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Analyzing satellite imagery to extract land cover information using remote sensing techniques

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Abstract

Population growth, infrastructural development, and the evolving need for urban expansion have led to dynamic changes in land use patterns over time. In this study, high-resolution Sentinel-2 satellite imagery was used to produce an annotated thematic map of Narayanganj district within a Geographical Information System (GIS) framework. The classification of land cover was carried out using ArcGIS 10.6.1 software, where the image was divided into the following land cover classes: water bodies, bare land, vegetation, built-up areas, wetlands, and mangroves. This classification was essential for calculating the percentage coverage of each land feature over the study area, aiding in urban planning and serving as a foundation for further research. The results show that water bodies had the highest percentage coverage at 49.1%, followed by bare land at 29.6%, vegetation at 14.1%, and built-up areas at 7.8%. Additionally, wetlands and mangrove areas were also identified, reflecting the environmental diversity of the region.

Keywords : Vegetation Mapping, Spatial Analysis of Land ,Use Remote Sensing for LULC

1.0 Introduction

Introduction : Narayanganj**,** a rapidly urbanizing district near the capital city of Dhaka in Bangladesh, is experiencing significant land use changes. As the region continues to develop, it faces challenges related to urban sprawl, industrialization, and environmental degradation. Effective land cover classification in Narayanganj is crucial for understanding these transformations and supporting sustainable urban planning and natural resource management. Land cover (LC) is an influential factor in geographical research, from physical geography observations to environmental science and spatial planning techniques(García-Mora et al., 2012). Classifying land cover is essential to determining the distribution of both naturally occurring and artificially generated features on Earth's surface. It is essential for resource management, environmental preservation, and urban planning (Gong et al., 2013). When paired with Geographic Information System (GIS) capabilities, remote sensing technology provides an effective means of monitoring and categorizing land cover over wide swaths of territory while requiring fewer field surveys. The phrase "land cover" refers to the observed biophysical cover of the earth's surface, which is made up of patterns resulting from many natural and human-derived processes (Rozenstein & Karnieli, 2011). Using remote sensing data, which offers spectral and geographical information about the Earth's surface, the categorization is carried out. To examine and visualise the spatial distribution of these classes, GIS tools are frequently added. There are two main approaches to classify land cover: supervised and unsupervised. (Enderle & Weih Jr, 2005). There are various types of land cover such as vegetation , water bodies, urban area ,bare soil , ice , wetlands etc. Land cover classification is a powerful tool for Environmental Monitoring, Urban Planning , Agriculture,Water Resource Management (Hansen et al., 2013). One of Bangladesh's fastest-growing metropolitan areas, Narayanganj is close to the capital Dhaka and has seen substantial industrialization and urban growth in recent years. (Li et al., 2016)The district has a dynamic environment that needs to be continuously monitored

in order to maintain sustainable development because of its closeness to important rivers, rich agricultural land, and growing urban infrastructure. Using GIS and remote sensing data, this study attempts to categorize Narayanganj's land cover (Olofsson et al., 2014). This study aims to offer important insights into the land use patterns of the area by distinguishing various land cover categories, such as vegetation, water bodies, urban areas, and bare soil. The findings will provide a thorough picture of the changes in land cover in Narayanganj, facilitating more informed decisions about resource management, urban development, and environmental preservation (Townshend et al., 2000).

The objectives for this research are-

●Monitor and assess changes in land cover over time (such as vegetation, urban areas, water bodies, and bare soil) within Narayanganj using remote sensing data.

2.0 Study Area

Narayanganj, situated in central Bangladesh, is a fast-growing district located just southeast of Dhaka, the nation's capital. Geographically positioned between 23°33′ N to 23°55′ N latitude and 90°26′ E to 90°45′ E longitude**,** the district spans an area of approximately 759.57 square kilometers**..**

