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ASSESSMENT OF FOREST COVER CHANGES IN TINSUKIA DISTRICT, ASSAM USING NDVI

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ABSTRACT

Located far off in the east surrounded by hills and mountains, Assam occupies an important place among the North-Eastern states of India. Its unique physiography, climate and inaccessibility have provided the region congenial condition for thick forest cover in the state. Tinsukia district id the easternmost district of the state covering an area of 3,790sq km. Out of which 1557sq km is covered by forest wherein lies the Dibru- Saikhowa National Reserve Forest and Burhidehing Reserve Forest. This paper is an attempt to evaluate the change detection of the forest cover in the district from 2001 to 2015. For carrying out this study NDVI assessment is done using space data and GIS tools. It is found that there is positive (increase) and negative (decrease) changes in the forest cover of the district during this period. Positive changes are seen in the northern part of the district in and around Dibru-Saikhowa National Reserve Forest in sub-Sadia district, whereas both positive and negative changes are encountered in the central part of the district. There is however increase in the built-up areas in the district, which is clearly evident from the NDVI assessed maps. There is negative change encountered in the southern sub- district during the year 2015 where the Burhidehing Reserve Forest lies. This indicates that the density of vegetation cover has declined in the area. Such vegetation cover assessment using NDVI assumes importance so as to detect the changes in vegetation coverage taking place in any region including the study area which is essentially required for monitoring the status of forest ecosystem.

Keywords: ***vegetation cover, NDVI, GIS, remote sensing.***

INTRODUCTION

Forest cover assessment using satellite data has been the most important activity of Forest Survey of India since 1987. The term 'Forest Cover' as used in the Indian State of Forest Report (ISFR) refers to all lands more

than one hectare in area with a tree canopy of more than 10 percent irrespective of land use, ownership and legal status. It may include even orchards, bamboo, palm etc. The world's forest resources are monitored by Food and Agriculture Organisation (FAO) at an interval of 5 to 10 years since 1946. The Global Forest Resource Assessments (GFRA) are normally brought out by FAO every five years now and it provides a consistent approach to describe the changes in the worlds forest resource. The latest GFRA 2015 has shown India among the few countries of the world indicating increasing trend in forest and tree cover. In terms of India the total forest cover as per current assessment is 701,673 sq km which constitutes 21.34% of the total geographical area of the country. In terms of density area covered by very dense forest is 85,904 sq km that with moderate dense forest is 315,374 sq km and open forest is 300,395sq km. The very dense forest class constitutes 2.61%, the moderate dense forest class constitutes 9.59% and the open forest class constitutes 9.14% of India's total forest cover. Assam has a geographical area of 78,438 sq km out of which recorded forest area constitute 27,018 sq km during 2001 and there is an increase in the forest cover to 27,623 sq km during 2015 according to the forest survey report. Tinsukia district in Assam covers a geographical area of 3,790 sq km out of very dense forest constitute 6.80% followed by moderate dense forest which constitute 44.70% and open forest constitute 48.49% which in total covers 1,557 sq km. There is a positive change in the forest cover as per 2001 forest survey report which recorded an increase of 0.21%. Increase in the forest cover in the district may be because of plantation within and outside forest areas. Thus forest cover mapping is essential in order to monitor and analyse the changes taking place in the district (Forest survey report 2001 and 2015).

For decades, the normalized difference vegetation index (NDVI) is one of the most widely used indices in assessing the amount of vegetation biomass (Rouse et al., 1973), especially for some commonly used resource satellites' images, such as Landsat TM and MSS, and SPOT satellite imagery. An NDVI is often used worldwide to monitor drought, monitor and predict agricultural production, assist in predicting hazardous fire zones, and map desert encroachment. The NDVI is preferred for global vegetation monitoring because it helps to compensate for changing illumination conditions, surface slope, aspect, and other extraneous factors (Lillesand 2004).

