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Analysis of Vegetation Coverage using NDVI Technique in Noa River Basin, India

*** Nilotpal Kalita**
****Niranjan Bhattacharjee**

Introduction

The detection of land cover changes has become popular in recent years due to advancements of new tools and techniques like geographic information systems (GIS) and remote sensing (RS). The NDVI index is particularly useful for monitoring land cover changes which have been caused by human activity, such as construction and unplanned development, as well as for analyzing the temporal spread of vegetation. Normalized Difference Vegetation Index (NDVI) is an index that measures the amount of vegetation present in a particular location based on the reflectance of red and near infrared light. It is derived from remotely sensed data and measured from Landsat satellite imagery. Moreover, various earth surface features can be identified and detected by Remote Sensing techniques. For example, soil moisture and temperature can be measured using remote sensing and GIS techniques. NDVI is one of the unique methods through used to measure types of vegetation, as well as to monitor pattern of vegetation for land management and agricultural practices. The concept of NDVI was first developed by the Texas A&M University in early 1970s. In 1973, Rouse et al. first began incorporating the Normalized Difference Vegetation Index (NDVI) into their research of the Great Plains — a ground breaking move that set the stage for future developments in the field. The red light is reflected more by relatively healthy green plant tissues, while the infrared light is reflected

* Dr. Nilotpal Kalita, *Assistant Professor, Nowgong Girls' College, Nagaon*
** Dr. Niranjan Bhattacharjee, *Associate Professor, Pandu College, Pandu, Guwahati*

more by dead plant material. By measuring the difference between these two values, one can calculate the amount of healthy vegetation present in the region. In this study, NDVI is derived from the reflectance of red and near infrared (NIR) light from the Landsat-8 satellite imagery. Landsat-8 have bands from different parts of the electromagnetic spectrum such as visible, infrared, and ultraviolet. The visible red and near infrared light is used to calculate NDVI. This is because plants preferentially reflect near infrared light and, conversely, absorb red light. The healthy plants reflect more near infrared light than red light, while dead plants reflect more red light than near infrared light. NDVI is an invaluable tool for agricultural and land management, as it can be used to measure the health of vegetation in a particular region. It helps in determining the patchiness of vegetation, which can be used to monitor crop health and yield. It can also identify areas that are lacking in water, as well as diagnose pest and disease outbreaks and diagnose nutrient deficiencies in vegetation. In addition, it also aids in land use evaluation, as identification of land use types and help identify areas for land reclamation. The advantages of NDVI also extend to natural resources management. NDVI, for example, may be used to locate places with a lot of vegetation and track the performance of restoration initiatives. It can also be used to detect areas with high levels of deforestation or to help prevent forest-fires. Lastly, it is used to prepare map of surface water temperature for the development of climate models.

The use of multispectral remote sensing images provides a better understanding of the earth's environment (Hassan and Nusrath, 2010). It is an analytical science that is both an art and a science, allowing users to uncover a variety of objects, areas, and phenomena without having physical contact with them (Karaburun, 2010). Several works have been done on Analysis of Vegetation Coverage Using NDVI Technique and its associated processes across the world. The works of Zhang, et .al.(2009), Karaburun(2010), Hassan and Nusrath (2010), Chouhan & Rao (2011), Bhandari & Kumar (2012), Gandhi, et. al.,(2015), Bid(2016) are worth mentioning. This paper highlights the utilization of the multispectral image of the Noa river basin in order to identify vegetation, areas and its changes.

