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Assessment of Land Use Patterns Using NDVI, NDWI, And NDBI Indices: The Case of Yangiyul District

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Abstract

This article analyzes land resource use in Yangiyol District based on the NDVI, NDWI, and NDBI spectral indices. The study utilized index maps derived from satellite imagery. The results enabled the identification and spatial assessment of vegetation cover, water bodies, and built-up areas. The findings are of practical importance for land-use planning and monitoring.

Keywords: Spatial distribution, land resources, monitoring, urbanization, Landsat, Sentinel, land cover, land management, land use, vegetation.

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1. Introduction

As Land is one of the most ancient and essential natural resources of humanity, and its proper and rational management plays a crucial role in ensuring the sustainable socio-economic development of any state. In the present day, rapid population growth, increasing urbanization, environmental challenges, and the expanding demand for agricultural land have significantly intensified the need for accurate accounting, assessment, and continuous monitoring of land resources. From this perspective, remote sensing (RS) and Geographic Information Systems (GIS) are regarded as among the most advanced achievements of modern science and technology and are widely applied in land resource management.

These technologies enable fast and reliable assessment of large territories through satellite imagery, facilitate continuous monitoring of land resource conditions, and allow the detection of spatial and temporal changes. Land use represents a complex set of socio-economic forms and production methods of utilizing land resources, developing objectively through the conscious application of economic laws in harmony with natural laws [1].

Over the years, remote sensing technologies have demonstrated high accuracy in analyzing indicators such as soil conditions, vegetation cover, salinization, water availability, and urbanization processes. GIS technologies, in turn, play a vital role in visualizing these data in cartographic form, as well as in their analysis, storage, and application within decision-making processes.

In the Republic of Uzbekistan, recent years have

witnessed an expansion in the application of remote sensing and GIS technologies within the framework of digitalization processes, modernization of the land cadastre system, the implementation of the Law "On Land Accounting and Monitoring," and the Digital Development Strategy for 2022–2026. In particular, data obtained from satellite systems such as Landsat, Sentinel, and MODIS serve as an important source for in-depth analysis of the ecological and economic conditions of the land surface. Nevertheless, despite these advancements, traditional approaches based on cadastral and statistical methods still dominate land resource accounting practices in many districts and regions of Uzbekistan. This situation often leads to outdated, incomplete, or inconsistent data.

Therefore, this study aims to scientifically and practically substantiate the effectiveness of applying remote sensing and GIS technologies in land resource accounting, as well as to assess their potential for wider implementation in practice. In addition, land resource use is considered as a continuous, cyclical, and multi-purpose process managed through market-based mechanisms, developing on the basis of the conscious application of the laws governing the interaction between society and nature.

Within the framework of this research, land cover conditions of the study area were analyzed using Landsat and Sentinel satellite imagery. Remote sensing data were pre-processed, and NDVI, NDWI, and NDBI indices were calculated using spectral bands. The NDVI index was applied to assess vegetation cover conditions, NDWI to identify water bodies and moist areas, and NDBI to delineate built-up and urbanized zones. The obtained results were evaluated using spatial analysis and comparative assessment methods.

