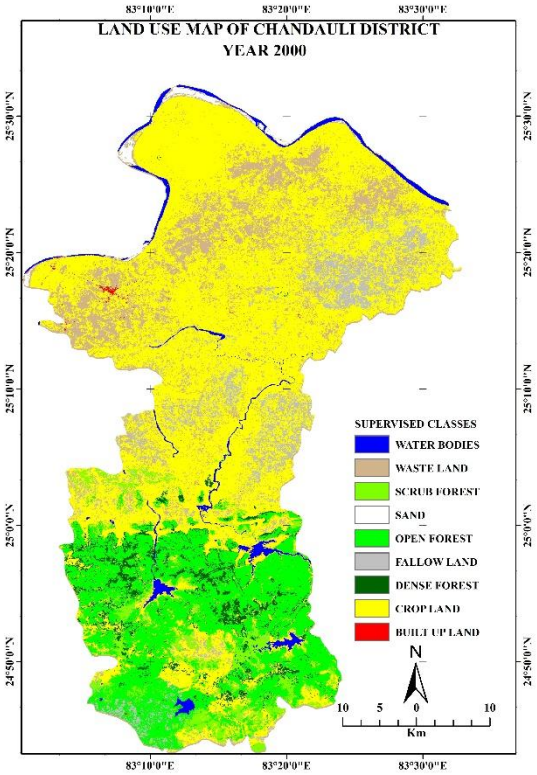

Figure 2. Land use Map of 2000

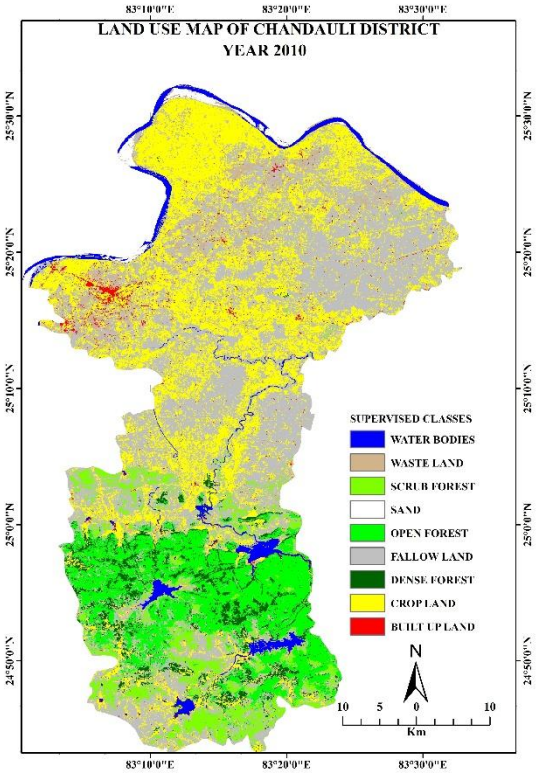

Figure 3. Land use Map of 2010

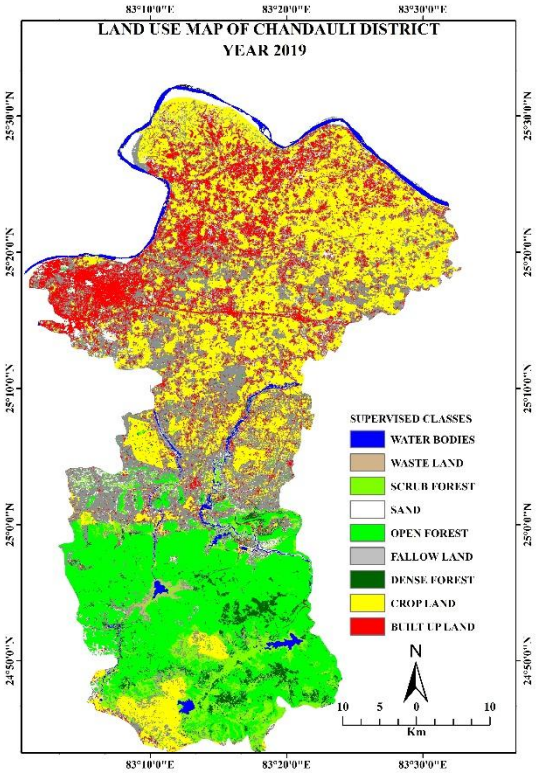

Figure 4. Land use Map of 2019

3.3 Change Detection by the Indexing Techniques

The indexing technique are the most use full methods in remote sensing it's demarked the changes in the surrounding environment by its shape, size and tone of the analysis map. The indexing technique is the automated technique that act upon the arc GIS tools and technique by the Arc GIS software. Normalized vegetation different index is most important automated technique that help in the analysis of the different type of the vegetation cover. NDBI, NDWI and LST these are some indexing technique used in this study for the environmental changes.