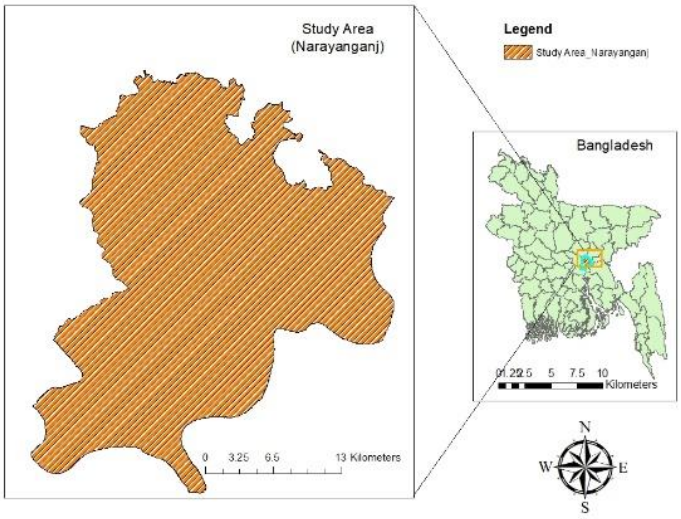


Fig 1.1 Study Area Map : Narayanganj

3.0 Data and Methodology

The primary data for this study was obtained from the Sentinel-2 Hub, which provides high-resolution satellite imagery. Sentinel-2 is part of the Copernicus Programme and is equipped with a Multispectral Instrument (MSI), offering 13 spectral bands.

3.1 Data Acquisition

The imagery was selected for its high spatial resolution and frequent revisit time, making it suitable for land cover classification. The district boundary shapefiles were sourced from processed using ArcGIS 10.6.1 software.

Table 1.1 below shows the details of the Sentinel-2 MSI data obtained for the analysis.

Satellite Name	Sentinel-2 (MSI)
Number of Scene Covering Study Area	6

Satellite Footprint (Path and Row)	S2A_MSIL2A_20240414T050601_N0214_R037_T51RKT_20240414T073413 S2A_MSIL2A_20240414T050601_N0214_R037_T51RKU_20240414T073413 S2A_MSIL2A_20240414T050601_N0214_R037_T51RLU_20240414T073413 S2A_MSIL2A_20240414T050601_N0214_R037_T51RLT_20240414T073413 S2A_MSIL2A_20240414T050601_N0214_R037_T51RLV_20240414T073413 S2A_MSIL2A_20240414T050601_N0214_R037_T51RKW_20240414T073413
Date of Imagery Acquisition	14th april, 2024
Imagery Resolution	10 meters (visible and NIR), 20 meters (red edge, SWIR), 60 meters (coastal, aerosol)
Number of Bands	13
Source	www.copernicus.eu
Imagery Cost	Free

3.2 Classification Procedure

The process involved removing the black background from the composite image to enhance clarity and improve visualization. A different band combination was applied,emphasizing key features and enhancing the distinction between land cover classes.

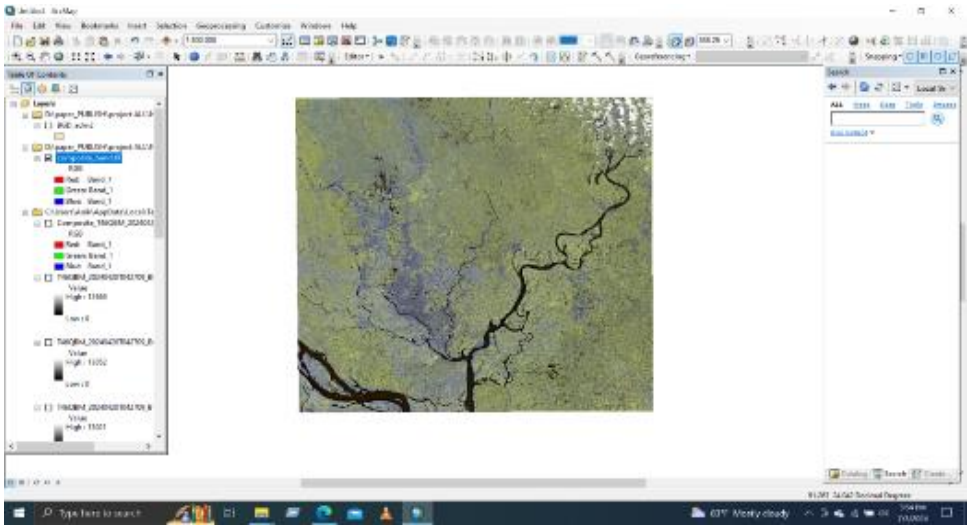


Figure 1.2: Displayed a changed band combination,

Table 1.2: Feature Classification

S/N	Land Cover Class	Description
1	**Water**	Include Streams, and inland waters
2	**Vegetation**	Include all types of vegetation coverage
3	**Bare land**	Include uncultivated lands, cleared space, and non-vegetated lands.
4	**Built up**	Include all forms of infrastructure

