

Change Detection Analysis in Vegetation Cover Using Remote Sensing and GIS for Nowboicha Revenue Circle of Lakhimpur District, Assam

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Abstract: In the today's changing world, there are many major disquieting problems which have been influencing to degrade the natural resources. Degradation of vegetation cover is one of such problems. The landuse/land cover change and change in vegetation cover are mainly due to tremendous pressure on available land. To detect the change in vegetation cover of an area, the remote sensing and Geographic Information System (GIS) techniques are the best and reliable sources now-a-days. Normalized Difference Vegetation Index (NDVI) is one of vegetation indices which help to determine the spatio-temporal changes of vegetation cover. The present study tries to understand the changes of vegetation cover of Nowboicha Revenue Circle of Lakhimpur district of Assam from 2001 to 2021. Multi-temporal satellite imageries of USGS have been used for the study. Landsat 7 ETM of 2001 and Landsat 8 OLI/TIRS of 2021 have also been used. ERDAS Imagine (9.1) and ArcGIS (10.4.1) have been used to process the data. The range of NDVI values in 2001 image from +0.56 to -0.28 and in 2021 from +0.55 to -0.11. From the study it is found that healthiest and dense vegetation cover found towards the North of the Nowboicha Revenue Circle because of the presence of Ranga reserve forest and Arunachal Himalayas. Apart from the dense forest, the maximum area of the revenue circle experienced by low vegetation cover or bare land.

Keywords: *Change Detection, Vegetation Cover, NDVI, Remote Sensing, GIS.*

I. INTRODUCTION

People, place and time is interlinked with each other. If one changes, the other one is bound to change. Therefore, with the changing of time, population increases. When population increases, the change is certain to an area which leads to so many changes of the surface of the earth and phenomena. The natural resources have been degrading with the increase of population in the world. Because the vegetation cover which act as a green shield of the earth surface has been exploring by human as passing time to

fulfil their daily requirements. So, change detection of vegetation cover of a place is critical component of environmental monitoring and management. This necessity arises from the need to understand the dynamics of ecosystem health, biodiversity and landuse practices over time.

In recent decades Remote Sensing and Geographic Information Systems (GIS) have emerged as powerful tools proving extensive high-resolution satellite imagery and advanced spatial analysis tools. Remote sensing captures detailed data on vegetation over large area, while GIS processes and visualizes these data to identify and analyse changes over time. One key metric used in this process is the Normalized Differenced Vegetation Index (NDVI) which quantifies vegetation health by measuring the difference between Near-Infrared (NIR) and red band reflected by vegetation. NDVI enables precise monitoring of vegetation dynamic, allowing for timely detection of changes, informing conservation strategies and supporting sustainable land management practice.

The present study aims to analyse the change detection of vegetation cover in Naoboicha Revenue Circle using NDVI for better environmental management and conservation efforts.

1. Objectives

The main objectives of this study are

1. To understand the vegetation cover of Nowboicha Revenue Circle.
2. To analyse the Changes of NDVI of Nowboicha RC from 2001 to 2021.
3. To prepare the spatio-temporal change detection map of NDVI.

II. MATERIALS AND METHODS

a. Study Area

Nowboicha Circle extends from 27°0' 42" N to 27°19'22" N latitude and 93°52'40" E to 94°5'50" E longitude. It shares boundary with Bihpuria revenue

circle in the West, Arunachal Pradesh in the North and North Lakhimpur revenue circle in the East and South. Nowboicha Circle has a total population of 148,973 as per the Census 2011. Out of which 75,537 are males while 73,436 are females. The Sex

Ratio of Nowboicha Circle is 972. Thus, for every 1000 men there were 972 females in Nowboicha Circle. The total literacy rate of Nowboicha Circle is 69.95%. The male literacy rate is 63.27% and the female literacy rate is 51.45% in Nowboicha Circle.