3.4 NDVI

Normalized difference vegetation index is the numerical indexing technique that uses the near- infrared and visible bands of the electromagnetic spectrum. NDVI mainly indicate the vegetation cover such as crop yield, forest and other agricultural land. Theoretically NDVI values are represent the values from -1 to 1 but on the mapping negative values represent the water bodies' values around the zero represent rocky and bare soil. The values of over the 6 represent dense vegetation or green vegetation.

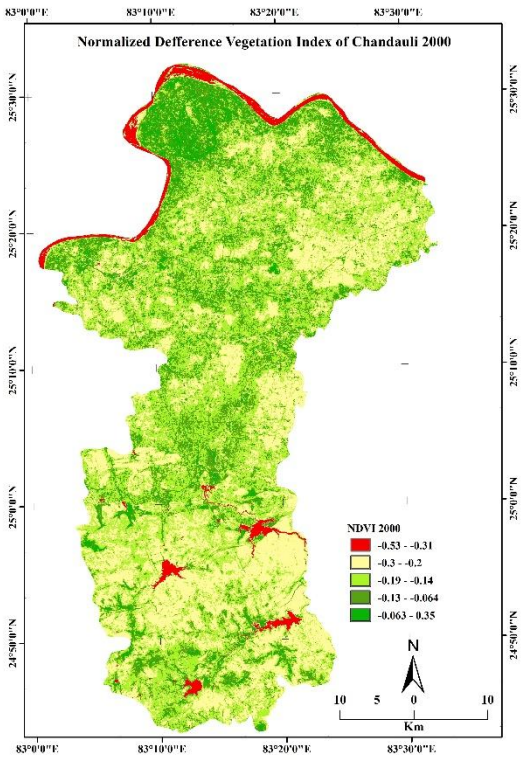

Figure 5. NDVI Map of 2000

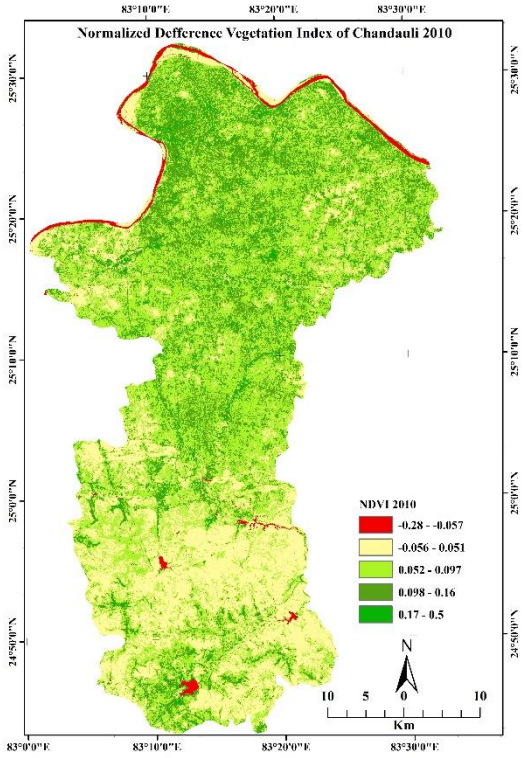

Figure 6. NDVI Map of 2010

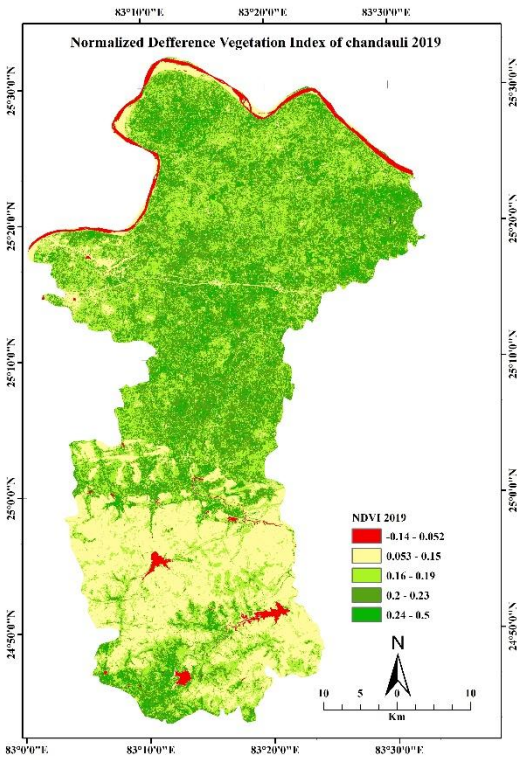

Figure 7. NDVI Map of 2019

For the year of 2000(Figure.5) the NDVI values is 0.063 to 0.35 represent the vegetation dense cover area and the value of 2010(Figure.6) is 0.17 to 0.5 represent the dense vegetated area, on the other hand in 2019 the highly vegetated area value is 0.24 to 0.5. On the map (Figure.7) the red colour shows the water bodies that indicate the negative value of the NDVI. The light pink colour is indicate the rocky land, bare soil and built up land of the above NDVI map. The yellow to dark green colour and values of 0.19 to 0.35, 0.052 to 0.5 and 0.16 to 0.5indicates the less vegetation cover to healthy vegetated area of 2000 to 2019.

3.5 NDBI

Normalized difference built up index is used for the identification of built up land that may be man-made or natural aspect like, rock land, bare soil. NDBI also help for the mapping of the building information or urban areas extracting. The bare land surface or less vegetable area shown in the NDBI images red colour it's an also a symbol to know about the natural aspect. The value of NDBI is 0 to +1 represent the built up area, non-covered area or bare soil area and rocky waste area. The value of 0.3 to 0.36 and 0.37 to 0.67 are indicate the highest built up index in the year of 2000(Figure.8) the value of 0.30to 0.36 is indicate the settlements and 0.37 to 0.67 is shown the rocky waste land it's a part of the built up land material that is situated in between of open forest of the study area. The value of 0.27 to 0.32, 0.33 to 0.7 and

the value of 0.0069 to 0.071, 0.072 to 0.19 are the highest built up index shown in the year of 2010(Figure.9) and 2019(Figure.10).

