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# Understanding Green Changes: Satellite NDVI Analysis of Vegetation in NARSINGDI

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## Abstract

*The study examines changes in vegetation cover in the Narsingdi district of Bangladesh from 2016 to 2024 using the Normalized Difference Vegetation Index (NDVI) derived from Sentinel-2 satellite imagery. This research aims to quantify vegetation health, density, and distribution patterns in a predominantly agricultural region, highlighting the impacts of urbanization and climate on vegetation dynamics. NDVI values were calculated for the study area, revealing significant findings: areas classified as "No Vegetation" increased from 3.45% in 2016 to 4.4% in 2024, while "Sparse Vegetation" saw a notable decrease from 36.06% to 14.72%. Conversely, "Moderate Vegetation" increased dramatically from 58.78% to 79.23%, indicating a substantial recovery or improvement in vegetation density. The category of "Dense Vegetation" experienced a slight decline, dropping from 1.92% to 1.58%. These findings suggest that while some areas are losing vegetation due to urbanization, there are significant improvements in vegetation density in other regions, possibly due to conservation efforts. The results underscore the importance of continuous monitoring for effective land management and policy-making.*

## 1.0 Introduction:

The process of gathering information from various electromagnetic spectrum bands typically more than simply visible light is known as multispectral remote sensing [1]. It provides important information about the components or characteristics in a particular location by measuring light reflected or emitted from the Earth's surface in discrete spectral bands. Significant data that is frequently utilized to determine the change values of land cover is referred to as satellite imaging. Using satellite data, the Normalized Difference Vegetation Index, or NDVI, is a commonly used index in remote sensing to assess and track the density and health of vegetation [2]. It is computed using the difference between red light, which plants absorb during photosynthesis, and near-infrared (NIR) light, which is significantly reflected by healthy vegetation [3]. It is an important index of vegetation widely used in research on global climate and environmental change. Normalized Difference Vegetation Index, or NDVI, is an effective way to gather a variety of variables, particularly those pertaining to vegetation, land use, and environmental health. Even while the NDVI is primarily concerned with vegetation health, it also indirectly sheds light on other varied landscape aspects. For example, land use classification, monitoring of agriculture, detection of water stress and drought, studies of carbon sequestration, monitoring of wetlands and water bodies, and distinction between urban and rural areas [4]. The NDVI was widely used to study the spatial and temporal variations in the area covering of vegetation as well as changes in land cover caused by human activities like building and developments [5]. The vegetation in the Narsingdi district of Bangladesh could be considered a precious natural resource, depending on its type, extent, and management. Narsingdi is primarily an agricultural area, and its vegetation plays an important role in both the local economy and the environment [6]. Resource distribution maps of Narsingdi districts are essential for resource management and development with Remote Sensing (RS) technologies [7]. The fundamental component of GIS is the geographical relationship between attributes, which is processed and analyzed using a

system. Utilizing remote sensing expertise has become increasingly crucial in recent times to support and track the constantly shifting vegetation pattern [8]. When plants or other cover types at a certain site experience changes in their spectral properties over time, this is known as change detection, which is the temporal effect in spectral reaction variation. Plant health is mainly represented by the NDVI (Normalized Difference Vegetation Index), which is strongly correlated with photosynthetic activity [9]. It measures the amount of chlorophyll in plant leaves and, consequently, the capacity of the plant to carry out photosynthesis, or the "greenness" of the vegetation.
NDVI is a simple statistical measure of how much photosynthetically active radiation (PAR) is absorbed by plants [10]. The region of the light spectrum (400–700 nm), mostly in the visible spectrum, that plants use for photosynthesis is known as photosynthetically active radiation [11]. It primarily measures how leaves and other foreshadowing vegetation appear on the surface of the earth over large areas.
The NDVI (Normalized Difference Vegetation Index) is calculated using the following formula [12]:

$$\text{NVDI}= \frac{NIR-RED}{NIR+RED}$$

Where:

- NIR (Near-Infrared Light): Light wavelengths between about 700 to 1300 nanometers, which plants reflect more when they are healthy.
- Red Light: Visible light with wavelengths between about 600 to 700 nanometers, which plants absorb for photosynthesis. [13]

The objectives for this research are-
●The objective of this study is to utilize satellite-derived NDVI data to analyze and monitor the vegetation health and distribution in Narsingdi.

### 1.1 Study area

Narsingdi, located in central Bangladesh, approximately located between 23°46'N to 24°14'N latitude and 90°34'E to 90°59'E longitude. The total area of Narsingdi district is approximately 1,140.76 square kilometers with an annual average rainfall is approximately 2,000 to 2,300 millimeters (mm).