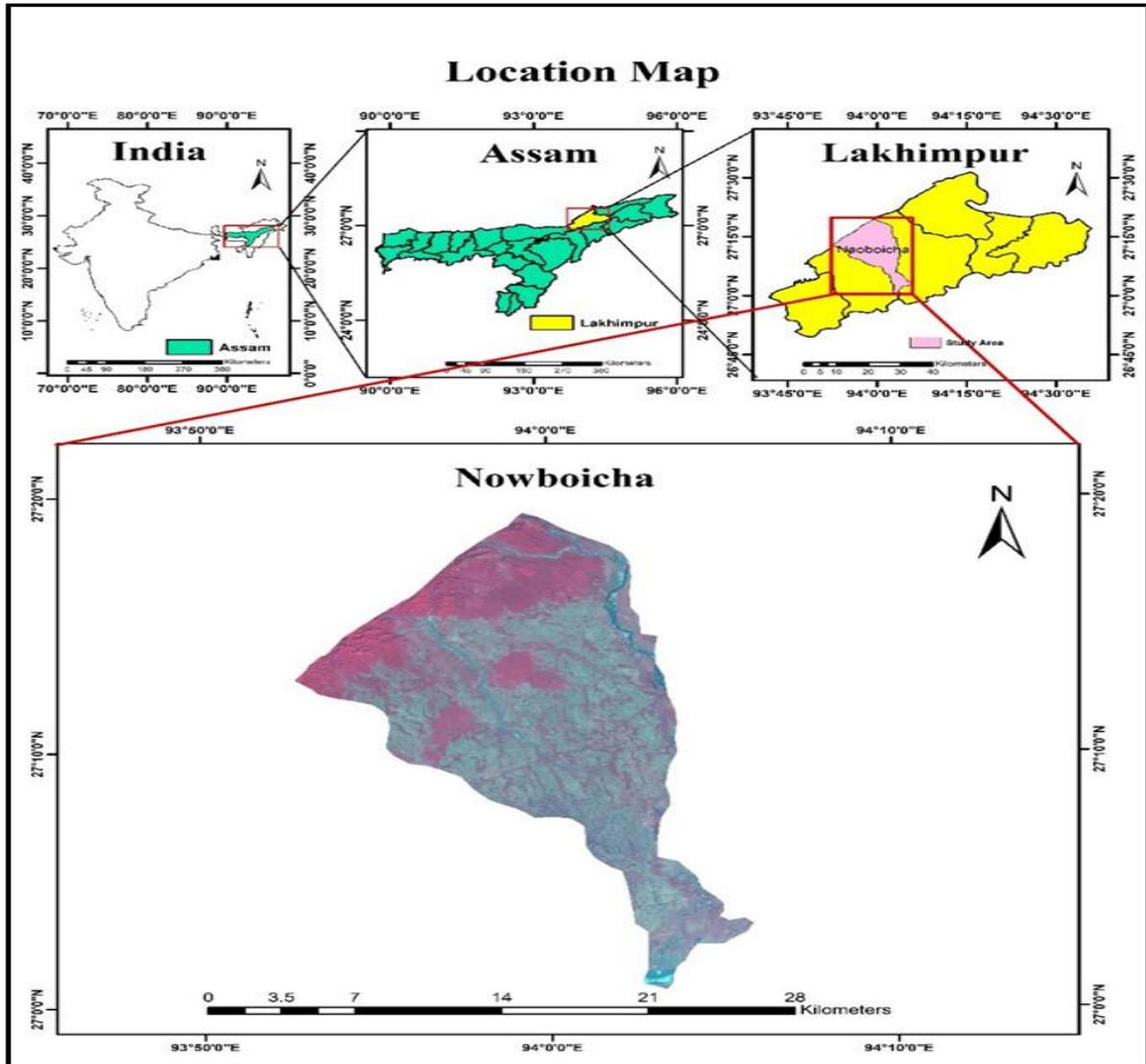


Fig. 1: Location Map, Nowboicha Revenue Circle

b. Materials

For this study to analyse the NDVI of Nowboicha Revenue Circle firstly two satellite imageries were downloaded from the United States Geological Survey. Landsat 7 ETM+ and Landsat 8 OLI/TIRS satellite images were selected for the year of 2001 and 2021 respectively, which has less than 10% cloud cover. Both images have 30 m spatial resolution.

Table I: Details of the satellite data used for NDVI Analysis in this study

Year	Satellite Sensor	Spatial Resolution	Path	Row	Date	Source
2001	Landsat 7 ETM+	30m	135	41	01-12-2001	USGS
2021	Landsat 8 OLI/TIRS				14-11-2021	

c. Methods

For data acquisition and processing ERDAS Imagine (9.1) and ArcGIS (10.4.1) Softwares are used. To detect the vegetation cover change, Normalized Difference Vegetation Index (NDVI) technique is applied. Near Infrared (NIR) and Red

(R) band are extracted from the multi-temporal satellite imageries of 2001 and 2021. After the extraction of required bands, the NDVI is calculated using the following formula for both imageries.

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

The NDVI value ranges from -1 to +1.

-1 to 0 indicates water, snow and cloud.

0 to 0.2 indicates built up, barren land and rock or soil cover.

0.2 to 1 indicates less vegetation cover to highly dense vegetation.