NDVI is a numerical indicator that uses visible and near infrared bands of electromagnetic spectrum, and is adopted to analyse remote sensing measurements and assess whether the target being observed contains live green vegetation or not. NDVI can also be defined as a representative index and many researchers have prepared regional or global vegetation map using this method (Ishiayama, 1997). NDVI employs remote sensing data to find vegetation index, land cover classification, vegetation, water bodies, open area, scrub area, hilly area, agricultural area, thick forest, thin forest with few band combinations of the remote sensing data. (Gandhi, 2015). Generally healthy vegetation will absorb most part of the incident energy in visible range, and reflect a large

portion of the EMR at near-infrared range. But in the case of unhealthy vegetation the reflection and absorption both are inversed to the healthy vegetation. On the other hand, bare soil reflects moderately in both red and infrared portion of the electromagnetic spectrum (Holmes, et al, 1987).

The NDVI algorithm subtracts the red reflectance values from the near infrared and divides it by the sum of near infrared and red bands.

NDVI= (NIR-RED)/ (NIR+RED)

RED= DN values from RED band

NIR= DN values from Near Infrared band

The formula allows us to cope with the fact that two identical patches of vegetation could have different values if one is, for example under bright sunshine, and another under cloudy sky. The bright pixel values would have larger values, and, therefore a large absolute difference between the bands. This is avoided by dividing the sum of difference. The output of the NDVI method creates a single- band dataset that only shows greenery. The NDVI values ranges from -1 to +1. The values close to zero represent rock and bare soil and negative values represent water, snow and clouds. Vegetation is of particular interest as it presents a versatile resource for effectively managing and moderating a variety of problems associated with urbanisation. (Li, 2017). To have a better understanding of the change in vegetation NDVI based study has real utility.

OBJECTIVES

The objectives of the study are:

1) To demarcate the differences introduced from 2001 to 2015 in the vegetation cover of Tinsukia district.
2) To evaluate the change detection of forest cover in the district based on NDVI values.
3) To assess the forest status scenario in the district.

STUDY AREA

Tinsukia district is a district in the state of Assam, India. It is the easternmost district of Assam which covers an area of 3,790 sq km. It is bordered by Arunachal Pradesh in the east, Dhemaji district in the north-eastern side and Dibrugarh district in the south-west. It extends from $26^0$30’ N to $27^0$01’N latitude and $92^0$16’E to $93^0$43’E longitude. The district has elevation ranging from 124 m to 143m. Brahmaputra, Lohit, Buri dihing, Dibru are the main rivers of the district. In 1999 Tinsukia district became home for Dibru-Saikhowa National Park, which has

an area of 340 km^2. There are many wetlands in the district such as Maguri beel, Borbeel, Daphlang beel, Koladuar beel etc. The climate of the district is moderate and its temperature ranges from 21^{o}C to 35^{0}C during summer and in winters it falls down to as low as 13^{o}C.

According to 2001 census, Tinsukia district had a population of 1,150,062 persons and in 2011 the population increased to 1,327,929 persons. There was a change of 15.47 percent in the population compared to population of 2001. Prior to the census of 2001, Tinsukia District recorded an increase of 19.51 percent of population compared to 1991. Tinsukia is an industrial district of Assam. The oldest oil refinery in India i.e. Digboi Refinery is situated in this district and places like Margherita and Ledo are famous for open cast coal mining. Tinsukia, the district headquarter is one of the premier commercial centres in Assam. It has four major sub districts Sadia in the north, Tinsukia and Doom Dooma in the central part whereas Margherita sub district in the south. The district produces sizeable amount of tea, oranges, ginger, other citrus fruits and paddy.

