www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

ASSESSMENT OF AFFORESTATION AND DEFORESTATION DYNAMICS THROUGH NDVI IMAGERY ANALYSIS

Sayantan Mandal[1]*, Sritama Choudhury[2], Shreetama Giri[3], Sayan Kumar Naskar[3]

[1]Department of Soil Science, IARI-Kolkata hub, CRIJAF, Barrackpore, West Bengal, India

[2]Department of Agronomy, Ramakrishna Mission Vivekananda Educational and Research Institute, Narendrapur, Kolkata, West Bengal, India

[3]Department of Agronomy, School of Agriculture and Allied Sciences, The Neotia University, Sarisha, South 24 Parganas, West Bengal, India

**Corresponding author email*: sayantanmandal456@gmail.com

ABSTRACT

The Normalized Difference Vegetation Index (NDVI) derived from satellite imagery is a powerful tool for monitoring vegetation dynamics over time. NDVI utilizes red and near-infrared (NIR) reflectance to assess vegetation health and density. In this study, LANDSAT data from different time periods were processed and analyzed using GIS techniques to assess spatial vegetation trends. NDVI rasters were reclassified into vegetation and non-vegetation classes and compared across timeframes to evaluate changes. The results indicate a general decline in vegetation density over the years, despite localized afforestation efforts. This methodology demonstrates the utility of NDVI analysis in environmental monitoring and sustainable land-use planning.

KEYWORDS: Afforestation, ArcGIS, Deforestation, LANDSAT, NDVI

INTRODUCTION

Vegetation dynamics are critical for maintaining ecosystem functions, influencing climate patterns, and sustaining biodiversity. Understanding spatial and temporal variations in vegetation cover is essential for informed environmental monitoring and resource management. Remote sensing, particularly through satellite imagery, provides a reliable means to observe and quantify vegetation changes over broad spatial and temporal scales (Htitiou et al., 2020).

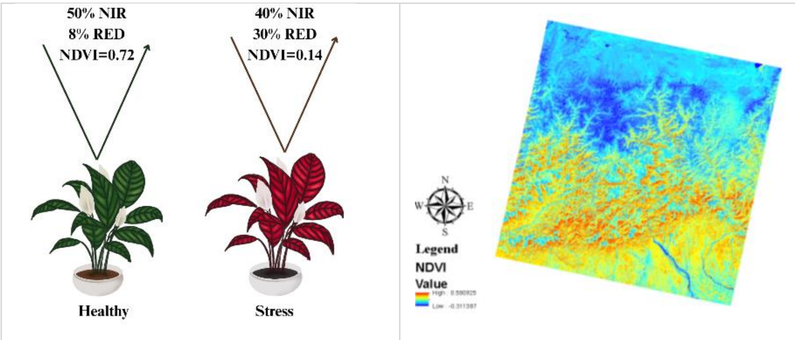
The NDVI is a widely used vegetation index calculated from satellite data that quantifies the greenness and photosynthetic activity of vegetation (Bhandari et al., 2012). It also helps distinguish between healthy vegetation and background features like soil, dead plant material, and surface roughness (Li et al., 2016).

NDVI

The NDVI is a widely used remote sensing index designed to measure and monitor plant growth, vegetation cover, and biomass production. It is derived from satellite or airborne sensor data by utilising the unique reflectance characteristics of vegetation in the red and near-infrared (NIR) regions of the electromagnetic spectrum. Healthy, dense vegetation strongly absorbs visible red light for photosynthesis and reflects a large portion of NIR light, while sparse or stressed vegetation reflects more red light and less NIR. The NDVI is calculated using the following formula:

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

Where 'NIR' refers to the reflectance in the near-infrared band, and 'RED' refers to the reflectance in the red band. NDVI values typically range between -1 and +1. Higher NDVI values (closer to +1) are associated with vigorous and dense vegetation, moderate values indicate sparse vegetation, and lower or negative values often correspond to barren surfaces, water bodies, or built-up areas (Blanco et al., 2020).



a)	b)

Figure1. a) Difference in reflectance and NDVI between healthy and stressed plants b) NDVI raster

METHODOLOGY

To monitor vegetation changes over time, NDVI must be generated for both periods using Landsat imagery. First, download relevant data from the USGS Earth Explorer and load it into ArcGIS. Use the Raster Calculator under Spatial Analyst Tools > Map Algebra to compute NDVI. For example, to compare vegetation between 1990 and 2024, you would need to use:

Landsat 4–5 for data from 1990, using Band 4 (NIR) and Band 3 (Red),

Landsat 8–9 for data from 2025, using Band 5 (NIR) and Band 4 (Red).

Since each Landsat generation has its sensor system, the correct band combination must be applied during NDVI calculation to ensure accurate and comparable results across different years.

