Oriental Renaissance: Innovative, educational, natural and social sciences
Research BIB / Index Copernicus
(E)ISSN: 2181-1784
5(10), 2025
www.oriens.uz

MONITORING VEGETATION COVER IN YUQORI CHIRCHIQ DISTRICT, UZBEKISTAN USING NDVI AND GIS

Oymatov Rustam Kamariddinovich
PhD, Associate Professor
Masharipov Siyovush Ochilbek ogli
Master's Student of the faculty of Earth Resources and cadaster
(Geodesy and Geoinformatics).

ABSTRACT

Remote sensing and geographic information systems (GIS) are widely used tools for monitoring agricultural land and vegetation dynamics. This study assesses spatial-temporal changes in vegetation cover in the Yuqori Chirchiq district of Tashkent region, Uzbekistan, using the Normalized Difference Vegetation Index (NDVI) derived from Landsat satellite imagery. NDVI maps were generated for the summer seasons from 2020 to 2025 to analyze vegetation condition and its temporal variation. The study area was delineated using administrative boundaries, and NDVI values were classified into moderate and dense vegetation categories. Quantitative analysis was performed based on pixel statistics to evaluate changes in vegetation coverage over time. The results indicate relatively stable vegetation conditions with minor interannual fluctuations, reflecting the influence of agricultural practices and seasonal variability. The proposed approach demonstrates the effectiveness of integrating remote sensing data and GIS techniques for agricultural land monitoring at the district level and can be applied to similar regions for environmental and land-use assessment.

Keywords: *Remote sensing; GIS; NDVI; Vegetation monitoring; Agricultural land; Yuqori Chirchiq district.*

INTRODUCTION

Vegetation plays a crucial role in maintaining environmental balance and supporting agricultural productivity, particularly in regions like Central Asia where land use and climate variability significantly influence crop and pasture conditions [1]. Monitoring vegetation dynamics over time allows for the assessment of ecosystem health, agricultural productivity, and land management practices [2], [3]. Remote sensing techniques, especially the Normalized Difference Vegetation Index (NDVI), have proven effective in detecting and quantifying spatial-temporal changes in vegetation cover [4], [5]. NDVI provides an objective measure of vegetation density and vigor, making it a widely used tool for agricultural monitoring and environmental assessment [6], [7]. Integration of NDVI with Geographic Information Systems (GIS) further enhances the capability to analyze vegetation at various spatial scales and to visualize temporal trends efficiently [8], [9], [10].This combined approach allows researchers to examine patterns of land cover change, evaluate the impact of agricultural practices, and support sustainable land-use planning[11], [12] . Despite the extensive use of these methods globally, studies focusing specifically on the Yuqori Chirchiq district are limited. This study aims to fill this gap by analyzing spatial-temporal changes in vegetation cover from 2020 to 2025 using NDVI derived from Landsat satellite imagery, coupled with GIS techniques. The study involves generating NDVI maps for each year, classifying vegetation into density categories, and assessing temporal changes in vegetation cover to provide insights into agricultural and environmental dynamics in the region.

Study Area

The study was conducted in the Yuqori Chirchiq district, located in the Tashkent region of Uzbekistan. The district lies in a semi-arid zone of Central Asia and is characterized by a continental climate with hot summers and cold winters. Average annual precipitation ranges between 400–600 mm, with most rainfall occurring in spring and early summer [1], [2]. The terrain includes agricultural fields, pastures, and scattered settlements, with a predominance of irrigated croplands supporting local agriculture [11]. Yuqori Chirchiq was selected for this study due to its agricultural significance and the need to monitor vegetation dynamics over time. The district represents a typical landscape in the region where seasonal variations, irrigation practices, and land-use changes directly influence vegetation cover. Monitoring this area provides valuable insights into the environmental and agricultural patterns that can inform sustainable land management strategies [2], [3].