After the calculation of NDVI, both images are further classified in six classes. The six classes are commonly used because they provide a balanced and detailed representation of vegetation conditions, allowing for better analysis and interpretation. J.W. Rouse et. al., developed the NDVI index in 1973.

A change detection map and highlight change detection map is prepared to know, whether the area undergo the process of increased, decreased or remain unchanged from 2001 to 2021.

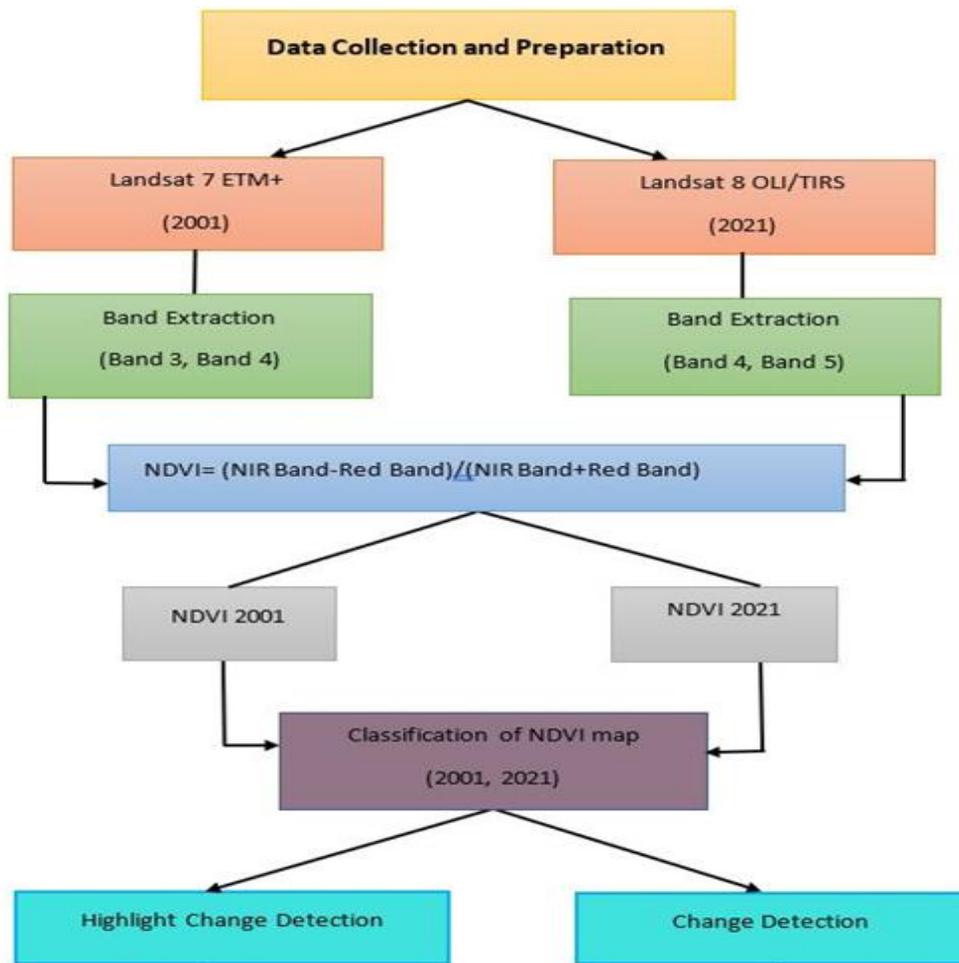


Fig. 2: Methodology Flow Chart

III. RESULTS AND DISCUSSION

a. Spatio-temporal distribution of Vegetation Cover of Nowboicha Revenue Circle (2001-2021)

The calculated range of NDVI values in 2001 image varies from -0.28 to +0.56 and in 2021 from -0.11 to +0.55 in Nowboicha Revenue Circle. The values have divided into six classes i.e., no vegetation, less

vegetation, less to moderate vegetation, moderate vegetation, dense vegetation and lastly highly dense vegetation. As shown at the table 2, the area of no vegetation cover increased during the two decades of time i.e., 7.49 sq. km. to 12.8 sq. km., which indicates that the area of water body has increased.

The less vegetation area has reduced drastically. The area undergone changes from 75.62 sq. km. to 42.98 sq. km. from 2001 to 2021. The less to moderate type

of vegetation is also decreased from 79.65 sq. km. to 67.91 sq. km. The area of moderate vegetation cover has increased by about 10 sq. km. which is 56.55 sq. km. to 65.96 sq. km. The dense vegetation cover has experienced the positive changes too, i.e., from 41.64 sq. km. to 50.11 sq. km. The highly dense vegetation cover increased by more than 20 sq. km.

i.e., from 30.33 sq. km. to 51.13 sq. km. The dense and highly dense vegetation have increased because the Forest Department and Joint Forest Management Committee (JFMC) planted trees in Ranga Reserve Forest, positioned between Ranganadi and Dikrong river.

