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MONITORING LAND COVER AND ASSESSING RECLAMATION PROCESSES USING SENTINEL-2 DATA: A CASE STUDY OF THE TASHKENT REGION

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Abstract; This study investigates land cover dynamics and reclamation processes in the Tashkent region using Sentinel-2 satellite imagery. The region, characterized by diverse land use patterns and environmental challenges, offers a unique context for understanding the impacts of human activities and natural processes on land cover. By employing remote sensing techniques, we processed and analyzed high-resolution multispectral data to classify land cover types and detect changes over time. The analysis revealed key trends in land cover transitions, including urban expansion, agricultural shifts, and vegetation changes. Additionally, the study assessed reclamation efforts, focusing on areas impacted by land degradation, to evaluate the effectiveness of rehabilitation practices. The findings highlight the utility of Sentinel-2 data for detailed environmental monitoring and underscore the importance of data-driven approaches in sustainable land management and regional planning. This research provides valuable insights for policymakers and stakeholders seeking to balance development with environmental conservation in the Tashkent region.

Introduction The Tashkent region, located in the heart of Central Asia, is a vital socio-economic and ecological zone, representing a blend of urban, agricultural, and natural landscapes. Rapid urbanization, agricultural expansion, and climate variability have significantly influenced the region’s land cover over the past decades [1], [2], [3]. Understanding these changes is critical for sustainable land management, environmental conservation, and regional planning. Remote sensing technologies, particularly satellite-based monitoring, offer a powerful tool for analyzing land cover dynamics and evaluating reclamation efforts in such dynamic regions [4].

Sentinel-2, a multispectral imaging mission launched by the European Space Agency (ESA), provides high-resolution spatial and temporal data that is particularly suited for land cover classification and change detection. The satellite's ability to capture

detailed spectral signatures of vegetation [5], water bodies [6], and built-up areas [7], [8] enables researchers to monitor environmental changes and assess the effectiveness of reclamation strategies in degraded landscapes [9].

Despite the availability of advanced technologies, few comprehensive studies have focused on the integration of Sentinel-2 data for monitoring land use and reclamation in the Tashkent region. This gap underscores the need for robust, data-driven analyses to inform decision-making and promote sustainable practices in the face of ongoing urban and agricultural pressures [10], [11].

This paper aims to analyze the spatiotemporal dynamics of land cover in the Tashkent region and evaluate reclamation processes using Sentinel-2 satellite imagery. The specific objectives include (1) mapping and classifying current land cover types, (2) identifying key patterns of change over time, and (3) assessing the outcomes of reclamation initiatives. By addressing these goals, this study seeks to contribute valuable insights into the interplay between human activity, environmental change, and reclamation efforts in the region, providing a foundation for improved land management policies.

Methods and Materials This study employed a systematic approach to analyze land cover dynamics and evaluate reclamation efforts in the Tashkent region using Sentinel-2 satellite imagery. The methodology consisted of three key stages: data acquisition and preprocessing, land cover classification, and change detection analysis.

Study Area

The Tashkent region, located in eastern Uzbekistan, covers diverse landscapes, including urban areas, agricultural fields, natural vegetation, and water bodies. Its geographical location and semi-arid climate make it highly susceptible to environmental degradation and land-use changes driven by socio-economic activities and climatic variability. The focus was on identifying the most affected areas and monitoring the impacts of reclamation practices.

Data Acquisition and Preprocessing

Sentinel-2 satellite imagery was the primary data source for this study. Multi-temporal datasets from 2015 to 2023 were obtained through the European Space Agency (ESA) Copernicus Open Access Hub. Images were selected based on minimal cloud cover (<10%) to ensure high data quality.