Study Area

The majestic Noa-nadi, extending from 91°55′30″E to 92° 2′ 30″E and 26°55′ 10″N to 26°21′ 55″N, is a north bank tributary of the revered Brahmaputra River in Assam. The region is a unique blend of urban and rural; its varied topography is a patchwork of forests and settlements, all bathed in the warm embrace of the monsoon climate. Lush tropical and subtropical forests are a common sight here, adding to the diverse beauty of the area. The notable tree species are Gonsoroi (Cinnamemum ceeicedaphne), Sam (Artocarpur chaplasha), Khoir (Acacia catechu), Gomari (Gmelina arborea), Amari (Amoora rohituka spectabilis), Hollock (Terminalia myriocarpa), Titasopa (Michelia champaka), Nahar (Mesuaferrea), and others. The alluvial plain of the basin is home to mixed deciduous trees, such as Outenga (Dillenia indicum), Choir (Bridelia restusasprang), Mango (Mangiifora indica), and Peepal (Ficus religosa). Riverine areas are dominated by tall grasses, including Birina (Phragmites species), Kher (Imperata cylindria), Cane (Calamus viminalis), and Reed (Saccharum spontaneum). These Shrubs and bushes make up the majority of the plant communities in lower reaches of the river, while riparian vegetation is found in shallow flood plains.

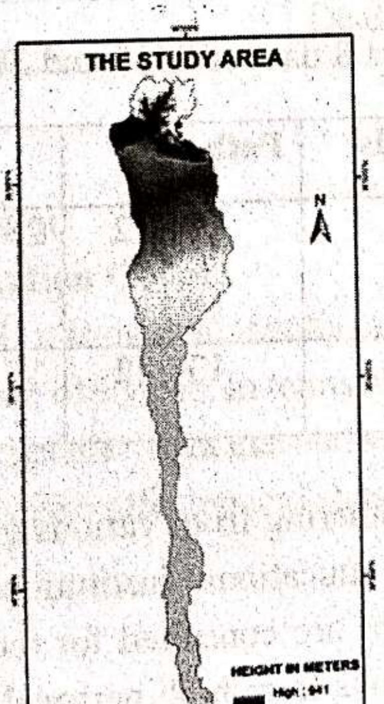

Figure 1: Study area (Noa river Basin)

Objectives

The study has been undertaken to fulfill the following objectives

1. To determine the vegetation classes using NDVI
2. To analyze the changing trend and pattern of vegetation in Noa river basin
3. To identify the nature of profile curvature, plan curvature and wetness index and its impact on river basin

Methodology

Landsat-8 OLI, 2015, and 2019 imageries are obtained from the USGS Earthexplorer website to estimate changing forest cover in the Noa river basin, and a vegetation index (slope-based) is produced in the SAGA GIS environment. The indices were calculated using data from Landsat-8 bands 4 and 5. The downloaded satellite images have a spatial resolution of 30 m. To ensure the correctness of the categorization techniques, a thorough field research is conducted, and the Kappa Coefficient is determined in QGIS. ArcGIS 10.6 is used to create final maps for visualisation. The Cartosat v3 DEM downloaded from NRSC Bhuvan portal is used for basic terrain analysis.

Table 1: Landsat 8 data of 2015 and 2019

Sensor	No. of Bands	Path-Row	Acquired on
OLI-TIRS Landsat 8	11	136-42	21 January, 2015
OLI-TIRS Landsat 8	11	136-42	16 January, 2019

In addition to manual data gathering from various government and non-governmental sources, including educational institutions, Survey of India's 1:50,000-scale topographical maps are consulted for mapping and analysis. Furthermore, e-journals and e-books from both personal and official sources are referred to and a generous number of government publications are tapped into in order to gather secondary data to implement research.

The NDVI algorithm involves subtracting the red reflectance from the near-infrared reflectance, then dividing the result by the sum of both reflectance values. Put simply, the equation is (NIR - RED) / (NIR + RED), where NIR stands for the spectral reflectance in the near infrared band and RED represents the reflectance in the red band (Tucker, 1979).As we are using Landsat-8 bands hence the formula is NDVI = (Band 5 – Band 4) / (Band 5 + Band 4). Here, NIR is represented by Band 5 and Red is represented by Band 4.Apart from calculating the NDVI in SAGA GIS, same values are calculated and classified using QGIS 3 and ArcGIS 10.6 environments.