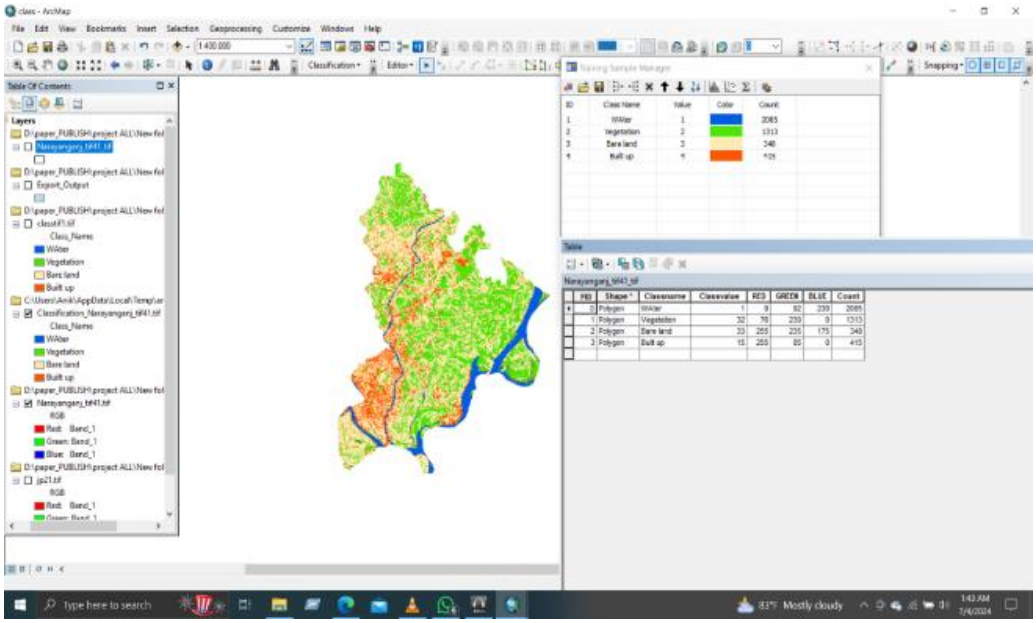


Figure 1.4: Classified into Four classes.

Using GIS, selected points in different colors were categorized into four regions: Water, Vegetation, Bare Land, and Built-Up. This process helped in spatially identifying and mapping distinct land cover types based on the selected features.

4.0 Result and Discussion

The satellite imagery of Narayanganj was classified into six land cover classes, each representing distinct features of interest within the area. These classifications help in identifying and mapping the diverse land cover types present in the district. summarizes the classification:

4.1 Estimate classification of area and percentage

In Table 1.3 highlights the distribution of land cover classes in terms of count, area, and percentage. showing that Water occupies the largest area, followed by Bare Land, with Vegetation and Built-Up covering smaller portions.

Table 1.3: Feature Class Distribution

Classname	Count	Area	Percentage
Water	2085	336.01987	49.10059
Vegetation	1313	96.458266	14.09487
Bare land	348	202.88936	29.64702
Built up	415	53.250014	7.781108