Table 1. List of different LANDSATS for different periods

Landsat Mission	Time Period Available	Bands Used for NDVI
Landsat 1–3	1972 – 1983	Band 2 (Red), Band 4 (NIR)
Landsat 4–5	1982 – 2012 (L5 longest)	Band 3 (Red), Band 4 (NIR)
Landsat 7	1999 – Present (gap-filled after 2003)	Band 3 (Red), Band 4 (NIR)
Landsat 8	2013 – Present	Band 4 (Red), Band 5 (NIR)
Landsat 9	2021 – Present	Band 4 (Red), Band 5 (NIR)

First, classify the NDVI raster into two categories: ‘vegetation’ and ‘no vegetation’. Use the Reclassify tool to assign the value +1 for vegetation and -1 for no vegetation. Then, go to the Conversion Tools and use the Raster to Polygon tool to convert the classified raster into polygons with only two grid codes: +1 and -1. Next, use the Dissolve tool from the Geoprocessing toolbox to merge polygons based on their grid codes. Open the attribute table of the dissolved polygons and create two new fields: one to calculate the area of each class, and another to label the grid codes as 'vegetation' and 'no vegetation'. After that, use the Intersect tool (under Geoprocessing) to overlay the two polygon layers from different time periods. This will create one intersected polygon layer that contains data from both years. In the attribute table of this new layer, create a field and calculate values using this format: "[Class of past year] + ' to ' + [Class of present year]"

This step defines the type of vegetation change (e.g., “vegetation to no vegetation”). Finally, create another field to calculate the total area under each change type. Based on this information, update the classes in the intersected polygon to reflect the vegetation change categories.

Table 2. New classes according to the vegetation change trends.

Vegetation changing type	New class of intersected polygons
No vegetation to No vegetation	No vegetation (unchanged)
No vegetation to vegetation	Afforestation
Vegetation to No vegetation	Deforestation
Vegetation to vegetation	Vegetation (unchanged)

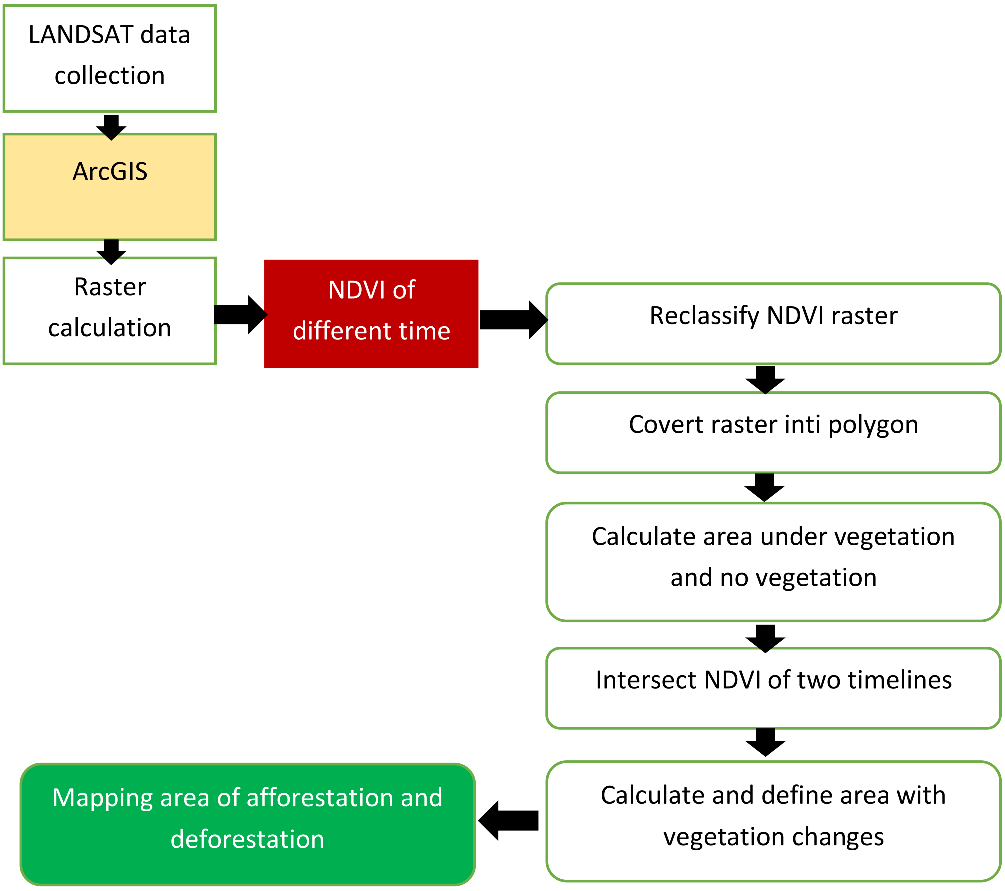
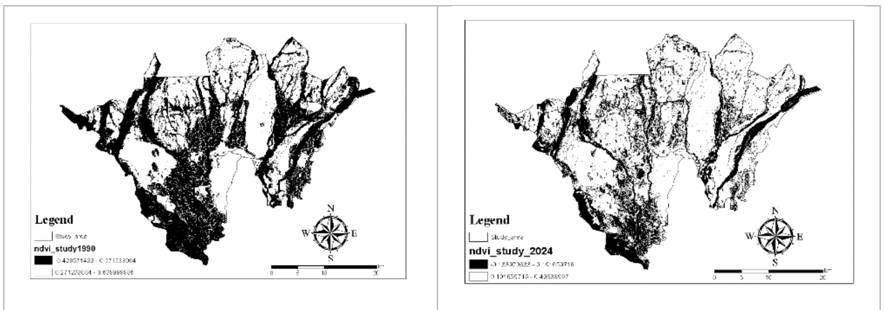


