Baku State University Journal of Earth Sciences & Environment **2025**, v 2 (1), p. 30-36

journal homepage: http://bsuj.bsu.edu.az/en

`

ANALYSIS OF THE CURRENT STATE OF LAND USE IN THE MASALLI DISTRICT: THE CASE of MAHMUDAVAR VİLLAGE

Alirza H. Fattayev

Baku State University, Baku, Azerbaijan

DOI: https://doi.org/10.30546/209805.2025.2.1.105

Abstract

Efficient use of land resources is a crucial factor for the sustainable development of any region. Proper management of land resources, particularly in the agricultural sector, is essential for increasing productivity and maintaining ecological balance. Masalli district possesses fertile land reserves and favorable climatic conditions for agriculture. However, the region also faces challenges such as land degradation, inefficient irrigation, and deforestation. This paper analyzes the territorial distribution, structure of agricultural lands, and land use patterns in Masalli district, with a specific focus on Mahmudavar village, using GIS-based mapping. The results obtained from the study form the basis of the analysis and provide insights into improving land resource management.

Keyword: Land use, efficient utilization, Masalli district, mapping, productivity.

* Corresponding author.

E-mail addresses**:** a.fhd@mail.ru – 0009-0002-2592-0033 (Alirza H. Fattayev)

1. İnitial insights into land use patterns of the area

Land resources play a vital role in the economic and ecological sustainability of any region. The efficient use of these resources ensures food security, supports biodiversity, and contributes to economic growth. In agricultural regions like Masalli, land use patterns directly affect productivity and environmental balance. Therefore, it is essential to conduct a comprehensive analysis of land utilization in the region.

The Masalli district, located in the southern part of Azerbaijan, is characterized by diverse landscapes, including plains, river valleys, and forested areas. The region's agricultural activities primarily focus on crop farming, horticulture, and livestock grazing. However, issues such as soil erosion, deforestation, and unregulated urban expansion threaten the sustainability of its land resources. Masalli district's lowland areas hold strategic importance in terms of agricultural potential, as they contribute significantly to the region's economic stability. A large proportion of the workforce, approximately 60-70%, is directly or indirectly employed in the agricultural sector. The remaining working population is engaged in sectors such as services, education, healthcare, trade, construction, and industry. Given this economic structure, the effective management and utilization of land resources in the district are crucial for ensuring long-term agricultural productivity and rural development.[3]

This research employs GIS technology to analyze the spatial distribution and utilization of land resources in Masalli district, particularly Mahmudavar village. The study is based on data collection, land classification, remote sensing analysis, field surveys, and impact assessment. First, satellite imagery, historical land use maps, and soil surveys specific to Mahmudavar were collected to establish a baseline of land conditions. The land was then categorized based on agricultural suitability, vegetation cover, and degradation status. Remote sensing analysis was conducted to evaluate land use changes over the past decade, providing insight into patterns of land transformation. Additionally, field surveys were carried out, including the collection of soil samples and interviews with local farmers to validate GIS findings. The impact assessment phase focused on analyzing anthropogenic influences on land degradation and productivity, allowing for a comprehensive understanding of the factors affecting land use in Mahmudavar village. By integratin This research employs GIS technology to analyze the spatial distribution and utilization of land resources in Masalli district, particularly Mahmudavar village. The study is based on data collection, land classification, remote sensing analysis, field surveys, and impact assessment.

To ensure the accuracy of the study, a diverse range of materials and data sources were used. High-resolution satellite images were acquired from commercial and open-access sources such as Sentinel-2 and Landsat-8. These images provided a detailed view of land use changes over the past decade, allowing for precise mapping and classification of different land cover types. Additionally, topographic and cadastral maps obtained from local government agencies were utilized to establish baseline conditions and verify land ownership patterns.[1]

Fig. 1. Satellite image of Mahmudavar Village

Soil samples were collected from various locations within Masallı district to analyze their composition, fertility levels, and potential degradation. Laboratory analysis was conducted to assess pH levels, organic matter content, and salinity levels, providing critical insights into soil health and agricultural potential. Field surveys were carried out to gather qualitative data from farmers and landowners regarding land use practices, irrigation methods, and common challenges faced in maintaining soil productivity.