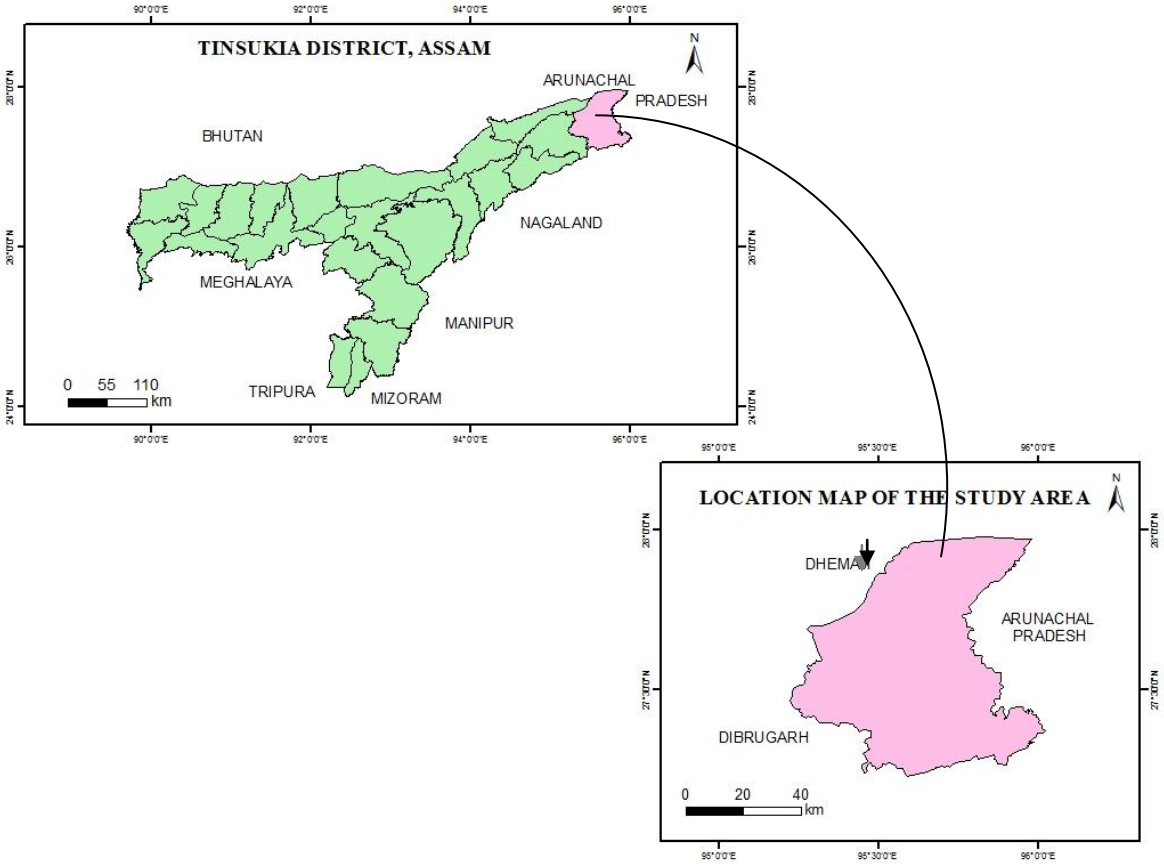

Fig.1 Location Map of the study area

DATA BASE AND METHODOLOGY

In order to carry out the analysis in the light of the objectives the following steps have been performed:

i. Satellite imagery of the study area was downloaded from USGS Earth Explorer for two different years, i.e. 2001 and 2015. For 2001 landsat 7ETM+ was used which consists of 8 spectral bands having spatial resolution of 30 meters for band 1 to 7. The panchromatic band 8 has a resolution of 15 meters. Whereas, for 2015 landsat 8 OLI/TIRS C1 Level 1 was used which consist of 9 spectral bands with a spatial resolution of 30 meters for band 1 to 7 and 9. The resolution for band 8 (panchromatic) is 15 meters. In addition, it also has two thermal bands of IR with a spatial resolution of 100 m.

ii. After downloading the satellite imagery, layer stacking was done for improving the spectral characteristics using Erdas 2014 software and then NDVI assessment was carried out on both the imagery.