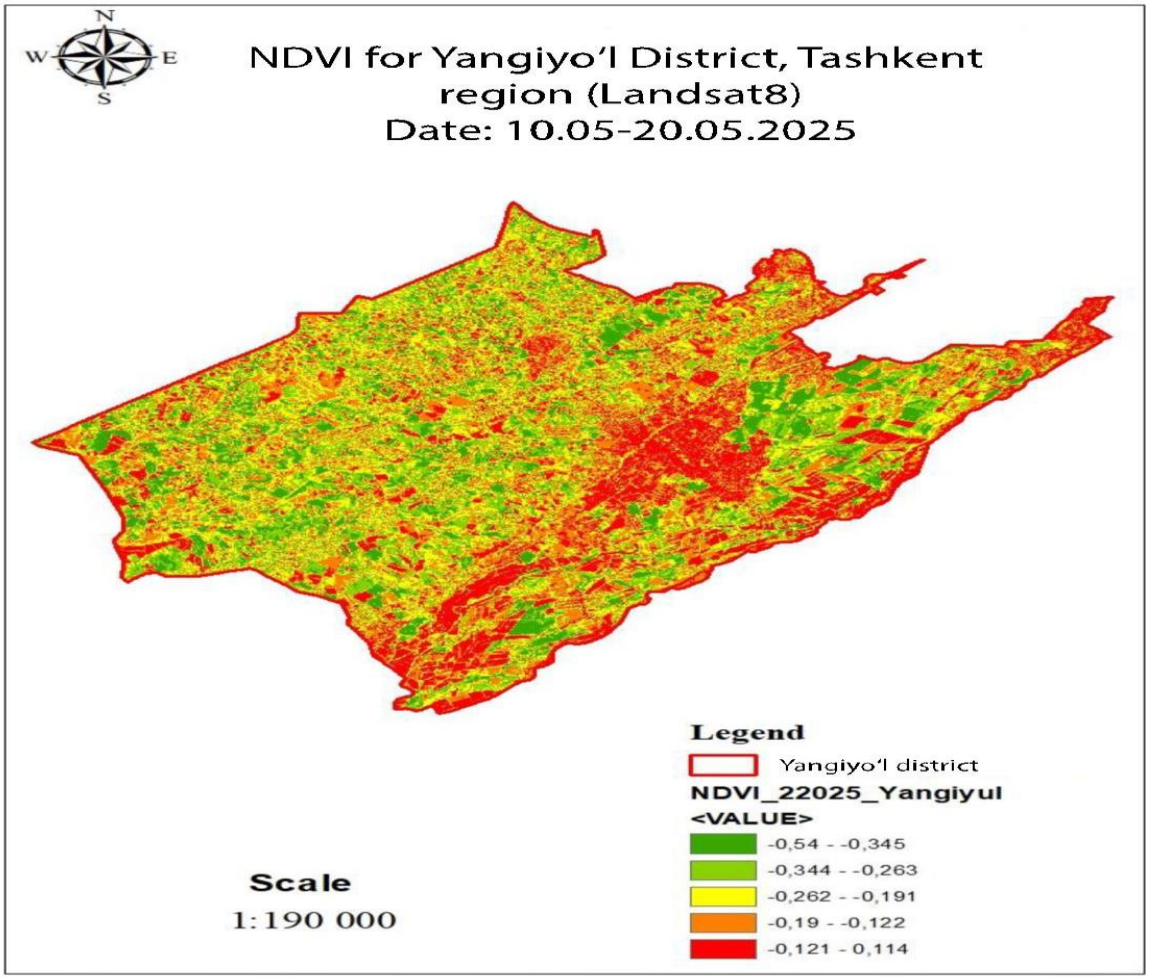

Figure 1. NDVI Analysis of Yangiyul District, Tashkent region (2025)

The analysis of the 2025 land cover map indicates a further expansion of red zones (NDVI values above −0.121) across the district. In particular, the central and eastern parts of the study area are characterized by noticeably low vegetation levels. In contrast, green zones representing healthy vegetation are predominantly preserved in the south-western and north-eastern parts of the district.

The 2025 analysis was conducted during the period from May 10 to May 20, which corresponds to the onset of the active vegetation growth stage. Nevertheless, vegetation levels were lower compared to other years. The 2025 map of Yangi Yo‘l District reveals generally low vegetation index values. This situation can be explained by several key factors:

- Intensification of urbanization processes;
- Expansion and conversion of agricultural lands;
- Scarcity of water resources;
- Climate change.

In the district, areas designated for central, eastern, and southern agricultural use have decreased, particularly in regions close to populated settlements. Meanwhile, the use of temporarily vacant lands has increased, indicating that some plots remain unused. The water resources have slightly expanded, especially in the south-eastern part of the district.

- The reduction of areas allocated for agriculture may negatively affect agricultural production [2].
- Changes in the extent of water bodies also reflect the direct impact of climatic conditions and land reclamation status.

The MNDWI (Modified Normalized Difference Water Index) is a widely used spectral index based on remote sensing for detecting water surfaces and monitoring the extent of water bodies. MNDWI is an improved version of the NDWI (Normalized Difference Water Index), providing more precise and reliable results for identifying areas saturated with water [4].

MNDWI quyidagi formulaga asosan hisoblanadi:

$$MNDWI = \frac{(Green - SWIR)}{(Green + SWIR)}$$

Here:

- Green — reflected light in the green spectrum (obtained from the satellite’s green band),
- SWIR — Short-Wave Infrared spectrum, i.e., values obtained from the SWIR band.