Remote sensing techniques were employed to monitor vegetation health and land cover changes. Normalized Difference Vegetation Index (NDVI) analysis was performed to evaluate plant

growth conditions and detect areas affected by soil degradation or improper land management. GIS software, including ArcGIS and QGIS, was used for data processing, visualization, and spatial analysis. The combination of satellite imagery, field observations, and geospatial analysis ensured a comprehensive assessment of land use patterns in Mahmudavar village.

By integrating GIS technology with field data, the study ensures accurate mapping and detailed analysis of land use trends in the region. This multi-source approach provides a robust foundation for understanding land dynamics and formulating sustainable management strategies. GIS technology with field data, the study ensures accurate mapping and detailed analysis of land use trends in the region.

1. Soil types and agrochemical properties

The village of Mahmudavar in the Masalli district possesses diverse landscape features in terms of relief. The area is partially mountainous but predominantly consists of lowland plains. This relief diversity is primarily due to the village's location at the foothills of the Talish Mountains. The soil cover of the village has been shaped by complex geological and geomorphological conditions, resulting in a variety of soil types that present both opportunities and challenges for agriculture. Specifically, the region contains dark and ordinary mountain chestnut soils, which are highly fertile, podzolic yellow-gley soils, which develop under humid conditions, and pseudo-podzolic yellow soils, which have undergone partial podzolization. These soil types require different agro-technical measures to ensure optimal agricultural productivity. The diversity of relief and soil composition necessitates a strategic approach to land use in agricultural activities. Now, let us examine the results of the conducted analyses:[4],[5]

Table 1. Physical and Chemical Properties of Soil Types in Mahmudavar Village

Soil indicators	podzolic yellow-gley soils	pseudo-podzolic yellow soils
Density, g/cm³	1.29-1.33	1.25-1.42
Porosity, %	55.4-45.2	53.6-47.1
Physical clay (<0.01 mm), %	52.8-61.6	58.2-61.4
Silt (<0.001 mm), %	25.3-28.2	22.4-28.9
Humus content, %	2.87-1.48	3.2-1.6
Humus reserves, t/ha	75.2-179.8	81.0-196.5
C:N Ratio	10.3-8.2	9.8-6.7
Nitrogen, %	0.15-0.1	0.16-0.1
Phosphorus, %	0.18-0.15	0.14-0.11
Potassium, %	2.54-2.61	2.59-2.63
pH (water)	5.3-5.4	5.6-5.8

The findings of this study reveal notable variations in the physical and chemical properties of the soils in Mahmudavar village, highlighting their direct impact on agricultural potential and land use strategies. The region encompasses a range of soil types, each shaped by distinct environmental and geomorphological conditions. These differences influence not only the productivity of agricultural lands but also the sustainability of farming practices and soil conservation efforts. One of the key observations is the contrast in soil structure between the highland and lowland areas of Mahmudavar. Podzolic yellow-gley soils, which form under more humid conditions, demonstrate higher porosity and increased silt content. While these characteristics enhance water retention, they also contribute to higher acidity levels, potentially limiting crop selection and requiring pH correction strategies such as liming. Meanwhile, pseudo-podzolic yellow soils, occupying transitional areas, present a mix of both characteristics, with moderate organic matter content and acidity, necessitating site-specific soil management approaches.

The nutrient availability across these soil types further influences their suitability for different crops. Podzolic yellow-gley and pseudo-podzolic yellow soils show a higher potassium content but comparatively lower phosphorus availability, emphasizing the need for phosphorus-enriched soil amendments. The variation in C:N ratios across these soils indicates differences in decomposition rates and organic matter stability, affecting nutrient cycling and soil fertility over time. Beyond fertility, the interplay between soil pH and nutrient uptake is another crucial factor impacting land use. the acidic nature of podzolic and pseudo-podzolic soils could lead to nutrient deficiencies or toxic metal mobilization, necessitating continuous soil conditioning efforts. Without proper interventions, these conditions could hinder plant growth and limit the economic viability of certain agricultural practices in Mahmudavar.