iii. Using the spatial analyst tool in ArcGIS software, extraction of study area was done.

iv. The entire methodology using space data and GIS tools has been carried out as shown in the flow chart mentioned below:

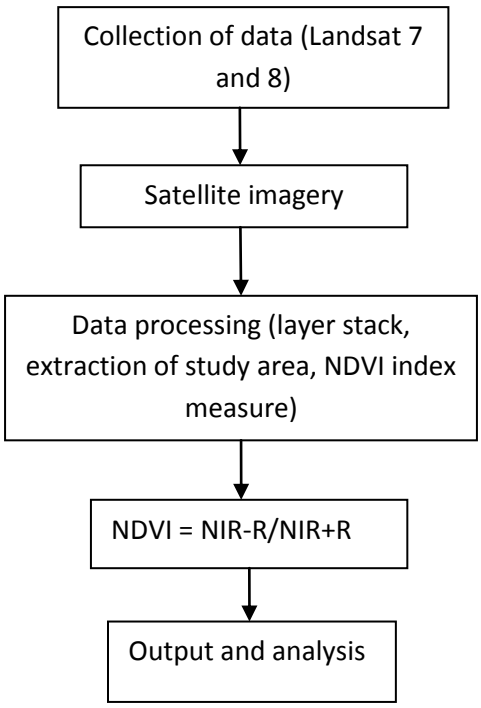

Fig 2 Flow chart of methodology

ANALYSIS

To analyse the changes in vegetation cover NDVI for both the years (2001 and 2015) have been measured. So far the status of forest covers in 2001 is concerned the district has dense vegetation cover in its north-eastern and western part. Dibru Saikhowa National Reserve Forest is situated in the north western part of the district and hence in this part both dense and mixed vegetations are found. Due to Dibru Saikhowa National Reserve Forest the NDVI value is very high ranging from 0.1 to 0.4. Dense vegetation cover is also found in the southern part of the district where the Burhidehing Reserve Forest lies. Some patches of dense vegetation cover are also found in the south eastern and central part of the district.