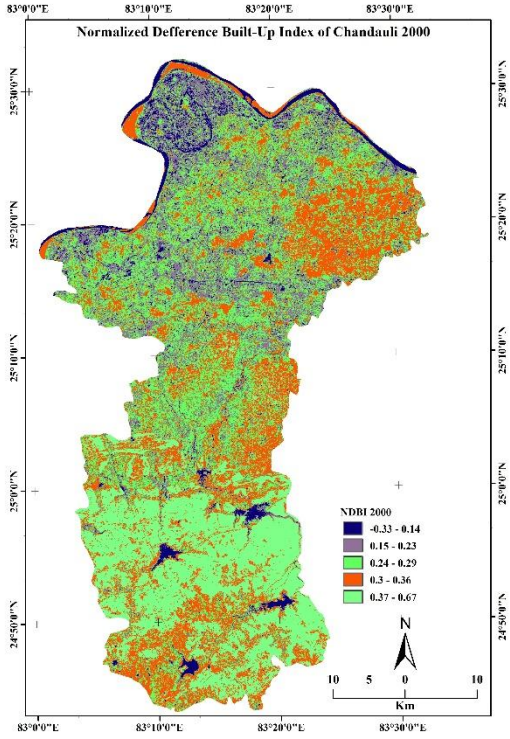

Figure 8. Built up index of 2000

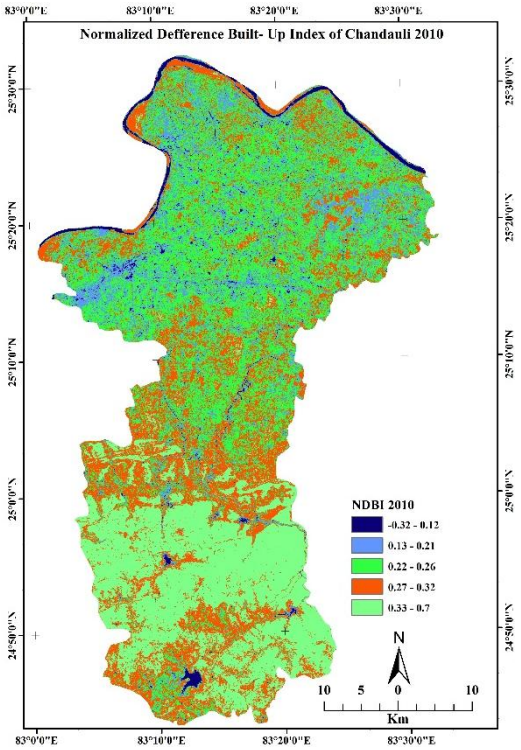

Figure 9. Built up index of 2010

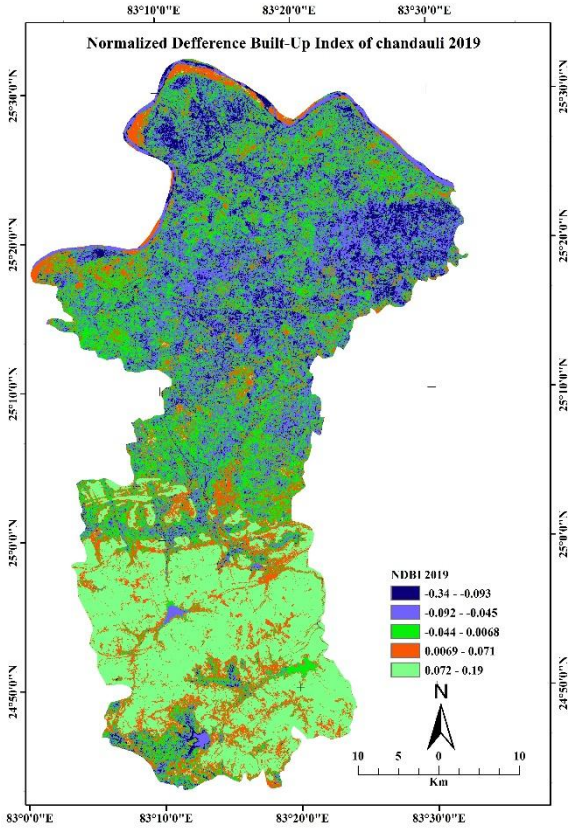

Figure 10. Built up index of 2019

3.6 NDWI

Normalized difference water index is calculated from the three deferent images that is 2000, 2010 and 2019 downloaded by USGS earth explorer Landsat data series. NDWI used to identify the good water zone in compression of vegetation land. NDWI show the opposite results of the NDVI.