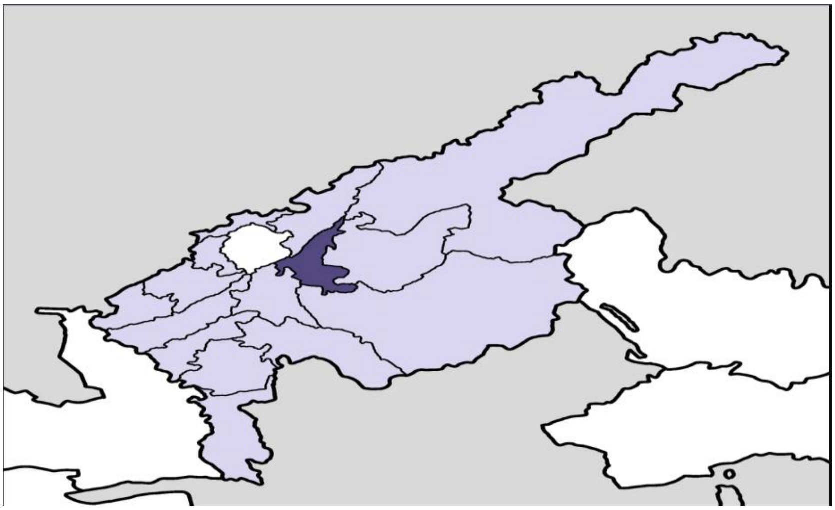

Figure 1. Location of Yuqori Chirchiq district in the Tashkent region, Uzbekistan [Wikipedia, n.d.].[13]

Data Sources and Methodology

The study employed Landsat Level-2 satellite imagery obtained from the USGS Earth Explorer platform for the period 2020–2025. Level-2 products provide atmospherically corrected surface reflectance values, suitable for vegetation analysis using NDVI [5], [6]. Images from the summer season (June–August) were selected to capture peak vegetation growth in the Yuqori Chirchiq district.

Spatial processing and analysis were performed using ArcGIS Pro to delineate the study area and organize raster data. Further quantitative and spatio-temporal analysis was carried out in Python using Jupyter Notebook within the Anaconda environment. Key Python libraries included rasterio, numpy, matplotlib, and geopandas for reading raster data, performing calculations, and visualizing NDVI maps.

NDVI Calculation

The Normalized Difference Vegetation Index (NDVI) was calculated using the formula:

NDVI = (NIR - Red) / (NIR + Red)

Where:

NIR – Near-Infrared band reflectance

RED – Red band reflectance

NDVI values were classified into vegetation density categories:

Pixel-based statistics were computed for each year to assess the area covered by each NDVI category. Change detection was performed by comparing classified NDVI raster’s across years to identify increasing or decreasing vegetation trends.

GIS Integration

NDVI raster’s were combined with the district boundary shapefile in ArcGIS Pro to extract vegetation statistics within the administrative area[9], [10]. Maps were generated for each year (2020–2025) to visualize spatial and temporal variations in vegetation cover.

Results and Discussion

Vegetation Classification and Pixel Statistics

The analysis of NDVI for the Yuqori Chirchiq district from 2020 to 2025 was classified into Moderate vegetation (NDVI 0.2–0.5) and Dense vegetation (NDVI >0.5). The pixel-based results are summarized in Table 1:

Year	**Moderate Vegetation (pixels / %)**	**Dense Vegetation (pixels / %)**
2020	235,583 / 99.19%	1,927 / 0.81%
2021	183,443 / 99.00%	1,850 / 1.00%

2022	205,908 / 99.06%	1,955 / 0.94%
2023	221,736 / 99.24%	1,703 / 0.76%
2024	223,963 / 98.88%	2,543 / 1.12%
2025	178,016 / 98.79%	2,186 / 1.21%

Table 1. Pixel count and percentage of Moderate and Dense vegetation categories in Yuqori Chirchiq district, 2020–2025.