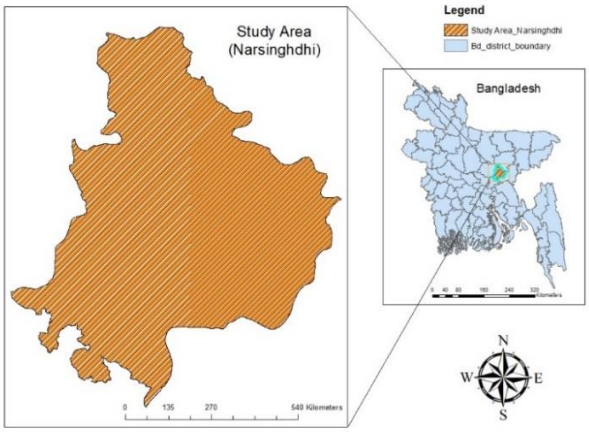



Fig1: Showing the study area of Narsingdi

## 2.0 Methodology

By analyzing satellite or aerial imagery over time, the NDVI (Normalized Difference Vegetation Index) technique can be used to reveal a quantitative assessment of vegetation cover change in Narsingdi.For digital image processing, remote sensing and GIS-based software (ArcGIS) were used. ArcGIS provides supervised and unsupervised classification tools that enable the classification of pixels into classes of land cover, including urban areas, forests, water bodies, and agricultural land. The false color composite is produced by combining the red, green, and near-infrared (NIR) Sentinel-2 data for 2016 and 2024 using ArcGIS [14].

**2.1 Acquisition and selection of data:** The image of the study area was acquired in April 2016 and April 2024 with minimal cloud cover, using standard FCC (False Color Composite) imagery generated by combining spectral bands on a scale of 1:20,000. Sentinel-2 data, accessed from the Copernicus Open Access Hub (https://scihub.copernicus.eu), is one of the most important and accurate datasets for assessing global land cover status.

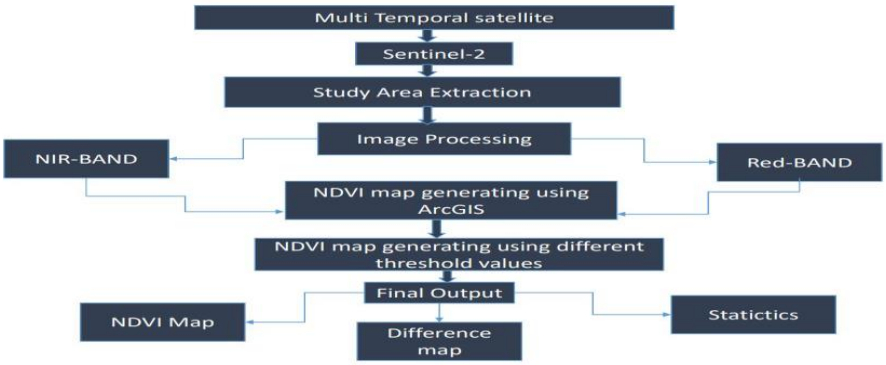



Fig2**:** Flowchart of Methodology

Table 1: Band Specifications for Sentinel-2

| Satellite | Acquisition Date | Band Range (µm) | Resolution |
|---|---|---|---|
| Sentinel-2 | 2016-2024 | 0.443 (Blue) | 30 m |
| | | 0.490 (Green) | 10 m |
| | | 0.560 (Red-Green) | 10 m |
| | | 0.665 (Red) | 10 m |
| | | 0.705 (Red-Edge 1) | 20 m |
| | | 0.740 (Red-Edge 2) | 20 m |
| | | 0.783 (Red-Edge 3) | 20 m |
| | | 0.842 (NIR) | 10 m |
| | | 0.865 (NIR) | 20 m |
| | | 1.610 (SWIR 1) | 20 m |
| | | 2.190 (SWIR 2) | 20 m |

Table 2: Band Combinations for NDVI Calculation

| Satellite Data | True Color | RGB | NDVI |
|---|---|---|---|
| Sentinel-2 | Band 4 (Red) | Band 8 (NIR) | NDVI = (BAND 8 - BAND 4) / (BAND 8 + BAND 4) |
| | Band 3 (Green) | Band 3 (Green) | |
| | Band 2 (Blue) | Band 2 (Blue) | |