4.2 Image classification

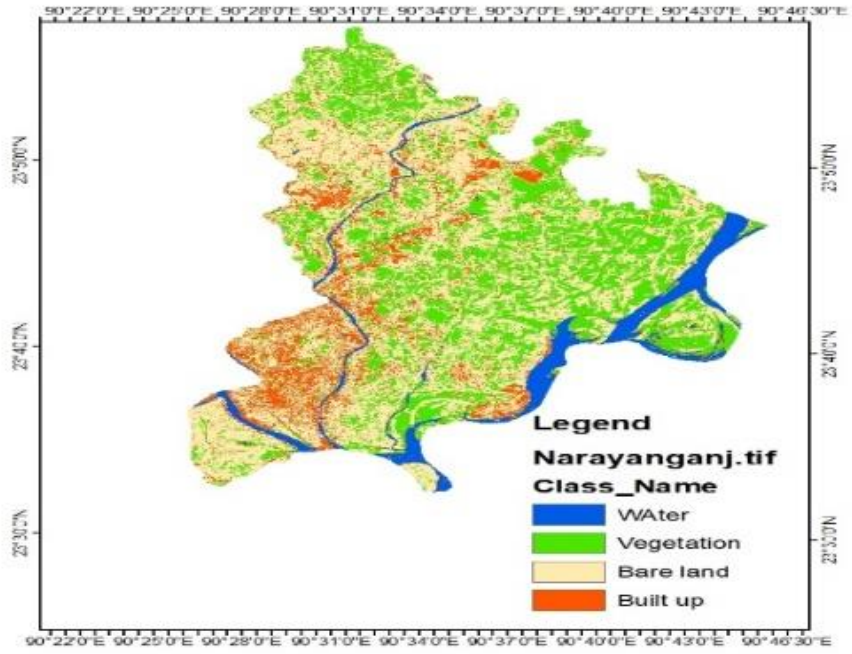


Figure 1.5: Thematic map of Narayanganj

In Figure 1.5, image classification map categorizes the study area into four distinct land cover classes: Water, Vegetation, Bare Land, and Built-Up. These classes visually represent spatial distribution and proportions of each category in the region.

4.3 Percentage Analysis

This picture shows that percentages of each category in the region**.**

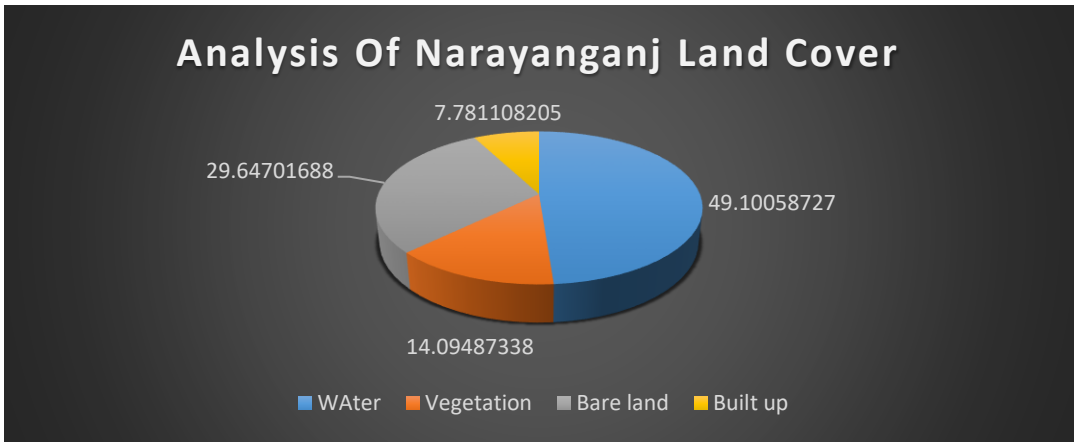


Figure 1.6: Percentage analysis classification of Narayanganj

1. In Figure 1.6: Water Bodies cover the highest percentage of land in Narayanganj, accounting for approximately 49.1% of the total area. This is primarily due to the presence of rivers like the Shitalakkhya, as well as numerous wetlands and water reservoirs. The dominance of water bodies highlights the importance of the river system in the district's economy, including fishing, transportation, and agriculture.
2. Vegetation (including dense and sparse vegetation) makes up about 14.1% of the land cover. Despite the rapid urban expansion, a significant portion of the land is still used for agriculture and forestry,

which contributes to the local economy. Seasonal variations and conservation efforts play a role in maintaining vegetation cover, especially during the wet season when plant growth is at its peak.

3. Bare Land occupies around 29.6% of the district's area. This includes undeveloped lands, open fields, and lands that are awaiting construction or are in transition due to urban sprawl. The extensive presence of bare land reflects the ongoing infrastructural development projects, which include the construction of roads, residential areas, and industrial zones.
4. Built-Up Areas constitute 7.8% of the land cover in Narayanganj. The built-up areas are characterized by a high density of residential, commercial, and industrial buildings. The rapid growth of this feature class is a clear indication of Narayanganj's urban expansion, driven by industrialization and population growth.

5.0 CONCLUSION

In conclusion, the primary objective of this project, which was to create an annotated thematic map of Narayanganj district, has been successfully accomplished by analyzing the percentage coverage of various land cover classes. Using high-resolution Sentinel-2 satellite imagery, the study area was classified into six distinct feature classes: Water Bodies, Bare Land, Vegetation, Built-Up Areas, Wetlands, and Mangroves.

The results revealed that Water Bodies dominate the landscape, covering approximately 49.1% of the area, largely due to the presence of the Shitalakkhya River and other water systems. Bare Land, which includes undeveloped land and areas under construction, accounts for 29.6%, reflecting the district's rapid urbanization and infrastructural growth. Vegetation, representing agricultural lands and forested areas, covers around 14.1% of the region, demonstrating the presence of rural areas amidst the urban expansion.

6. REFERENCE

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