Temporal Variation of NDVI

The temporal dynamics of vegetation are further illustrated in the graph (**Figure 1**), which shows the **yearly change in vegetation density**:

NDVI values peak in 2023–2024, indicating higher vegetation activity.

Lower NDVI values are observed in 2021 and 2025, reflecting reduced vegetation cover.

The trend demonstrates **relatively stable vegetation** with minor interannual fluctuations.

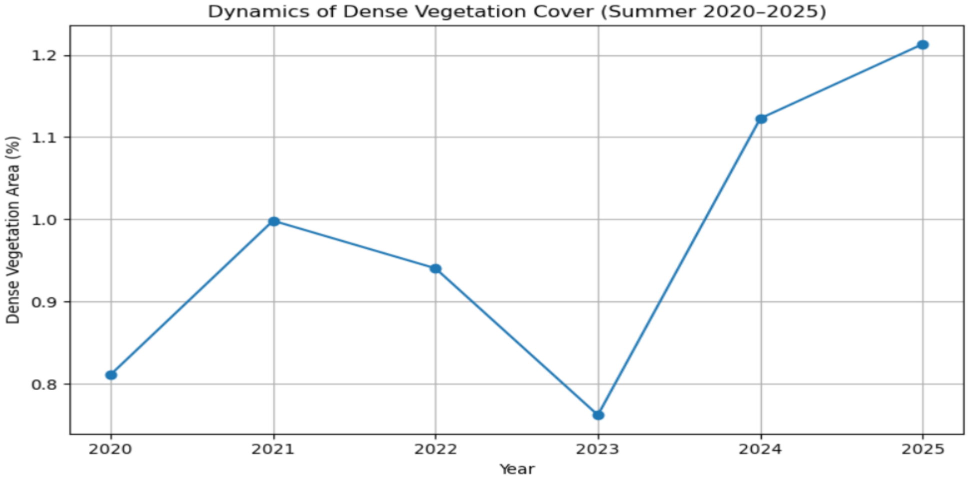

Figure 1. Annual NDVI-based vegetation dynamics in Yuqori Chirchiq district (2020–2025).

Spatial Distribution of NDVI

NDVI maps generated for each year (2020–2025) reveal **spatial patterns** of vegetation:

Areas with consistently dense vegetation correspond to irrigated croplands and regions of permanent cultivation.

Areas with moderate vegetation represent less intensively managed or seasonal croplands.

Minor spatial changes are observed across years, consistent with pixel statistics.

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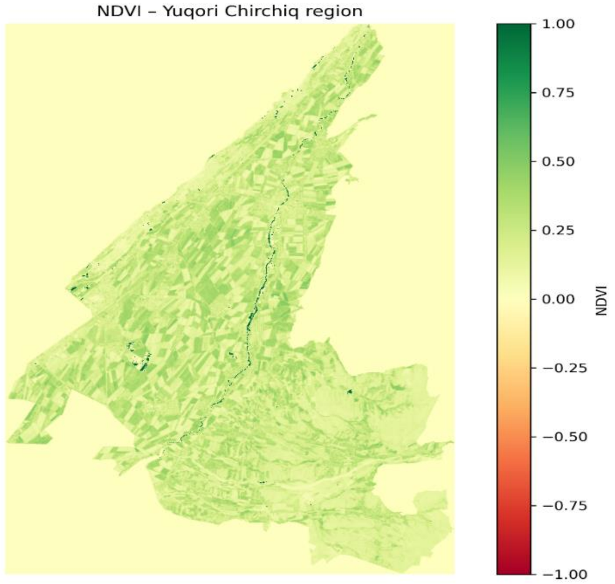

Figure 2. Spatial distribution of the NDVI index and vegetation classification in 2020.