## 3.0 RESULT AND DISCUSSION

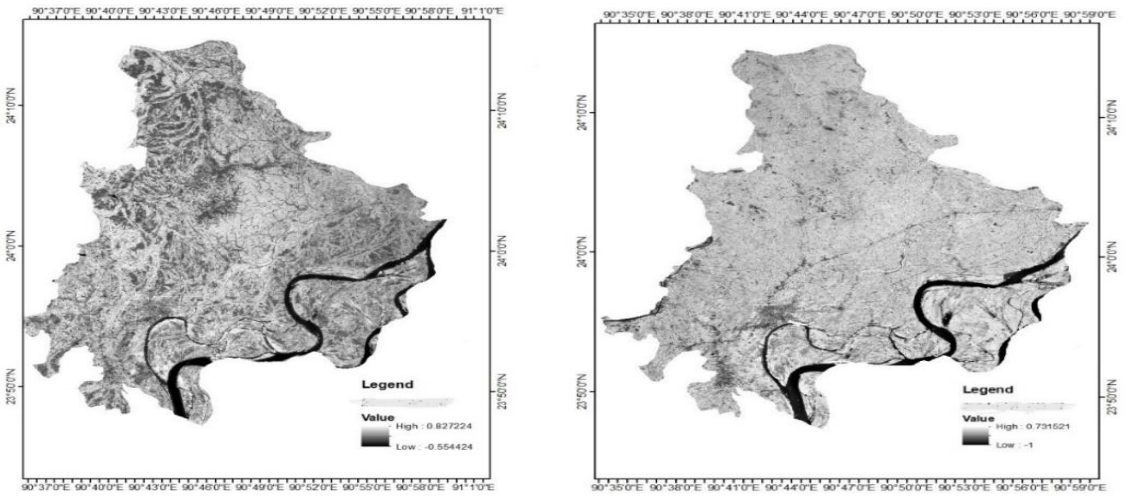



Figure 3: showing satellite images With Value (a) 2016 (b) 2024

In Figure 3, It is seen that Upon analyzing the satellite images, it was observed that multispectral images provide optimal results across various features at NDVI values. The NDVI values in this study range from -0.5 to 0.8 for the first image, while the second image shows a range from -1 to 0.77

Table 3: NDVI Index

| | NDVI(2016) | NDVI(2024) |
|---|---|---|
| Minimum | -.554424 | -1 |
| Maximum | .827224 | .731521 |
| Mean | 0.20844 | 0.26284 |
| Standard Deviation | 0.4670 | 0.3755 |

Table 4 : Vegetation and Land Classification Values

| Class | Value |
|---|---|
| Water | -0.12-0 .015 |
| Built up | .015-0.14 |
| Barren Land | . 014- 0.18 |
| Shrub | . 018 -0.27 |
| Sparse Vegetation | . 027 -0.36 |
| Dense Vegetation | . 036 -.074 |

Table 3 presents the statistical analysis of Normalized Difference Vegetation Index (NDVI), highlighting variations in vegetation health and density across the study area.
Table 4 categorizes the NDVI values into distinct classes, such as vegetation and land types, offering insights into spatial patterns and land cover distribution.

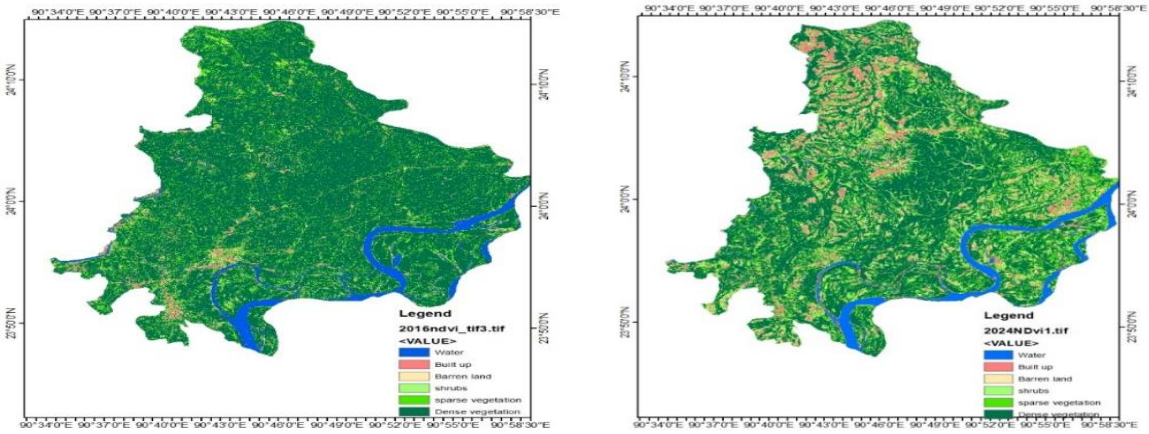



Figure 4: Showing NDVI Map (a) 2016 (b) 2024

Figure 4 illustrates various land cover classifications derived using GIS tools, including categories such as Water, Built-Up, Barren Land, Shrubs, Sparse Vegetation, and Dense Vegetation. This classification highlights the spatial distribution and diversity of land cover types within the study area.