2. Land use intensity and degredation zones

Spatial distribution of NDVI values in Mahmudavar Village, derived from satellite imagery. The analysis reveals variations in vegetation health and potential land degradation. The transition from green to red zones indicates a decline in vegetation density, emphasizing areas requiring soil rehabilitation or improved land management practices. Green areas represent actively used agricultural lands, yellow areas indicate limited-use or low-productivity soils, and red areas correspond to non-agricultural zones or degraded lands.

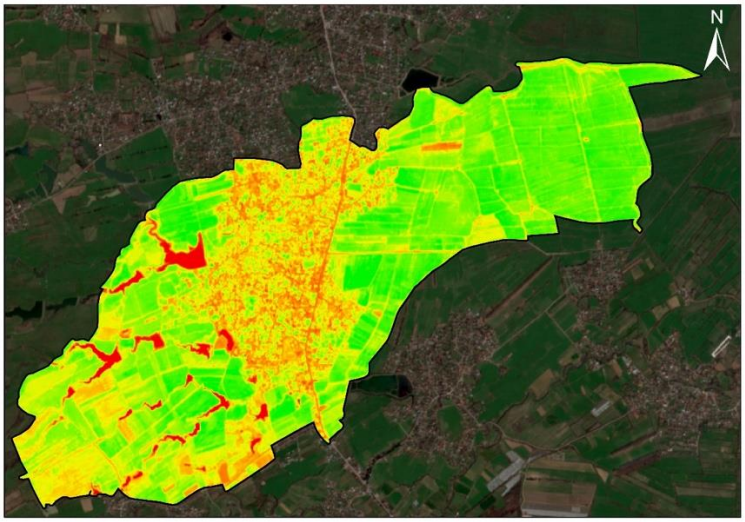

Fig. 2. NDVI (Normalized Difference Vegetation Index) analysis map of Mahmudavar Village

A comparison of the NDVI analysis and the land use map of Mahmudavar Village reveals significant correlations between vegetation health and land utilization patterns. Areas classified as agricultural land in the land use map generally correspond to high NDVI values, indicating active cultivation. However, some cultivated lands exhibit lower NDVI values, suggesting potential soil fertility issues, inadequate irrigation, or land degradation. Additionally, regions used informally as grazing lands, despite being designated as agricultural fields, show clear signs of soil degradation and reduced vegetation cover. This underscores the urgent need for sustainable land management strategies to mitigate soil exhaustion and preserve agricultural productivity. The following land use map provides a detailed representation of how different land categories are distributed across Mahmudavar Village.

A critical observation in Mahmudavar is the informal conversion of agricultural lands into grazing areas. Despite the absence of officially designated pasturelands, many arable lands are currently being used for livestock grazing. This practice has led to widespread land degradation, as continuous grazing depletes soil nutrients, reduces vegetation cover, and accelerates erosion. NDVI analysis confirms this trend, with significant portions of these areas displaying low vegetation indices, indicating soil exhaustion and decreased productivity. Overgrazing in these areas not only affects soil structure but also disrupts natural nutrient cycles, further exacerbating fertility loss.