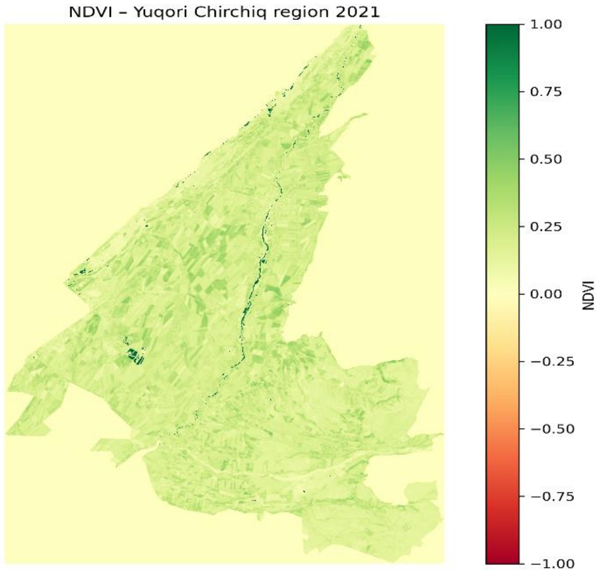

Figure 3. Spatial distribution of the NDVI index and vegetation classification in 2021.

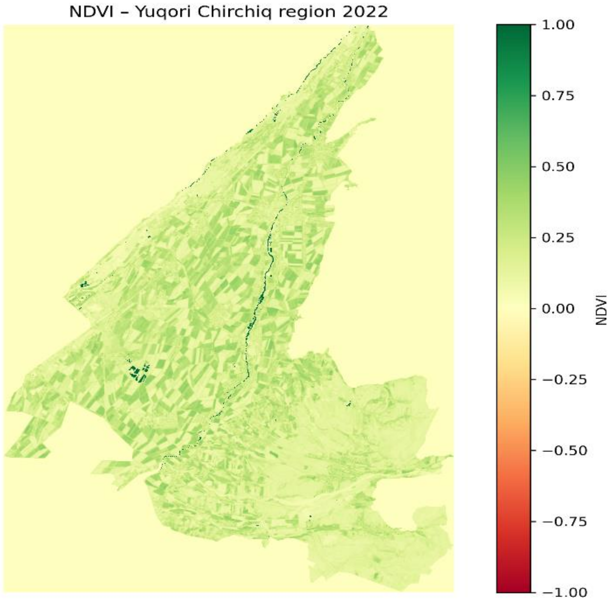

Figure 4. Spatial distribution of the NDVI index and vegetation classification in 2022.

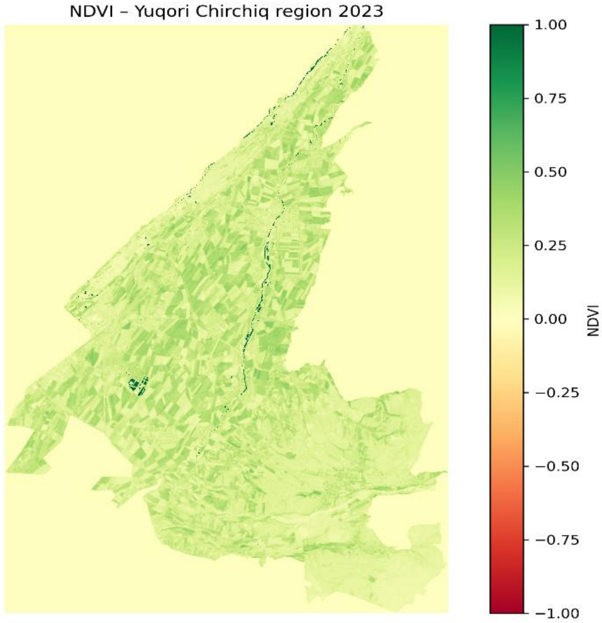

Figure 5. Spatial distribution of the NDVI index and vegetation classification in 2023.