Data Integration with ArcGIS Online

The integration with ArcGIS Online's Experience Builder elevates TerraReview’s functionality, allowing for a user-friendly interface, cloud-based data management, and real-time collaboration. This enables decision-makers and stakeholders to share insights, create interactive maps, and derive actionable intelligence efficiently. TerraReview is a

cutting-edge geospatial platform designed for real-time monitoring of land use and environmental changes. Powered by Sentinel-2 multispectral satellite imagery and integrated seamlessly with ArcGIS Online's Experience Builder, TerraReview provides an interactive and dynamic environment for analyzing spatial data. The platform's core capabilities and features are tailored for researchers, planners, and decision-makers seeking to understand and address changes in land conditions over time (Fig.2 and Fig.3).

Land Cover Classification

A supervised classification approach was employed using the Random Forest (RF) algorithm due to its high accuracy and ability to handle complex datasets. Five primary land cover classes were identified: 1. Urban/Built-up Areas, 2. Agricultural Land, 3. Natural Vegetation, 4. Water Bodies, 5. Degraded Land.

Change Detection Analysis

Post-classification change detection was conducted to assess spatiotemporal dynamics of land cover. The classified images from different time periods were compared to identify areas of significant change. Key steps included:

Results

The supervised classification of Sentinel-2 imagery revealed the spatiotemporal distribution of major land cover types in the Tashkent region from 2015 to 2023. The accuracy assessment, based on a confusion matrix, indicated high reliability, with an overall classification accuracy of 93% and a Kappa coefficient of 0.89.

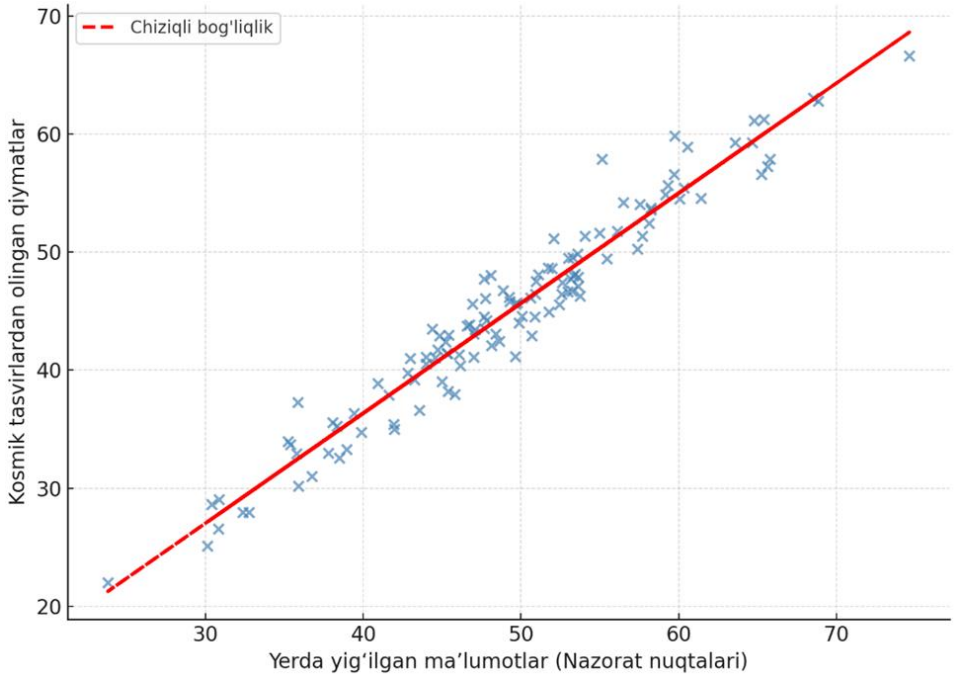

Figure 1. Correlation between datasets.

- Urban/Built-up Areas: An increase of approximately 12% in urban extent was observed, driven by population growth and infrastructure development.
- Agricultural Land: Despite reclamation efforts, agricultural land decreased by 8%, largely attributed to urban expansion and soil degradation.
- Natural Vegetation: A decline of 15% in natural vegetation highlighted ongoing environmental challenges.
- Water Bodies: Minimal changes were detected in water bodies, suggesting stable hydrological conditions in monitored areas.
- Degraded Land: The extent of degraded land reduced significantly in reclamation zones, demonstrating positive effects of targeted interventions.