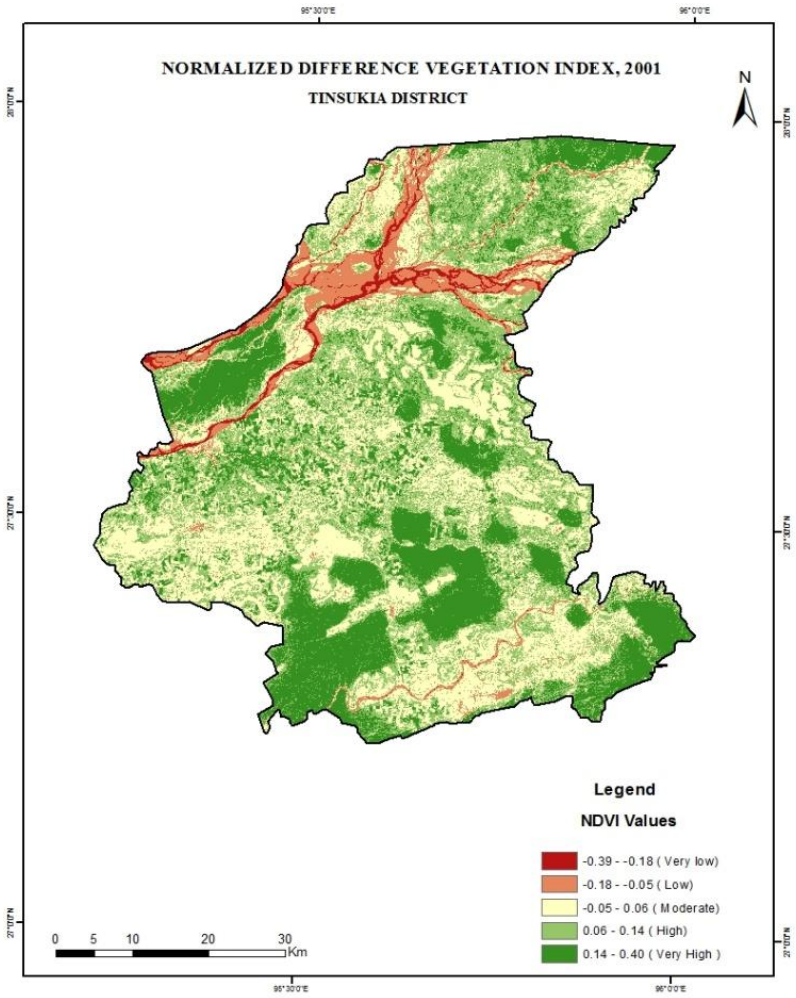

Fig.3 Map showing NDVI assessment, 2001

Shrubs and grasslands are found in patches confined to the central part of the district and the NDVI values for these range from 0.06 to 0.14. Built-up areas are also found in the central part of the district which have shown very low NDVI ranging from -0.05 to -0.06. Built-up areas represent various economic activities taking place in

the district. However the district also has a number of tea gardens and agricultural fields which are included in the category of moderately dense vegetation cover. The mighty Brahmaputra and other river systems in the district exhibit low NDVI value ranging from -0.18 to -0.3.

As of 2015 the district has dense vegetation cover in its northern and north eastern part having high NDVI values ranging from 0.2 to 0.5. There is decline in the vegetation cover in the southern part of the district because of growing urbanisation as it is seen that during this year there is an increase in the built-up areas in the district. Moderate and mixed vegetation cover is found to be distributed evenly in the central, eastern and western part of the district.