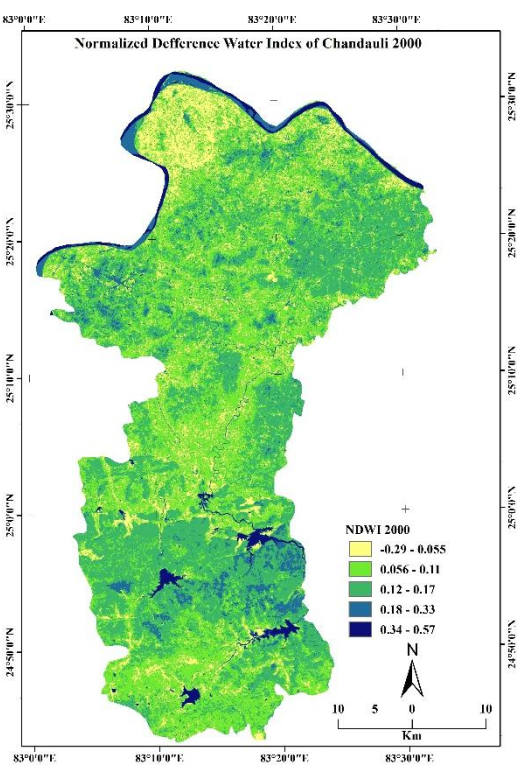

Figure 11. NDWI Map of 2000

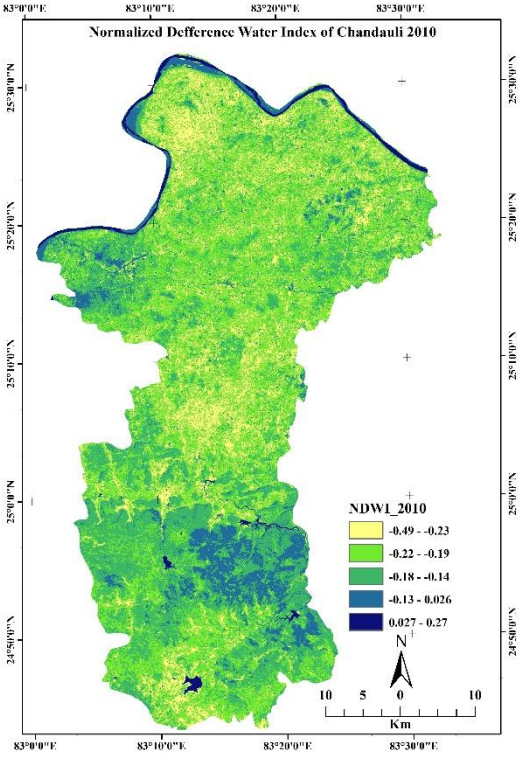

Figure 12. NDWI Map of 2010

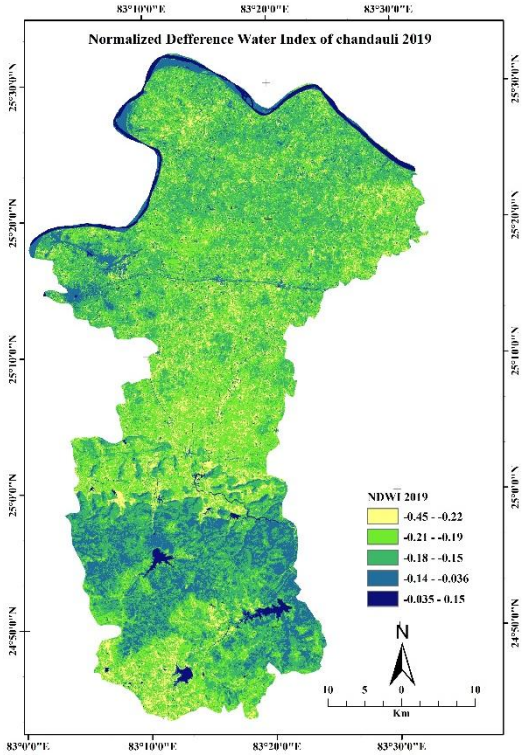

Figure 13. NDWI Map of 2019

The values of -0.29 to 0.055, -0.49 to 0.23 and -0.45 to -0.22 indicates the built-up land or rocky land in the Image of 2000(Figure.11), 2010(Figure.12) and 2019(Figure.13) separately. The values of 0.18 to 0.33, -0.13 to 0.026 and -0.14 to 0.036 are the good water bodies' area of the district.

3.7 Land Surface Temperature

The land surface temperature is the indicator of environmental changes and climate changes of the several year. The influences of human and decreases of the land, water and forest the environmental temperature increasing. The preparation of LST thermal band firstly converted in to the spectral radiance there after brightness temperature. The computed land surface temperature map of 2000, 2010 and 2019 has been shown in Figure. 14, 15and 16. The analysis of LST in the year 2000(Figure.14) the temperature Value show range in between 24°C to 37°C and 2010(Figure.15) 22°C to 37°C. The value range of 2019(Figure.16) is show the maximum temperature 25°C to 45°C. The average minimum temperature of 2000 to 2019 is 3°C and maximum average temperature increases of the total area in 2000 to 2019 is 8°C. The some southern part of the district is having more temperature dew to rocky waste, plateau and bare soils also a dominant factor to increase the temperature of southern part of the district.

