LAND USE AND LAND COVER ANALYSIS OF FERGANA VALLEY USING REMOTE SENSING AND GIS

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Abstract: The Fergana Valley, an agriculturally significant and densely populated region in Central Asia, faces immense pressure from urbanization and land use changes. Understanding land use and land cover (LULC) dynamics is crucial for sustainable planning. This study employs remote sensing and Geographic Information Systems (GIS) to analyze LULC changes in the Fergana Valley over a 20-year period. The study integrates satellite imagery, supervised classification, and GIS-based spatial analysis to assess LULC dynamics. Results indicate rapid urban expansion and agricultural intensification, with significant implications for water resource management and environmental sustainability.

Keywords: Land Use and Land Cover (LULC), Remote Sensing, Geographic Information Systems (GIS), Fergana Valley, Urbanization, Agricultural Expansion, Change Detection, Sustainable Land Management

1. Introduction

1.1. Background

The Fergana Valley, located at the tri-junction of Uzbekistan, Kyrgyzstan, and Tajikistan, is a strategic agricultural zone. With a population exceeding 10 million, it is a hub of irrigated agriculture, primarily growing cotton, wheat, and rice. Over the last few decades, population growth and urbanization have drastically altered the valley's land use patterns. Consequently, there has been increased concern regarding the sustainable management of land and water resources in the region.

1.2. Research Problem

Understanding the spatio-temporal dynamics of land use and land cover (LULC) is key to sustainable resource management. Remote sensing and GIS have proven to be effective tools in detecting these changes over large areas and extended periods. However, there is limited literature on the Fergana Valley's LULC changes using these techniques.

1.3. Objectives

This study aims to:

1. Map the LULC types in the Fergana Valley using satellite data.
2. Analyze changes in LULC over a 20-year period.
3. Examine the implications of LULC changes for regional planning.

2. Materials and Methods

2.1. Study Area

The Fergana Valley is situated between the Pamir and Tien Shan mountain ranges. It covers approximately 22,000 km², with elevations ranging from 320 to 1,000 meters above sea level. The valley is a critical agricultural zone in Central Asia, and it has a semi-arid climate with an average annual precipitation of 200-300 mm.

2.2. Data Acquisition

Landsat 5 TM (Thematic Mapper) and Landsat 8 OLI (Operational Land Imager) satellite imagery from 2000 and 2020 were acquired for this study. The spatial resolution of both datasets is 30 meters. Additionally, topographic maps and administrative boundary data were collected from local sources.

Dataset	Sensor	Resolution	Acquisition Date
Landsat 5 TM	Thematic Mapper	30m	2000
Landsat 8 OLI	Operational Land Imager	30m	2020

2.3. Methodology

The workflow consists of the following steps:

1. **Preprocessing**: The satellite images were corrected for geometric and radiometric distortions.

2. **Supervised Classification**: A maximum likelihood classification was applied to classify the LULC into six categories: agricultural land, urban areas, water bodies, forest, barren land, and wetlands.

3. **Change Detection**: Post-classification comparison was used to detect LULC changes between 2000 and 2020.

4. **Accuracy Assessment**: Ground truth data and confusion matrix were employed to evaluate the accuracy of the classification.

Land Cover Class	Area (2000)	Area (2020)	Change (%)
Agricultural Land	10,500 km²	11,300 km²	+7.62
Urban Areas	1,500 km²	2,100 km²	+40
Forest	2,300 km²	2,100 km²	-8.7
Water Bodies	500 km²	480 km²	-4
Barren Land	5,700 km²	4,900 km²	-14.03
Wetlands	1,500 km²	1,300 km²	-13.33

2.4. GIS Analysis

Using GIS, a spatial analysis of LULC changes was conducted. Buffer zones around urban areas were created to assess the extent of urban sprawl. Additionally, proximity analysis was performed to evaluate the relationship between agricultural land expansion and water resources.

3. Results

3.1. LULC Classification

Agricultural land and urban areas show a marked increase, while barren land and wetlands have decreased. The forest cover has also slightly declined.

3.2. LULC Change Detection

Table 1 summarizes the changes in each land cover class. The most significant change is observed in urban areas, which increased by 40%, largely due to population growth and economic development. Agricultural land has also expanded by 7.62%, primarily due to the conversion of barren lands.

3.3. Implications for Water Resources

The expansion of agricultural land near major rivers such as the Syr Darya raises concerns about water usage. The GIS proximity analysis shows that 80% of new agricultural lands lie within a 5 km radius of major water bodies, potentially leading to increased water extraction and strain on local resources.

4. Discussion

4.1. Drivers of LULC Changes

The results indicate that urbanization and agricultural expansion are the primary drivers of LULC changes in the Fergana Valley. Population growth, economic reforms, and the introduction of modern irrigation techniques have spurred these changes.

4.2. Environmental Impacts

The reduction in forest cover and wetlands poses risks to biodiversity and ecosystem services. Furthermore, the over-reliance on irrigation may lead to water scarcity in the long term.

4.3. Policy Recommendations

Policymakers need to address the unchecked expansion of urban and agricultural land through integrated land use planning. Sustainable water management strategies, such as drip irrigation and crop rotation, should be promoted to mitigate the adverse effects on the environment.

5. Conclusions

This study provides a comprehensive analysis of LULC changes in the Fergana Valley using remote sensing and GIS over a 20-year period. The findings underscore the need for sustainable land management practices to balance urban growth and agricultural demands with environmental preservation.

References

1. Nigmatov A.N., Tobirov O.K. The Methodological Basis of Geographical Tourism. Nat Sci 2021;19(5):19-25

2. Nigmatov A.N., Tobirov O.Q. Classification Of Geosystem For The Purpose Of Tourist Zoning And The Role Of Natural Geographical Approach. N Y Sci J 2022;15(2):7-13

3. Nigmatov Askar Nigmatullaevich, and Tobirov Odiljon Kobiljon Ugli. "The necessity to develop geographical tourism in diversification of tourism industry" European science review, no. 5-6, 2021, pp. 9-16.

4. Odiljon, T. Methodology for Assessing the Tourist Potential of the Nature of the Fergana Valley using GIS Technologies and Experimental Methods. Preprints 2022, 2022090181.

5. Tobirov Odiljon Kobiljon ugli. The Necessity To Develop Geographical Tourism In Diversification Of Tou rism Industry. N Y Sci J 2021;15(5):31-38

6. Tobirov, Odiljon. "ГАТ ёрдамида баҳоланган табиат компонентлари ва комплексларини дала- экспедициявий тадқиқотлар билан таққослаш". Natural Sciences, 2022.

7. Tobirov, Odiljon. "ГАТ технологиялари ёрдамида туристик-рекреацион зонарни ажратиш (Фарғона водийси мисолида)". Natural Sciences, 2022.

8. Тобиров Одилжон Кобилжон Угли, and Мадаминжонова Шахноза Абдумалик Кизи. "Географическое туристическое районирование территорий" Наука, техника и образование, no. 8 (83), 2021, pp. 98-107.

9. Тобиров Одилжон Кобилжон Угли. "Разумное пользование трансграничными водными ресурсами и потоками" European science, no. 3 (25), 2017, pp. 31-36.

10. Тобиров, О. «Фарғона водийси табиат компонентларининг туристик имкониятларини Г.А.Т ёрдамида комплекс баҳолаш». Евразийский журнал академических исследований, т. 2, вып. 12, ноябрь 2022 г., сс. 1019-27