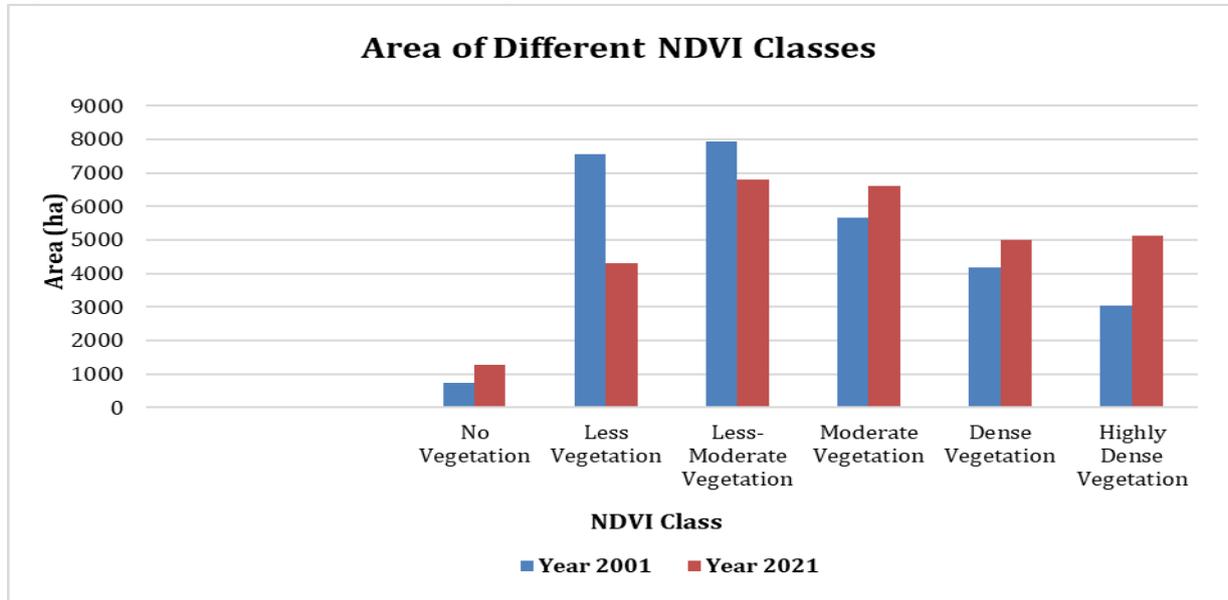


Fig. 3: Area of Different NDVI Classes in hectares for 2001 and 2021

b. Vegetation change Detection Analysis of Nowboicha Revenue Circle (2001-2021)

Based on the NDVI map of both 2001 and 2021 images, a vegetation change detection analysis has computed highlighting whether the area of the vegetation cover has undergone to the way of change or not. So basically, the map of NDVI: highlight change detection analysis and vegetation change detection (figure 6 and 7 respectively) show the overall increased, decreased and unchanged area of vegetation cover of the present study area. In the

vegetation change detection analysis out of the total area (which is 290.92 sq. km.) of Nowboicha revenue circle, 59.93 sq.km. area has increased, 39.96 sq. km. has decreased and 190.32 sq. km. of vegetation cover remain unchanged. It's mainly due to the presence of Ranga Reserve Forest and three notable tea gardens i.e., Dejoo tea Estate, Dolohat tea estate and Silonibari tea garden which located at Dejoo. Dolohat Sonapur area and Singra area respectively.

Table II: Distribution of NDVI of Nowboicha Revenue Circle (Year 2001 & 2021)

Vegetation Cover	Year 2001				Year 2021			
	NDVI Values	Area (ha)	Area (Sq. Km)	Area (%)	NDVI Values	Area (ha)	Area (Sq. Km)	Area (%)
No Vegetation	-0.28 – -0.02	749.43	7.49	2.57	-0.11 – 0.11	1280.2	12.8	4.40
Less Vegetation	-0.02 – 0.09	7562.94	75.62	25.99	0.11 – 0.21	4298.6	42.98	14.77
Less-Moderate Vegetation	0.09 – 0.17	7925.8	79.25	27.24	0.21 – 0.26	6791.69	67.91	23.34
Moderate Vegetation	0.17 – 0.26	5655.75	56.55	19.44	0.26 – 0.32	6596.39	65.96	22.67
Dense Vegetation	0.26 – 0.36	4164.45	41.64	14.31	0.32 – 0.39	5011.53	50.11	17.22
Highly Dense Vegetation	0.36 – 0.56	3033.85	30.33	10.43	0.39 – 0.55	5113.82	51.13	17.58
Total	-0.28 – 0.56	29092.22	290.92	100.0	-0.11 – 0.55	29092.23	290.92	100.0