Table 5: NDVI Density classes analysis between 2016 & 2024

| **NDVI Density classes** | **class2016** | | **class2024** | | **Change between** | **Percentage Change** |
|---|---|---|---|---|---|---|
| | Areakm2 | percentage | Areakm2 | percentage | (2016-2024) | % |
| No vegetation | 37.090154 | 3.4012328 | 47.306725 | 4.332383889 | 10.216571 | 2.078339635 |
| sparse vegetation | 386.991259 | 35.487784 | 158.0254 | 14.47207994 | 228.965857 | 46.57813425 |
| Moderate vegetation | 630.803459 | 57.845795 | 867.09445 | 79.40913309 | 236.29099 | 48.06827358 |
| Dense vegetation | 35.606603 | 3.2651886 | 19.506323 | 1.786403086 | 16.10028 | 3.275252534 |
| Total | 1090.491475 | 100 | 1091.9329 | 100 | 491.573698 | |

Table 5 compares NDVI density classes between 2016 and 2024, highlighting changes in vegetation cover over time. It shows shifts in areas under No Vegetation, Sparse Vegetation, Moderate Vegetation, and Dense Vegetation, with corresponding percentage changes. The analysis reveals a decline in sparse vegetation and dense vegetation, alongside an increase in moderate vegetation, indicating notable transformations in land cover dynamics over the study period.

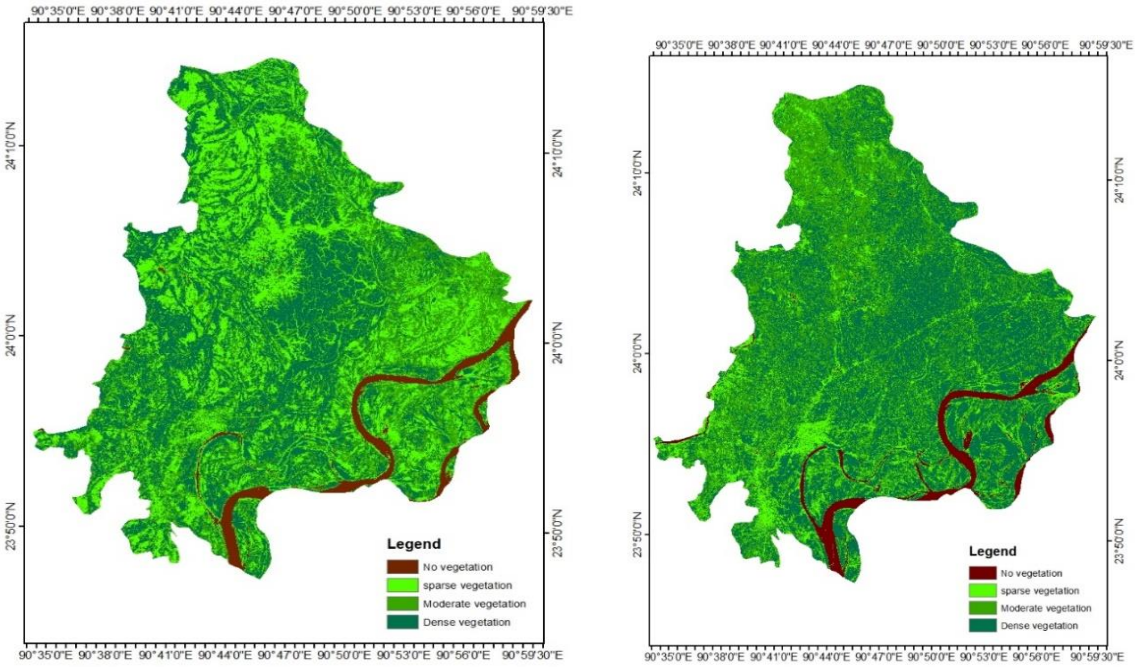



Figure 6: showing reclassified map of NDVI (a) 2016 (b) 2024

In Figure 6,We have four categories of subtypes of vegetation For further analysis to understand the changes of urbanization and land-use.