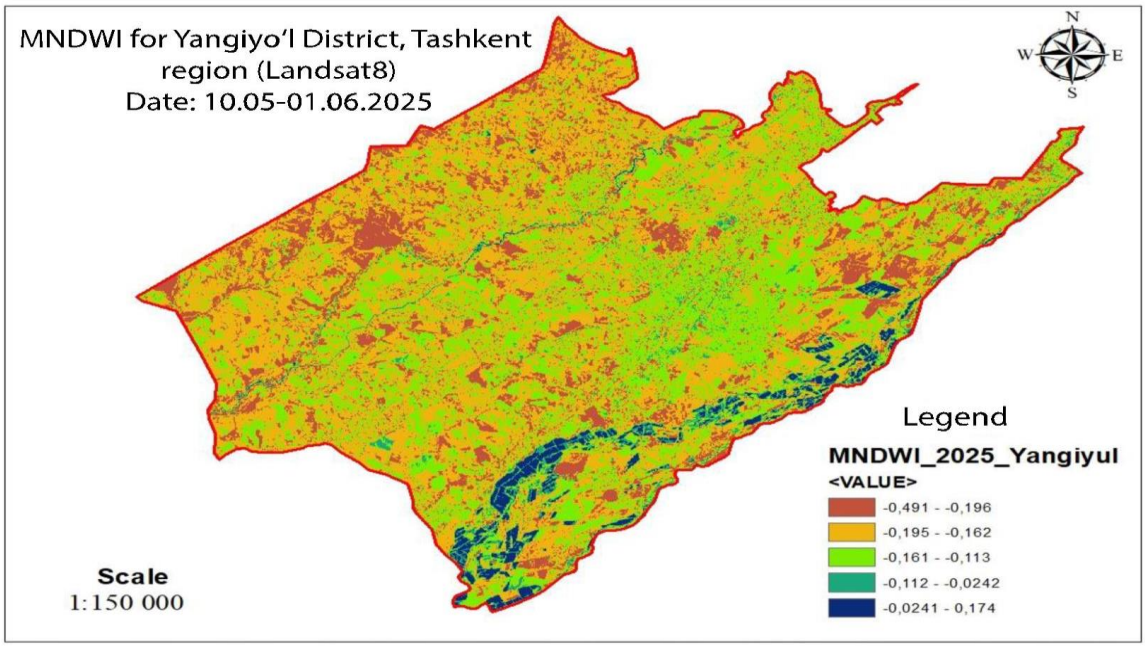

Figure 2. MNDWI Analysis of Yangiyul District, Tashkent region (2025)

Value ranges and interpretation of the MNDWI index:

MNDWI value	Interpretation
> 0.0	Areas with the presence of water surfaces
0.0 – (-0.2)	Moist soil and marshy areas
< -0.2	Dry lands, agricultural areas, and built-up regions

Using the MNDWI, it is possible to monitor and account for the following: monitoring of water bodies (rivers, canals, lakes), identification of irrigated areas, analysis of water scarcity or flooding events, and monitoring of water infiltration in urbanized areas. The MNDWI index of Yangi Yo‘l District in Tashkent Region was analyzed to assess the presence and condition of water resources.

The NDBI (Normalized Difference Built-up Index) is a spectral index developed for detecting urbanized (built-up) areas using remote sensing [5,6]. NDBI is based on the characteristic reflection of built-up surfaces in the infrared spectrum [7] and is commonly used to distinguish urban areas from agricultural lands, bare soils, and water bodies.

$$NDBI = \frac{(SWIR - NIR)}{(SWIR + NIR)}$$

here:

- SWIR — Shortwave Infrared band,NIR — yaqin infraqizil kanal (Near Infrared).