Table III: Vegetation Change Detection Analysis of Nowboicha R.C. (From 2001 to 2021)

Vegetation Change Detection	Area (ha)	Area (Sq. Km)	Area (%)
Increased	5993.57	59.93	20.65

Decreased	3996.92	39.96	13.77
Unchanged	19032.75	190.32	65.58

The analysis of NDVI values across the Nowboicha Circle revealed that areas under dense and highly dense vegetation, particularly forested and perennial plantation zones, consistently exhibited higher NDVI values. Notably, the Ranga Reserve Forest recorded the highest NDVI, reflecting its relatively undisturbed and dense forest cover. In addition, tea gardens such as Dolohat, Silonibari and Dejoo also showed elevated NDVI values due to their evergreen canopy, systematic planting of shade trees and continuous vegetative maintenance leads to strong

reflectance in the near-infrared (NIR) spectrum- an indicator of dense and healthy vegetation. These findings are validated by the fig. 6 & 7, highlight change detection map and change detection map, which distinctly marks Ranga Reserve Forest and these tea estates as NDVI hotspots. The results indicate that, alongside natural forested areas, well-managed tea plantations significantly contribute to maintaining vegetation health and density in the region.

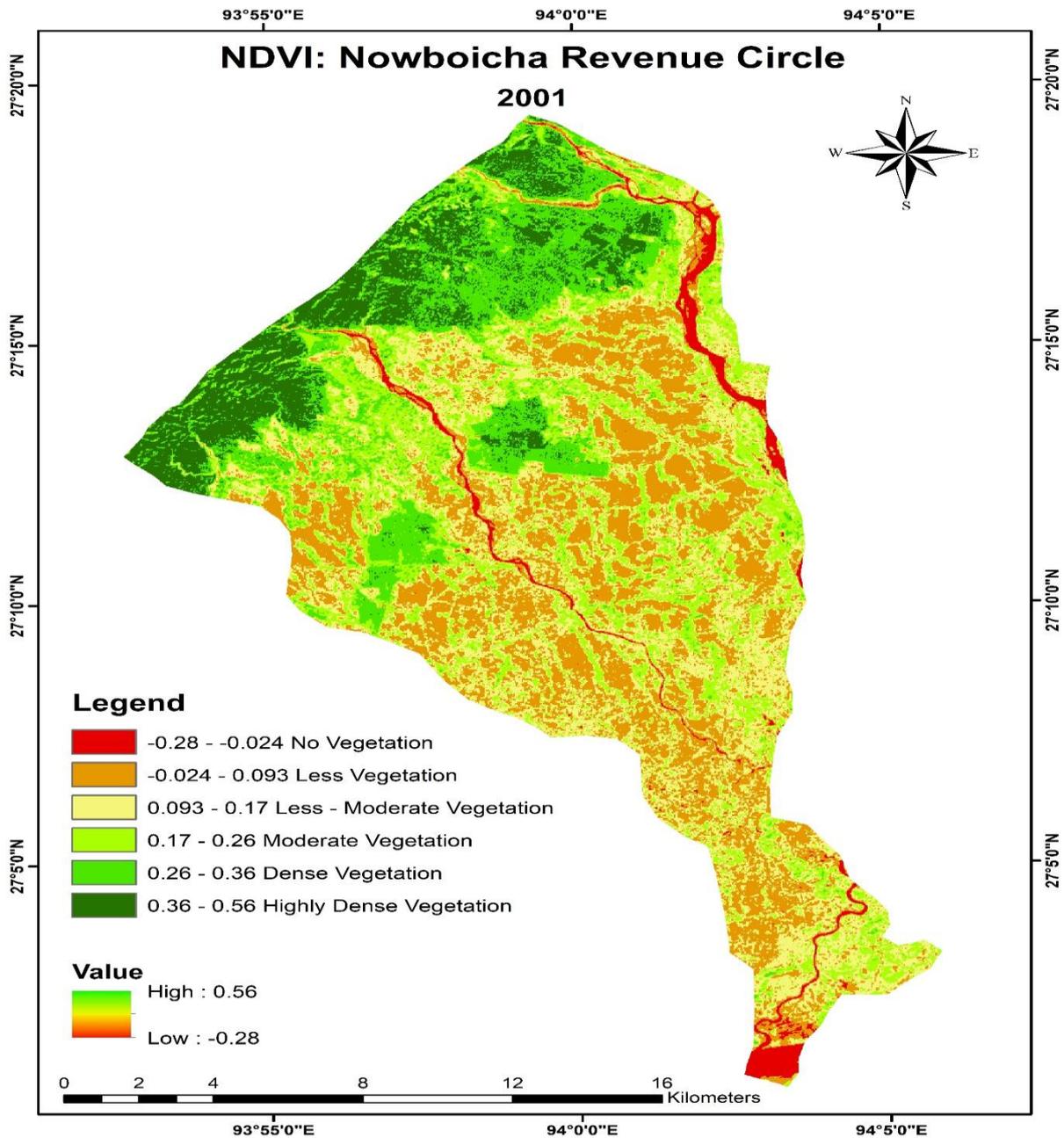


Fig. 4: NDVI of Nowboicha Revenue Circle, 2001

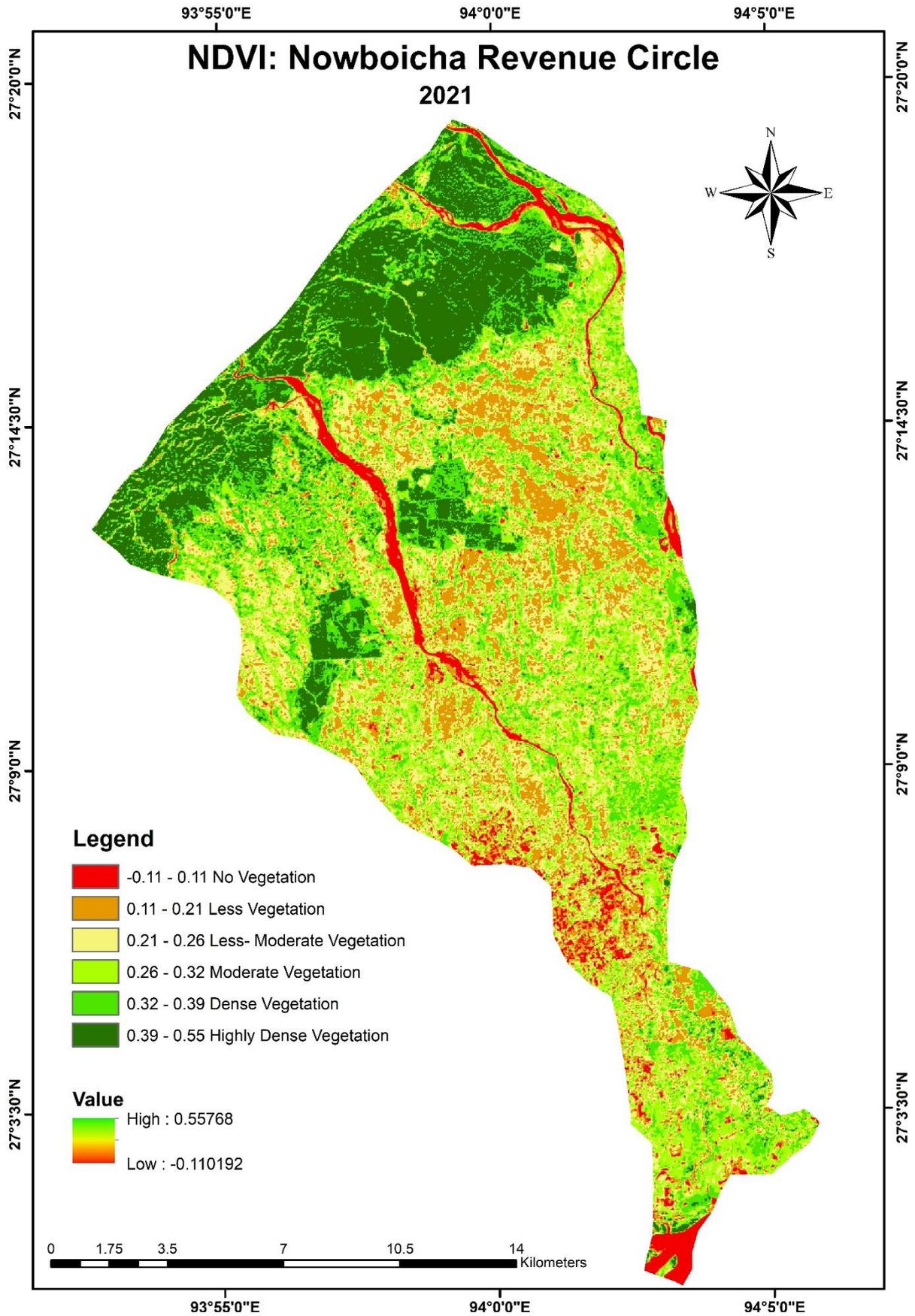


Fig. 5: NDVI of Nowboicha Revenue Circle, 2021

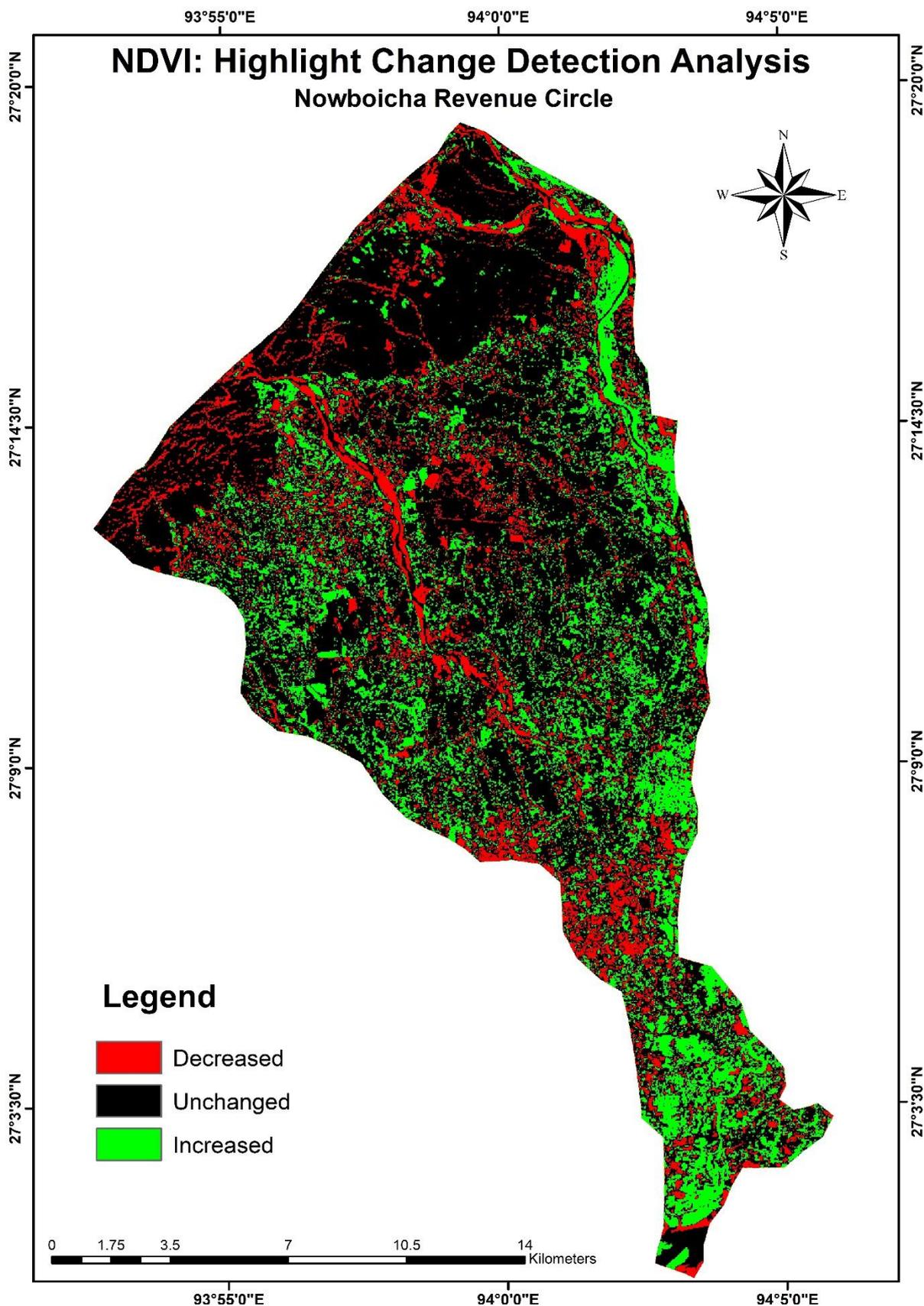


Fig. 6: NDVI: Highlight Change Detection Analysis of Nowboicha R.C.