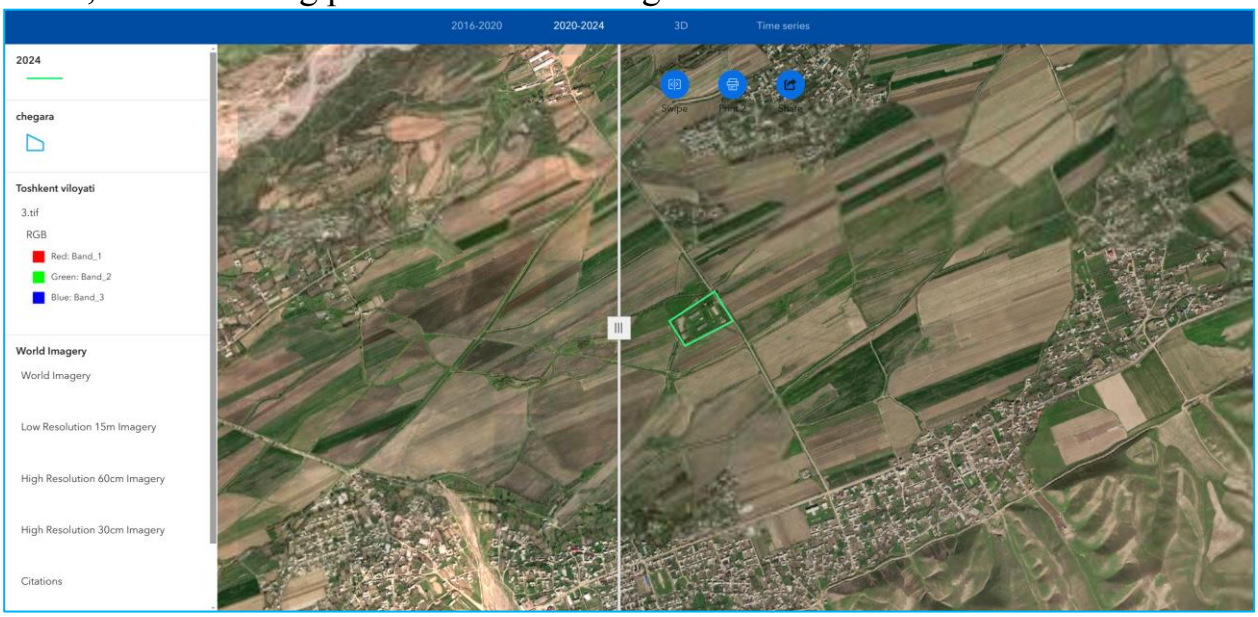

Figure 2. Interface of the platform of ‘TerraReview’