Table 2: NDVI Range and Identified Objects

NDVI value	Objects
-1	Water
0	Bare Soil, Rock, Sand and Snow
0.2-0.3	Shrub and Grassland
0.3-0.5	Sparse Forest
>0.5	Dense Forest

Source: Bid (2016)

Results and discussion

a) Change of Vegetation Cover

From the table 3, it is evident that the non vegetated area are increasing to 4 percent within a span of 4 years. In terms of total vegetation area the maximum change is on high vegetation area that shows negative change of 58 %. The low density vegetation is also affected and shows a negative change of 8 percent.

Table 3: Change of Vegetation cover (2015 to 2019)

NDVI density classes (Vegetation cover)	2015 NDVI		2019 NDVI		Percent Change
	Classes Area		Classes Area		
	Sq. km	%	Sq. km	%	
Non vegetated area	145.19600000000	0.564816	151.24100000000	0.588332	4.163459393
Low (0.2-0.3)	96.35850000000	0.374837	88.63290000000	0.344785	-8.017452082
Medium (0.3-0.4)	14.98860000000	0.058306	16.97760000000	0.066043	13.27021745
High(>0.4)	0.52470000000	0.002041	0.21600000000	0.00084	-58.83357117

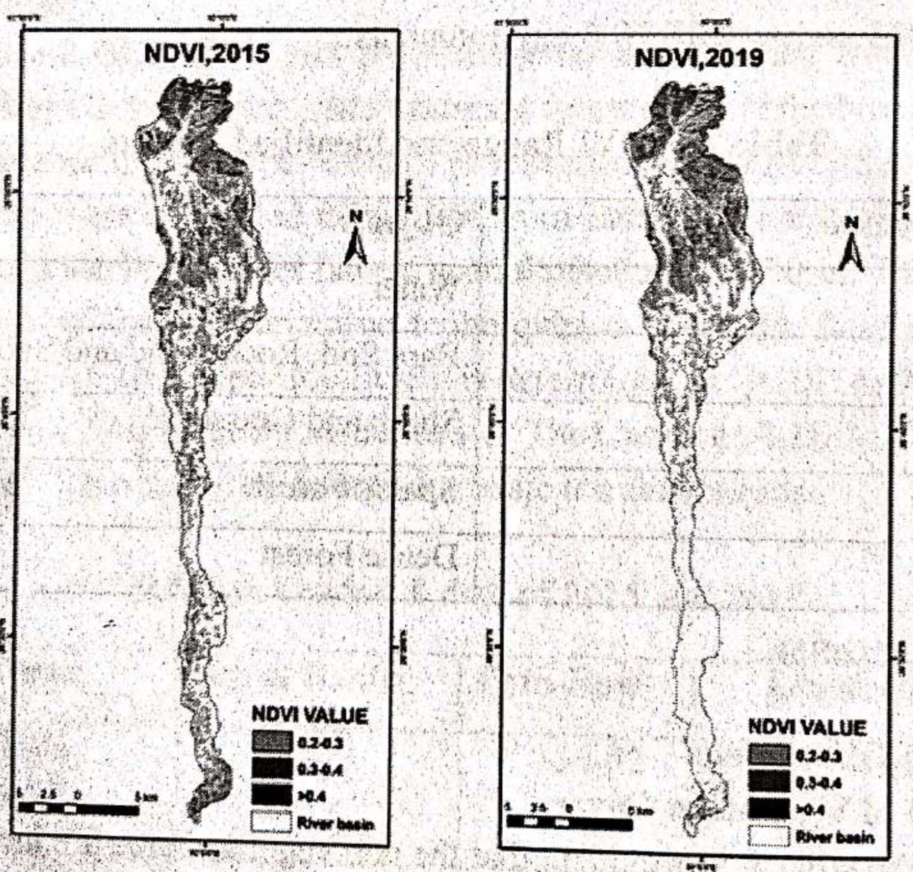

Figure 2: NDVI Map of the Noa river Basin, 2015 and 2019

b) Accuracy Assessment

To achieve the accuracy of the classified NDVI image, a comparison was made between a classified NDVI image, an interpreted map and a reference map or points and ground truth. This comparison was illustrated by an error matrix and a kappa coefficient which revealed an increase in accuracy from