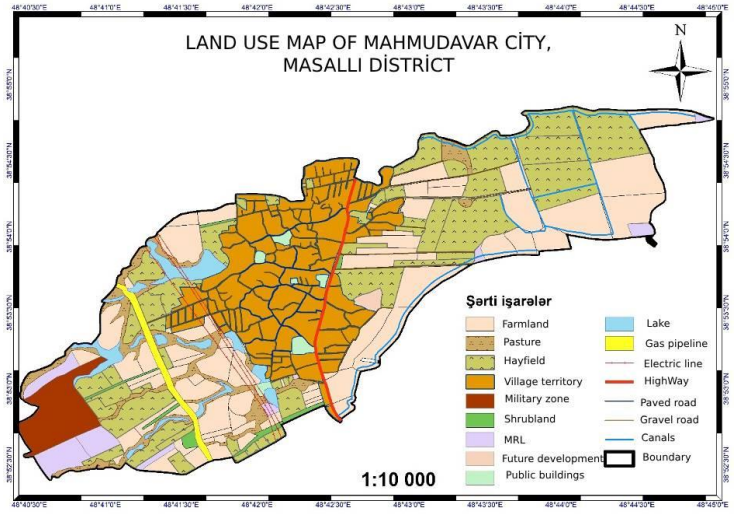

Fig. 3. Land use map of Mahmudavar village, Masallı district

Soil degradation is particularly evident in areas where podzolic yellow-gley and pseudo-podzolic yellow soils dominate. These soil types, already prone to acidity and organic matter depletion, are further stressed by excessive grazing pressure. The compacting effect of livestock movement reduces porosity, limiting water infiltration and increasing surface runoff. Consequently, erosion risks rise, further diminishing the land's agricultural viability. The introduction of organic farming techniques in Azerbaijan has been identified as a key solution to mitigate soil degradation and enhance agricultural productivity[3]

On the other hand, more fertile dark and ordinary mountain chestnut soils, primarily found in the village's higher elevations, demonstrate better resistance to degradation. However, improper land management practices, including the lack of rotational grazing or fallow cycles, threaten their long-term sustainability. Without intervention, these lands could also experience severe depletion, impacting both agricultural output and ecological stability.

At the same time, there has been a gradual effort to expand cultivated lands in Mahmudavar village over the years. Farmers have been working to increase the area of arable land and introduce more diverse cropping patterns. Additionally, new orchards have been established, contributing to long-term agricultural sustainability and economic diversification. These efforts are essential in balancing soil conservation with increased agricultural production.

3. Conclusions

A comparative analysis of the land use map and NDVI results suggests that proactive land management strategies are essential for mitigating degradation and ensuring the long-term sustainability of agricultural lands in Mahmudavar village. The continued reliance on de facto pastures, where arable lands are informally used for livestock grazing, has contributed significantly to soil depletion, erosion, and reduced vegetation cover. Without systematic intervention, these lands will continue to deteriorate, leading to decreased agricultural output and economic losses for the local farming community. Therefore, integrating these areas into structured and sustainable land-use planning is crucial.

To achieve this, regulated rotational grazing systems should be introduced to prevent overgrazing and allow vegetation recovery. Soil rehabilitation measures, including organic matter enrichment and compost application, can improve soil fertility, while afforestation projects in degraded zones can reduce erosion and enhance water retention. Targeted fertilization programs, combined with precision agriculture techniques, will help address nutrient deficiencies and optimize soil productivity. Additionally, soil amendments such as lime application should be used in acidic soils to balance pH levels and improve crop growth.

The adoption of controlled irrigation methods, such as drip irrigation, and organic farming practices, including conservation tillage and crop rotation, will further support soil restoration efforts. Educating local farmers on sustainable agricultural practices through training programs and policy incentives is crucial for ensuring long-term success.

Local authorities should consider formalizing certain grazing zones to prevent uncontrolled livestock movement into arable lands. Establishing regulated pasture areas and implementing policies to support sustainable land use can help balance agricultural and livestock activities. Incentives for farmers adopting conservation techniques, such as financial support or subsidies, could encourage widespread implementation of these measures.

The results indicate that without a strategic approach to land use planning, Mahmudavar village may face long-term declines in soil health and agricultural productivity. Future research should focus on quantifying soil degradation rates and assessing the socio-economic impact of land-use changes. By integrating remote sensing technologies, predictive modeling, and policy-driven incentives, authorities can develop adaptive land management strategies that promote both ecological sustainability and economic resilience. Ensuring the balance between agricultural expansion and soil conservation is key to securing the long-term viability of Mahmudavar's agricultural sector.

References

[1] Copernicus Programme (2023). Sentinel-2 User Guide and Technical Documentation. European Space Agency (ESA).

[2] World Bank. Environmental Impact Assessment for Rayon Masallı, Baku City, 2011.

[3] Aksoy U., Boz İ., Eynalov H., Quliyev Y. Organic Agriculture in Azerbaijan: Current status and potentials for future development. Baku:FAO, 2018.

[4] Memmedov Q.Ş. Land Resources of Azerbaijan, Baku-"ELM", 2002

[5] Memmedov Q.Ş., Khalilov M.Y., Memmedova S.Z. Ecological Atlas of the Republic of Azerbaijan. Baku: Cartography Factory, 2009.