Figure 2. Flowchart of complete methodology for monitoring vegetation change trends

RESULTS

We have gained a change of vegetation at three blocks of Jalpaiguri district of West Bengal, calculating the NDVI of 1990 and 2025 using LANDSAT 5 and LANDSAT 8, respectively. Surprisingly big area with afforestation though, has been indicated still difference between NDVI of these two terminal time has shown us that the density of the vegetation has been reduced gradually.



a) b)

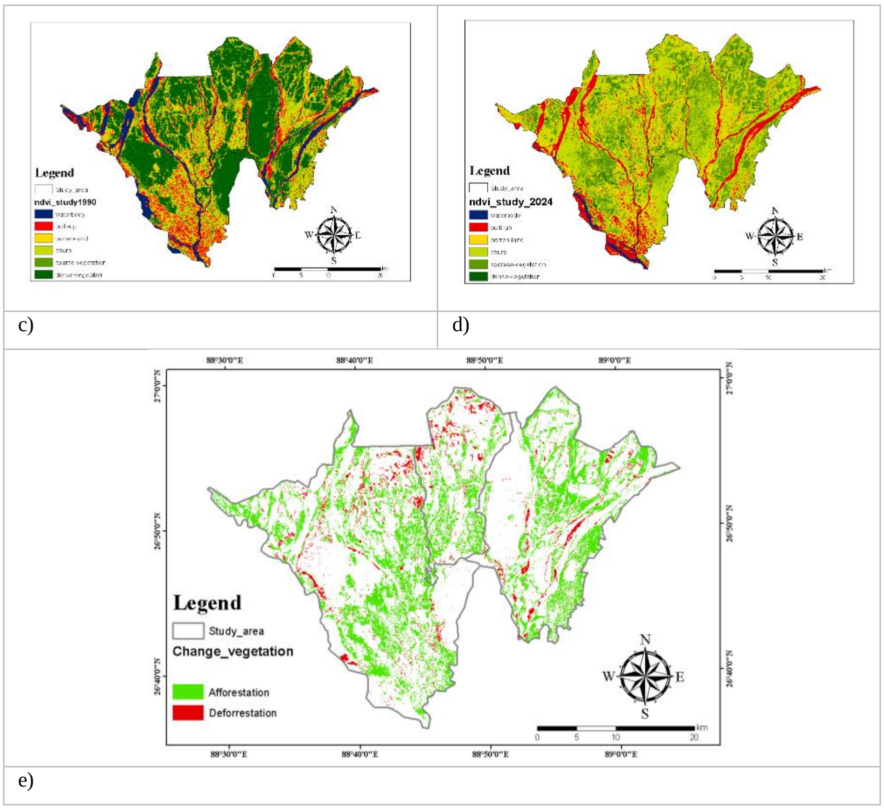


Figure 3. Reclassified NDVI of a) 1990. b) 2024. NDVI raster of c) 1990 and d) 2025 e) Afforestation and deforestation area mapping of the study area

CONCLUSION

Urban expansion and agricultural development continue to reduce vegetation cover and density. Monitoring these changes using NDVI-based analysis provides critical insights for managing afforestation and deforestation dynamics. This study highlights the effectiveness of satellite imagery and GIS in assessing vegetation loss, planning reforestation initiatives, and promoting sustainable land use. Such tools are vital for timely decision-making and improved environmental conservation strategies.

REFERENCES

Blanco, V., Blaya-Ros, P. J., Castillo, C., Soto-Vallés, F., Torres-Sánchez, R., & Domingo, R. (2020). Potential of UAS-Based Remote Sensing for Estimating Tree Water Status and Yield in Sweet Cherry Trees. *Remote Sensing*, *12*(15), 2359. https://doi.org/10.3390/rs12152359

Htitiou, A., Boudhar, A., Lebrini, Y., & Benabdelouahab, T. (2020). Deep Learning-Based Reconstruction Of Spatiotemporally Fused Satellite Images For Smart Agriculture Applications In a Heterogeneous Agricultural Region. *International Archives of the Photogrammetry, Remote*

Sensing and Spatial Information Sciences, *XLIV-4/W3-2020*, 249–254. https://doi.org/10.5194/isprs-archives-xliv-4-w3-2020-249-2020

GIS & RS Solution. (2023). [Video]. You Tube. Retrieved April 25, 2025, from https://youtu.be/JLUhzjS3v0U?si=9y9TglHg5jI_bwE5

How to cite:

Mandal S., Choudhury S., Giri S., and Naskar, S. K. (2025). Assessment of Afforestation and Deforestation Dynamics through NDVI Imagery Analysis. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 30-35.

*********XXXXX**********