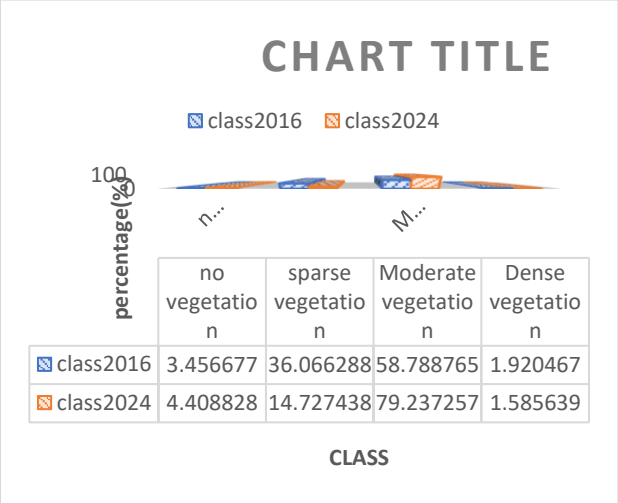



Figure 8 : showing percentage-wise distribution reclassified map of NDVI in 2016 and 2024

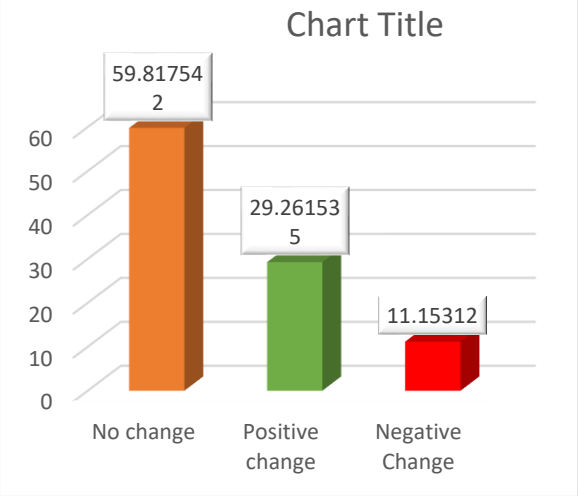



Figure 9 : showing NDVI difference values

In Figure 8 ,In 2024, the area with no vegetation has increased slightly from 3.45% in 2016 to 4.4%. This rise suggests a small expansion in areas where vegetation cover has been lost entirely..The proportion of land with sparse vegetation has drastically reduced from 36.06% in 2016 to just 14.72% in 2024. This significant reduction

indicates a shift away from areas with limited vegetation cover. The most striking change is seen in the category of Moderate Vegetation, which has increased dramatically from 58.78% in 2016 to 79.23% in 2024. This indicates substantial vegetation recovery or afforestation in many regions, leading to improved vegetation density. The dense vegetation category has seen a slight decline, dropping from 1.92% in 2016 to 1.58% in 2024. This could suggest some areas with high-density vegetation may have experienced minor degradation, transitioning into the moderate vegetation class.

In Figure 9, It is seen that The majority of the study area (59.81%) shows no significant change in NDVI values between 2016 and 2024. This stability indicates that more than half of the regions have maintained consistent vegetation cover and density over time.Nearly 30% of the area experienced a positive change in NDVI values, indicating improved vegetation health and density. This positive change likely corresponds to the increase in moderate vegetation observed in the comparison, suggesting that some regions have seen a greening effect, possibly due to reforestation efforts, sustainable agriculture, or favorable climatic conditions.A smaller portion of the area (11.15%) showed a negative NDVI change, meaning a decline in vegetation cover or quality. This could be linked to factors such as deforestation, land degradation, or urban expansion.

## 4.Conclusion

The analysis of NDVI values over the period from 2016 to 2024 in Narsingdi district reveals a complex interplay of vegetation dynamics influenced by anthropogenic activities and environmental changes. The increase in areas classified as "No Vegetation" from 3.45% to 4.4% indicates a slight rise in land degradation, likely linked to urbanization and land-use changes. However, the significant increase in "Moderate Vegetation," from 58.78% to 79.23%, showcases positive environmental developments, possibly due to enhanced land management practices and reforestation initiatives. The slight decrease in "Dense Vegetation," from 1.92% to 1.58%, suggests that while high-density vegetation areas remain stable, they may face pressures from expanding urban landscapes. Overall, these results highlight the necessity for ongoing monitoring and effective resource management strategies to mitigate the negative impacts of land-use changes while promoting ecological recovery in the region. Continuous assessment of vegetation health through NDVI provides critical insights that can inform policy decisions and promote sustainable development in the Narsingdi district.

## 5.Reference


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