2015 with a kappa coefficient of 0.67 to 2019 with a kappa coefficient of 0.69.

$$\textbf{\textit{Khat}} = \mathbf{(Obs - exp)/(1 - Exp)} \quad \textbf{(Cohen, 1960)}$$

This means that the classification process was successful in avoiding above two-thirds of the errors that a randomly generated classification would make(Congalton, 1991). Thus, the results of this study provide an outstanding insight into improving accuracy.

c) Basic Terrain Analysis and its Relation to NDVI Calculations

The profile curvature, moisture index, and LS factor are only a few of the variables which influence the NDVI results. By accounting for the geography of a region, the profile curvature parameter employed in NDVI computations improves the accuracy of the data. The topography slope and aspect are measured at each pixel by the profile curvature. It is predicated on the idea that the topography has an impact on how much radiation reaches the plants, which in turn has an impact on the NDVI values. A pixel will receive less radiation and have a lower NDVI score if it has a steep slope or aspect. A pixel with flat terrain, on the other hand, will receive more radiation and have a higher NDVI score.

An area's level of moisture is determined using the Topographic Wetness Index (TWI). The formula determines how much water is accessible to the soil by taking into consideration the slope, aspect, and elevation of the terrain. The amount of vegetation and soil moisture in a region may then be estimated using this information. To comprehend the water availability and vegetation of a region, the TWI is utilised in many hydrological and ecological investigations.

The topographic LS factor has a direct impact on an area's NDVI and vegetation. Slope and aspect influence the quantity of direct sunlight received by a region, and consequently the amount of photosynthesis that is feasible. Elevation impacts air pressure and temperature, which in turn affects vegetation's capacity to photosynthesize. The quantity of NDVI and vegetation in a region is determined by the mix of these three elements. The quantity of direct sunlight is reduced in locations with a steep slope and at a high elevation, and thus the amount of NDVI and vegetation is reduced. Areas with a flat slope and a low height will receive more direct sunshine, increasing the quantity of NDVI and vegetation. regions with an east or west orientation receive more direct sunlight than regions with a north or south orientation, and consequently have greater NDVI and vegetation values.

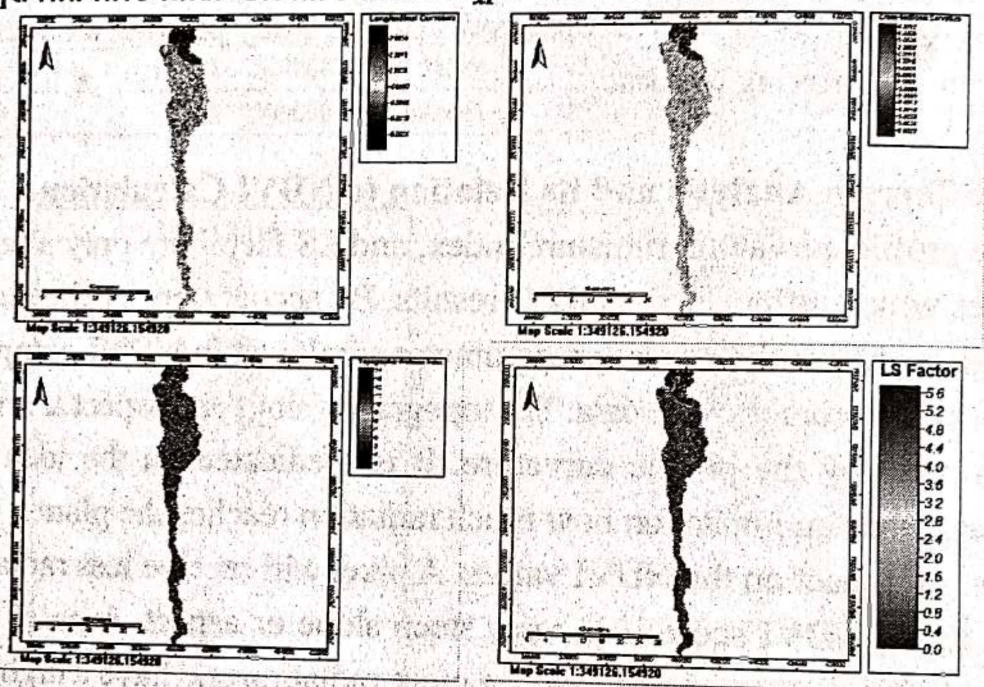

Figure 3: Profile Curvature (Longitudinal Curvature, Cross-sectional curvature), Wetness Index and LS factor Map Prepared in SAGA GIS