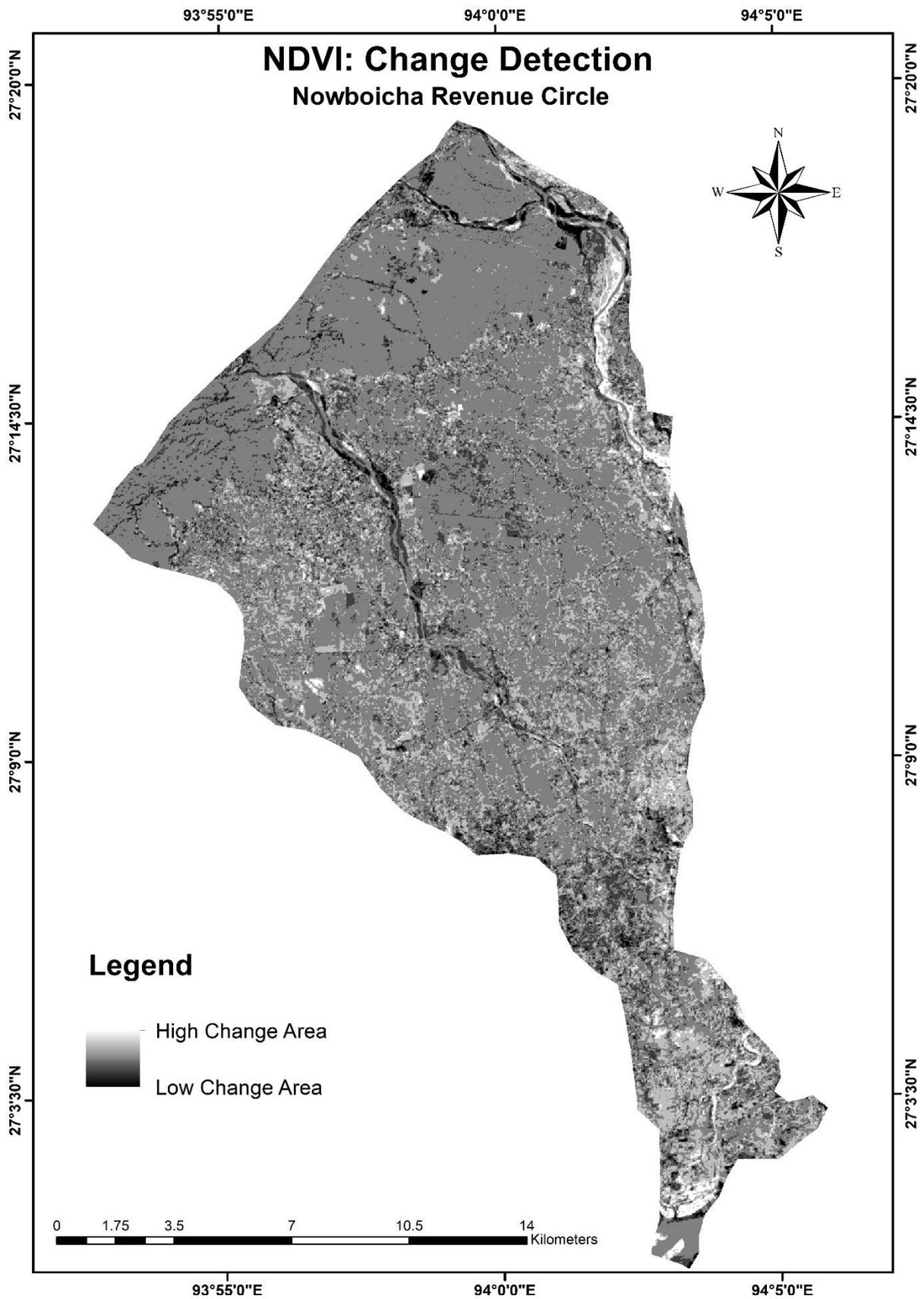


Fig. 7: NDVI: Vegetation Change Detection of Nowboicha R.C.

IV. CONCLUSION

Decline in vegetation cover is a major threat to the ecological stability. The quality of vegetation cover of Nowboicha have degraded by 0.01 from 0.56 to 0.55 over the years. The water body and sand bar which comes under no vegetation area has increased due to the natural factor i.e., Singra and Ranganadi river. The shrub and grassland area which is in less vegetation area has decreased due to the increase of population, deforestation, increase of built-up area, infrastructure facility etc. The health of vegetation cover has undergone a positive change because of plantation in some part of Ranga reserve forest and tea gardens. 190.32 sq. km. of the Nowboicha R. C. remains unchanged because of the presence of Ranga Reserve Forest in the Northern part of the revenue circle. The findings emphasize the importance of preserving and managing areas with green covers to maintain environmental sustainability and support biodiversity.

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