2025 Map Analysis:

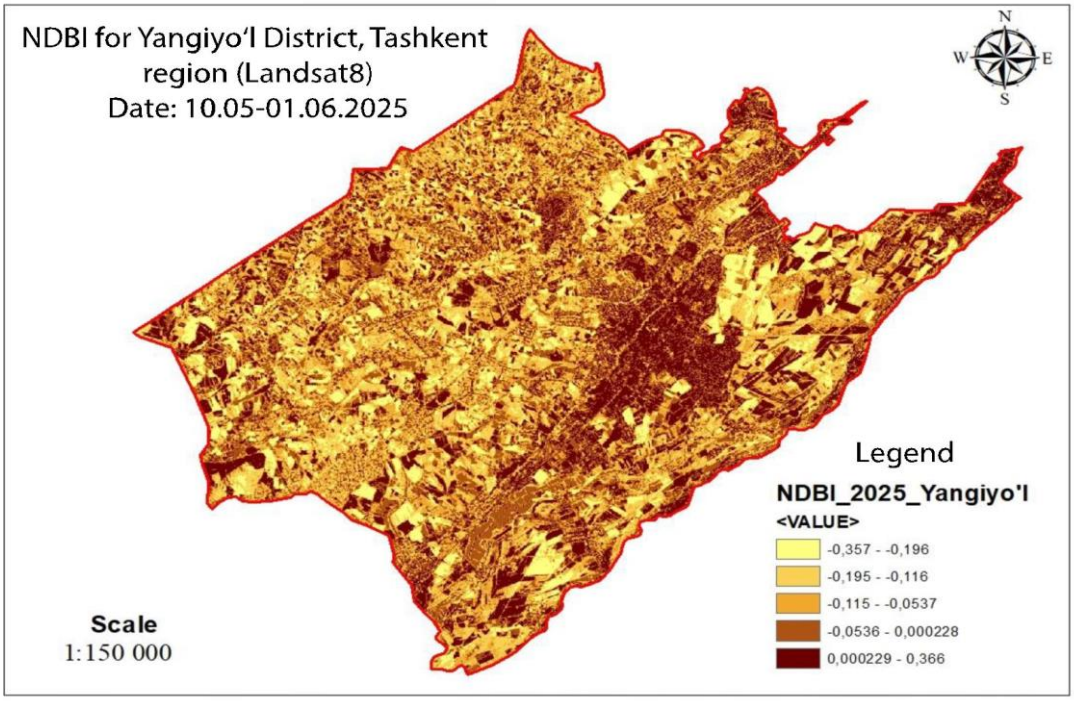

Figure 3. NDBI Analysis of Yangiyul District, Tashkent region (2025)

On the map, dark brown and deep yellow colors indicate urbanized areas. In the northern and central parts, NDBI values are high, reflecting dense concentrations of buildings, asphalt roads, and industrial facilities. Lower values (lighter colors) correspond to agricultural lands, bare soils, and areas without vegetation.

NDBI value range	Interpretation
> 0.2	High density of buildings, constructions, and urban areas
0.0 – 0.2	Moderately urbanized area
< 0.0	Areas of vegetation, water, or bare soil

As of 2025, the central and north-eastern areas of Yangi Yo‘l District are urbanized. This reflects the high population density and advanced development of infrastructure in the district. When NDBI results are compared with NDVI, urban zones can be more clearly distinguished due to the lack of vegetation or the presence of artificial surfaces. GIS technologies allow for the mapping, storage, and analysis of spatial data derived from these indices, which in turn supports scientifically grounded decision-making in land resource management [8]. The term “land cover” refers to the physical state of the land surface, including forests, vegetation, as well as natural, semi-natural, managed, or human-made objects and features [9].

2. Conclusion

In conclusion, for the year 2025, remote sensing analyses were conducted in Yangi Yo‘l District using Landsat 8 satellite imagery. NDVI (Vegetation), MNDWI (Water availability), and NDBI (Urbanization) indices were processed in ArcGIS 10.8 to generate thematic maps. The analysis results were evaluated based on the average index values as follows:

- NDVI: With a value of 0.32 on a scale from −1 to +1, this indicates a moderate level of vegetation health. The density of green vegetation is primarily high in agricultural areas.

- MNDWI: With a value of 0.12 on a scale from −1 to +1, this indicates a low presence of water surfaces. Water resources are limited and are mainly confined to irrigation canals and rivers.

- NDBI: With a value of 0.28 on a scale from −1 to +1, this indicates the expansion of urbanization and artificial surfaces. The index is higher around district centers and infrastructure facilities.

The ratios between these indices serve as an important source for monitoring land resources, planning agrotechnical measures, implementing land reclamation activities, and analyzing urbanization pressure.

Thus, the combined analysis of NDVI, MNDWI, and NDBI indices demonstrated a comprehensive assessment of the ecological condition of land resources and highlighted the effectiveness of GIS technologies in their management.

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