d) Impact on River Basin

Analysis and field observation suggest that the drainage net, vegetation distribution pattern, differential relief, and slope characteristics all contribute to flood and associated problems. The hilly terrain of the northern part of the basin has historically been home to lush forests; however, human interference has led to its degradation. The high drainage density (more than 4 km per square km) and drainage frequency (more than 10 nos per square km) have created ideal conditions for retaining soil moisture and promoting forest growth. Despite such favorable conditions, the quality and quantity of forest in the basin has decreased from 2015 to 2019 due to human activity. This has caused severe soil erosion in the upper part of the basin, leading to major problems in the downstream part of the basin.

Conclusion

The current research has provided a comprehensive overview of the NDVI technique in the Noa river catchment in India, based on the parameters Profile curvature, wetness index and LS factor. It has shown that the NDVI technique is a reliable tool for industry, academic, and governmental stakeholders when assessing vegetation coverage in the catchment. Furthermore, this study has demonstrated that the NDVI technique provides a useful, reliable measure of vegetation coverage when used in conjunction with the parameters Profile curvature, wetness index and LS factor. In conclusion, this research has implicated that the NDVI technique is a valuable tool in assessing vegetation coverage in the Noa river catchment in India and provides useful insights into the impact of these parameters on the NDVI values.

References

Ahmadi, H., & Nusrath, A. (2010). Vegetation change detection of Neka River in Iran by using remote-sensing and GIS. *Journal of geography and geology*, *2*(1), 58.

Bhandari, A. K., Kumar, A., & Singh, G. K. (2012). Feature extraction using Normalized Difference Vegetation Index (NDVI): A case study of Jabalpur city. *Procedia technology*, *6*, 612-621.

Bid, S. (2016). Change detection of vegetation cover by NDVI technique on catchment area of the Panchet Hill Dam, India. *Int J Res Geogr*, *2*(3), 11-20.

Chouhan, R., & Rao, N. (2011). Vegetation detection in multispectral remote sensing images: Protective role-analysis of vegetation in 2004 indian ocean tsunami. *PDPM Indian Institute of Information Technology*.

Cohen, J. (1960). A coefficient of agreement for nominal scales. Educational and Psychological Measurement, 20, 37-46.

Gandhi, G. M., Parthiban, B. S., Thummalu, N., & Christy, A. (2015). Ndvi: Vegetation change detection using remote sensing and gis–A case study of Vellore District. *Procedia computer science*, *57*, 1199-1210.

Karaburun, A. (2010). Estimation of C factor for soil erosion modeling using NDVI in Buyukcekmece watershed. *Ozean Journal of applied sciences*, *3*(1), 77-85.

National Remote Sensing Centre, Bhuvan. https://bhuvan-app3.nrsc.gov.in/data/

download/index.php

Rouse, J. W., Haas, R. H., Schell, J. A., & Deering, D. W. (1974). Monitoring vegetation systems in the Great Plains with ERTS. *NASA Spec. Publ*, *351*(1), 309.

Tucker, C. J. (1979). Red and photographic infrared linear combinations for monitoring vegetation. *Remote sensing of Environment*, *8*(2), 127-150.

U.S. Geological Survey, EarthExplorer. https://earthexplorer.usgs.gov/

Zhang, X., Hu, Y., Zhuang, D., Qi, Y., & Ma, X. (2009). NDVI spatial pattern and its differentiation on the Mongolian Plateau. *Journal of geographical sciences*, *19*, 403-415.