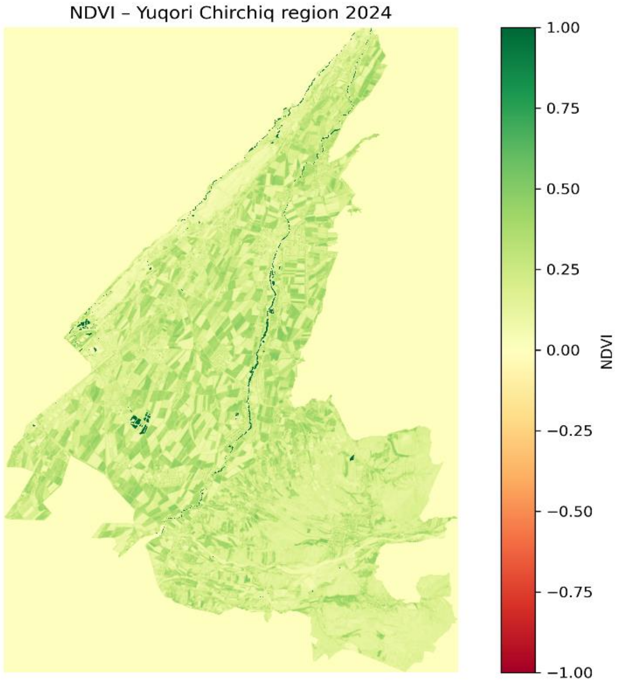

Figure 6. Spatial distribution of the NDVI index and vegetation classification in 2024.

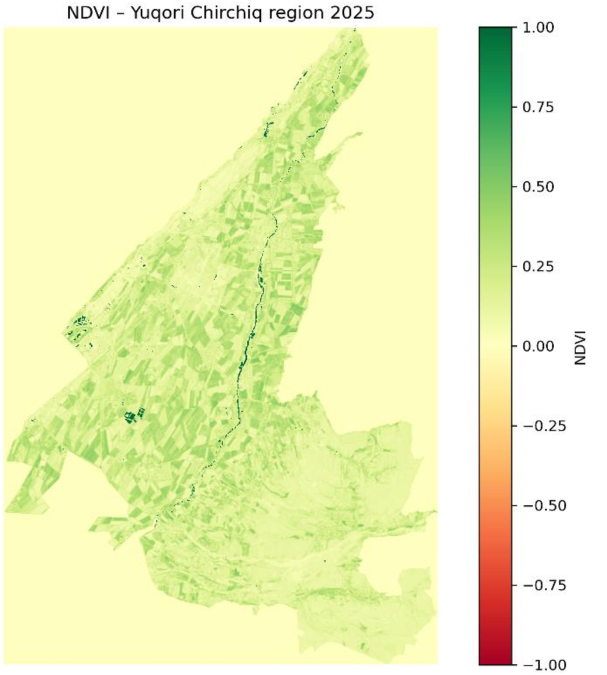

Figure 7. Spatial distribution of the NDVI index and vegetation classification in 2025.

Discussion of Trends

The analysis highlights several key trends:

Stability of vegetation cover: Moderate vegetation dominates the district, showing stable land use over the study period.

Minor increase in dense vegetation (2024–2025): Could indicate improved irrigation or cropping intensity.

Interannual variability: Years with slightly lower dense vegetation (2021) may reflect reduced rainfall or delayed crop growth.

Overall, the integration of NDVI analysis with GIS techniques allows for **effective monitoring of vegetation dynamics**, providing insights into land management, agricultural planning, and environmental assessment in the region.