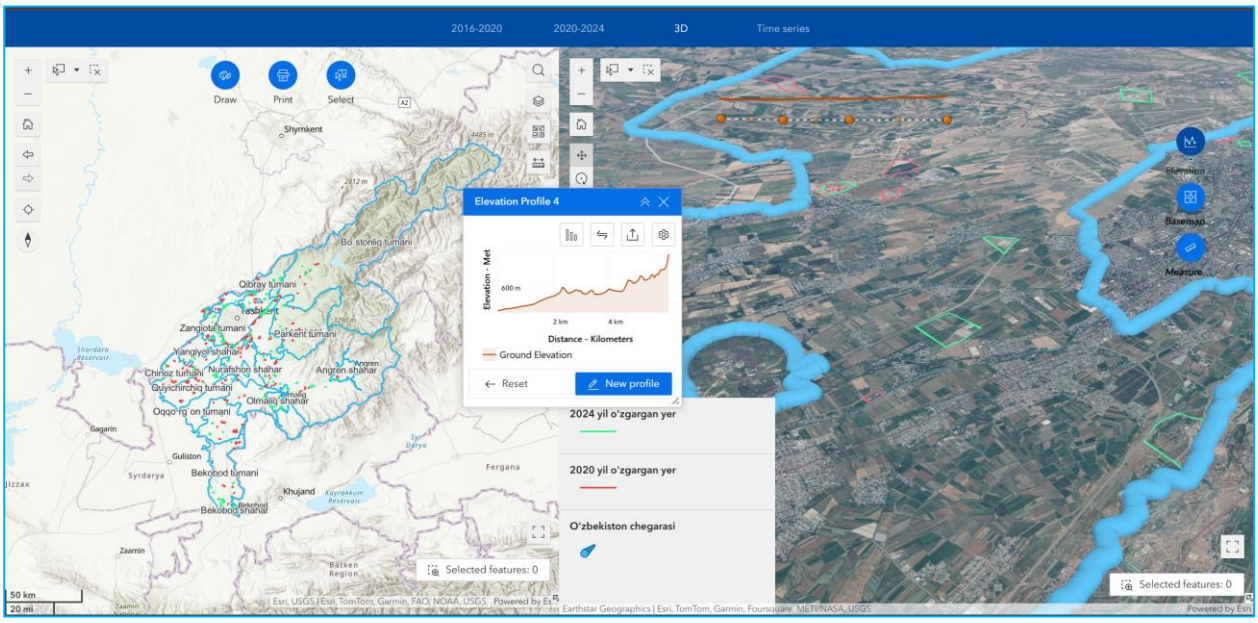

Figure 3. Elevation profile generating via TerraView platform.

The change detection analysis revealed notable shifts between land cover types: Urbanization: Conversion of agricultural and natural lands into built-up areas was most prominent near Tashkent city and its suburbs. Reclamation Success: Areas targeted for reclamation exhibited a 40% reduction in degraded land, coupled with an increase in vegetation indices. Hotspots of Degradation: Persistently degraded zones were identified in the southern and southwestern regions, necessitating further attention. Using NDVI as a proxy, vegetation health and coverage were quantified. Reclaimed Areas: NDVI values increased from an average of 0.23 (2015) to 0.45 (2023), indicating improved vegetation density. Non-reclaimed Areas: Stable or declining NDVI values were observed, highlighting the impact of reclamation efforts. Seasonal Dynamics: Vegetation recovery showed pronounced seasonality, with peak growth during spring and summer months.

Discussion

The observed reduction in degraded land underscores the effectiveness of reclamation programs. Practices such as afforestation, soil stabilization, and irrigation development significantly contributed to land restoration. However, some areas exhibited slower recovery rates, potentially due to insufficient resources, climatic constraints, or ongoing human pressures.

Rapid urbanization emerged as a major driver of land cover change. The conversion of fertile agricultural land to urban uses raises concerns about food security and sustainable development in the region. Strategies to balance urban growth with agricultural preservation are urgently needed.

The decline in natural vegetation highlights vulnerabilities in the region's ecosystems. Degradation hotspots demand intensified conservation measures to combat desertification and loss of biodiversity.

The findings emphasize the need for:

1. Integrated Land Use Planning: To harmonize urban development, agricultural activities, and ecological conservation.

2. Sustained Reclamation Efforts: Scaling up afforestation and soil improvement programs to mitigate land degradation.

3. Monitoring Systems: Enhanced use of remote sensing technologies for continuous assessment of land dynamics and program effectiveness.

Conclusion

The results highlight the transformative potential of reclamation initiatives in the Tashkent region while underscoring challenges posed by urban expansion and environmental degradation. These findings provide a foundation for informed decision-making and sustainable land management policies. While this study provides valuable

insights, certain limitations exist, including the reliance on NDVI as a vegetation proxy, which may overlook non-photosynthetic vegetation. Future research could incorporate advanced indices and integrate socio-economic data for a holistic evaluation.

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