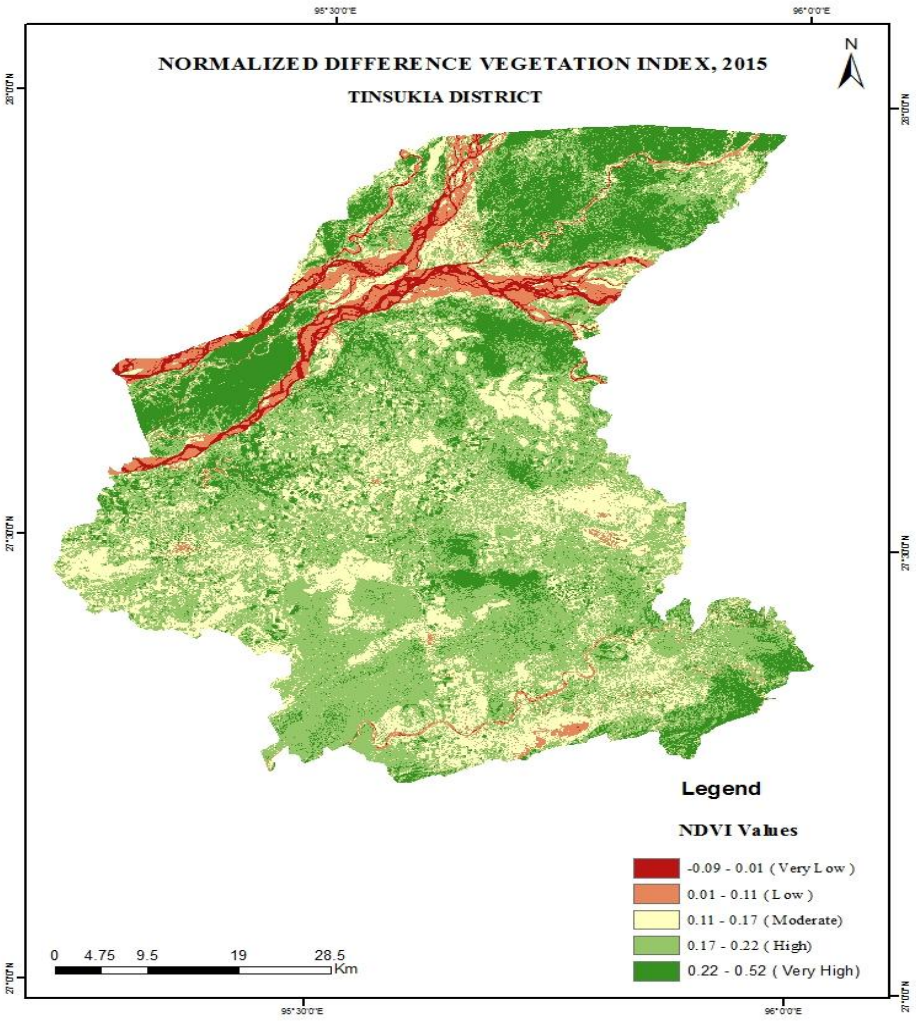

Fig.4 Map showing NDVI assessment, 2015

The NDVI values for these areas vary from 0.1 to 0.2. This region also includes many tea estates and agricultural plots. There is an increase in the built-up areas all over the district which exhibits an NDVI value of 0.11 to 0.17.

NDVI assessed map of 2015 shows that there is increase in the vegetation cover in the north eastern and north western sub district of the region especially near Dibru Saikhowa National Park and this can be because of plantation in or around the National Park. There is a decrease in the density of vegetation cover in the southern Margherita sub district as these areas shows low NDVI values in 2015 as compared to 2001. The area under agricultural land has shrinked dramatically during 2015.

RESULTS AND DISCUSSION

The results of NDVI show that there is both positive and negative change in the vegetation cover of Tinsukia district from 2001 to 2015. During 2001 the vegetation cover was dense in the northern, western and also southern part of the district, whereas during 2015 there was increase in the vegetation cover mostly in the northern part and decrease in the density of vegetation in the southern part. The district had agricultural fields to a great extent during 2001. But there is drastic shrinkage of agricultural fields due to increase in built-up areas in the region. The increase in population results in deforestation which has further accelerated the process of declining forest cover in the district. Due to increase in the concentration of population during 2015 the built-up areas also increased during the same period. There is an increase in the built-up area as seen in the NDVI assessed map as there is a increase in the NDVI value for the same. Grasslands and shrubs were evenly distributed in the district and these are clearly visible in the NDVI map of 2001, but there is increase of same during 2015. The change in density of vegetation cover is thus directly related expansion of settlement areas due to population growth which resulted in clearing of forest and grasslands for human habitation and other uses.

CONCLUSION

It can be concluded that NDVI is a very useful tool in studying the vegetation cover of a region as shrinkage of vegetation is one of the burning issues of the present world. NDVI provides reliable information on vegetation productivity over large temporal and spatial scales and it has been widely used in recent ecological studies. Vegetation cover in Tinsukia district has shown remarkable changes from the year 2001 to 2015. These changes are prominent in various parts of the district especially in the northern and south central part. As seen in the NDVI assessed map there is an increase in the built-up areas mostly in the central part which can be because of increase in population in the district. Increase in population results in expansion of settlement areas which can be the cause of decline in the vegetation cover. There is a decrease in the NDVI values for from very high to high in some parts of the southern district which indicates that there is a decrease in the density of vegetation near Burhi Dihing Reserve Forest. It is moreover seen that there is a positive change in the northern part of the district during 2015 as per the assessed NDVI values which indicate that there is increase in the density of vegetation

near Dibru Saikhowa National Park and towards the north eastern part of Sadia sub district. The negative change in the vegetation cover is very prominent in the southern part of Margherita sub district as seen in the NDVI map of 2015. Finally we can conclude that there is overall increase in the of vegetation cover as seen in the NDVI assessed maps for both the years. Assessing of the vegetation cover is very important as it helps in monitoring the ecological balance of the ecosystem. Such study can be successfully carried out in various regions to analyse, monitor and to take necessary measures if needed to keep a track of the changing vegetation cover of any region.

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