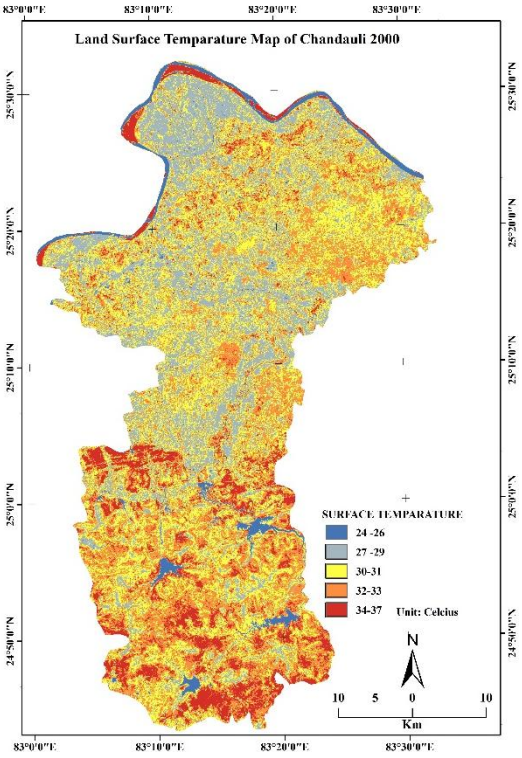

Figure 14. LST Map of 2000

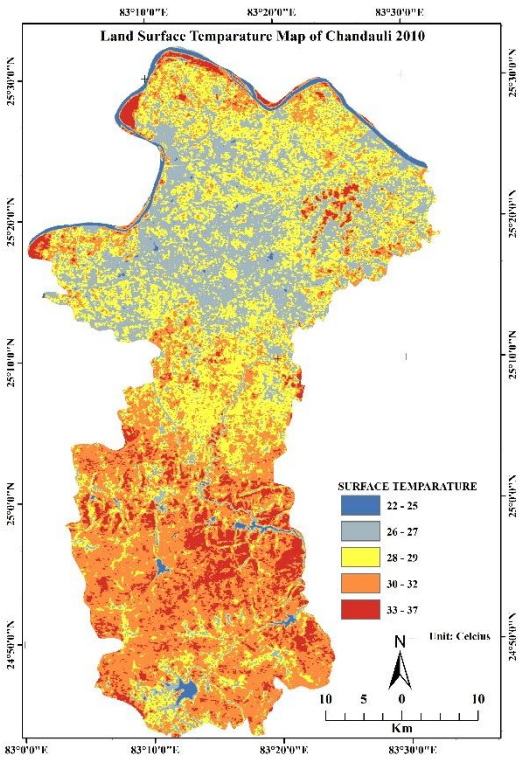

Figure 15. LST Map of 2010

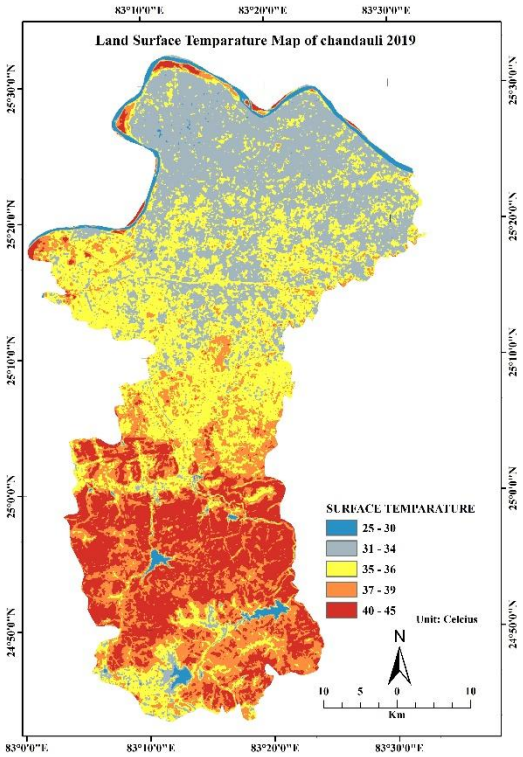

Figure 16. LST Map of 2019

4. Conclusion

The assessment of environmental changes by the help of remote sensing indexing technique are very use full to know about the changes of lands, water bodies and increasing order of settlements. Land use and land cover by the supervised maximum likelihood technique is also delineate the present changes of the study area. The technique of Normalized difference vegetable index shown the changes in vegetation cover of the chandauli district by its positive or negative pattern. The normalized difference built up index shown the pattern of changes in urban and rural settlements of the year 2000 to 2019. NDWI delineate the water suitable area in compression to the NDVI of the chandauli district. The land surface temperature of the study area deucedly increased by the human influence in forest cover mitigation and rapidly increasing by the built up land.

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