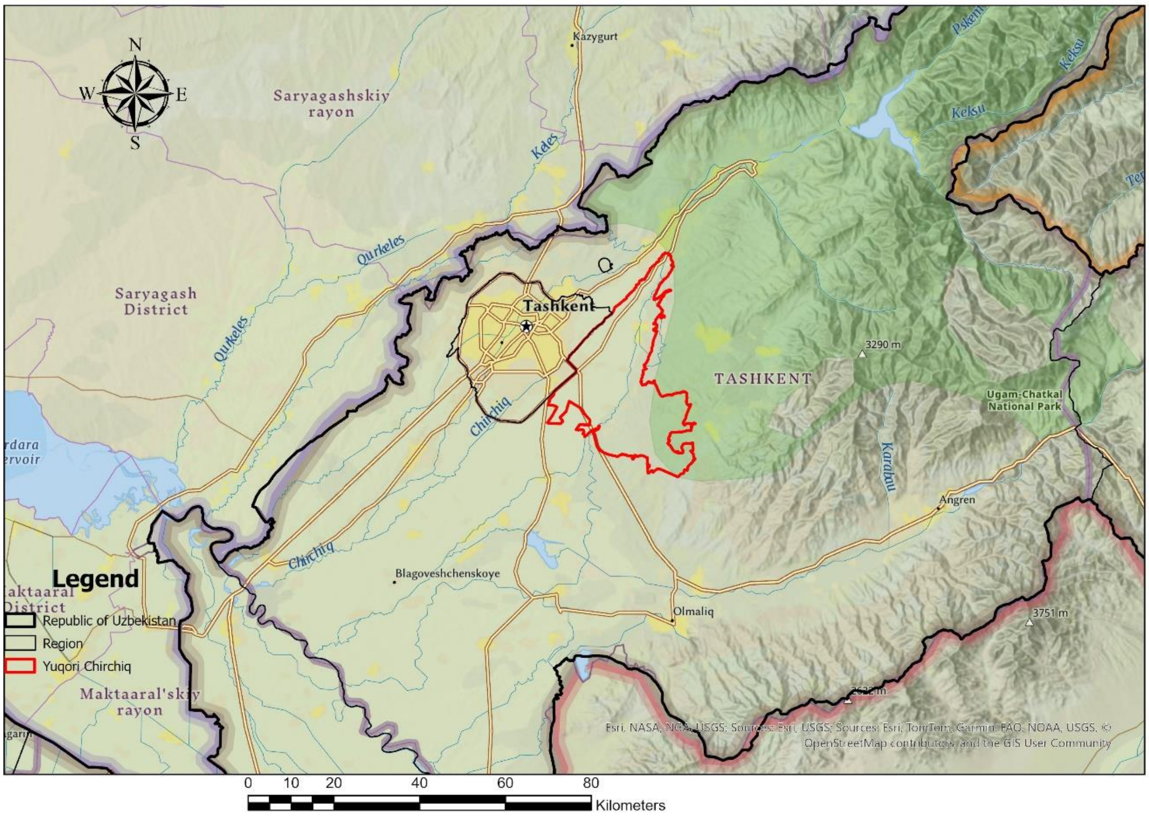

Figure 8. Location of Yuqori Chirchiq District within Tashkent Region, Uzbekistan. The map was created using ArcGIS Pro.

Conclusion

This study analyzed spatial-temporal changes in vegetation cover in Yuqori Chirchiq District, Tashkent Region, Uzbekistan, using NDVI derived from Landsat satellite imagery and GIS techniques. The results indicate that vegetation in the district has remained relatively stable over the period 2020–2025, with minor interannual fluctuations. Notably, a slight increase in dense vegetation was observed in 2024–2025, which may reflect improved irrigation practices or intensified cropping. Conversely, lower NDVI values in 2021 likely correspond to reduced rainfall or delayed crop growth.

The integration of NDVI analysis with GIS allowed for the visualization and quantification of both spatial and temporal variations in vegetation, providing valuable insights into agricultural and environmental dynamics at the district level. The study highlights the effectiveness of remote sensing and GIS for monitoring land use and supporting sustainable agricultural planning.

Some limitations were identified. For example, distinguishing buildings or artificial surfaces from vegetation using NDVI alone was challenging, as the index primarily captures vegetative activity. Future studies could integrate additional indices or high-resolution imagery to better separate land cover types.

Overall, this research contributes to understanding vegetation dynamics in a semi-arid region of Uzbekistan and demonstrates a practical approach for environmental monitoring, which can inform land management and agricultural decision-making in similar areas.

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