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Establishment and Development Prospects of the Land Cadaster Database in the Qazakh District within the Context of Technical Research

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Abstract. *This article examines the establishment of a land cadaster database within the territory of the Qazakh District, emphasizing its legal, economic, and environmental significance, as well as the application of digitalization and GIS technologies. The study analyzes the classification of land categories, cadaster registration of state-owned and special-purpose lands, the implementation of satellite and drone-based monitoring systems, and the prospects for integration with electronic government platforms. The research substantiates the strategic importance of a digital cadaster system for improving land administration and ensuring sustainable land resource management.*

Keywords: *land cadaster, GIS technologies, land administration, digital mapping, satellite monitoring, NDVI index, land resources, Qazakh District*

Introduction

The establishment of a land cadaster database within the territory of Qazakh District constitutes a fundamental mechanism for the legally, economically, and environmentally efficient management of land resources (Dale & McLaughlin, 1999; Williamson et al., 2010). Land distribution across the district has been carried out in accordance with the Land Code of the Republic of Azerbaijan and the Law "On the State Land Cadaster," whereby lands are classified into state, municipal, and private ownership categories. State-owned lands account for approximately 26–28% of the total land fund and mainly include forest and water reserves, specially protected areas, defense territories, and infrastructure-designated lands. In particular, the territories surrounding the Aghstafachay Reservoir and Jandargol Lake represent a significant component of the state land fund.

Cadaster registration of state-owned lands is conducted through a unified GIS-based system incorporating data on land category, parcel size, legal status, land-use type, and environmental indicators (Burrough & McDonnell, 1998; Longley et al., 2015). This system enables the precise delineation of land boundaries, the prevention of illegal land use, and the enhancement of environmental monitoring processes. Special-purpose lands, constituting approximately 6–8% of the total land fund, include defense facilities, energy and transport infrastructure, melioration systems, and industrial zones (Dale & McLaughlin, 1999; Williamson et al., 2010).

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The principal challenges associated with this category involve legal ambiguities, insufficient boundary demarcation, coordinate inconsistencies, and weak data integration among various governmental institutions. In particular, archival documents and outdated topographic maps inherited from the Soviet period are often incompatible with modern GPS measurements, which negatively affects the accuracy and reliability of cadaster data (Longley et al., 2015).

Methods

The study is based on GIS-based spatial analysis, remote sensing data, and cadastral documentation (European Space Agency, 2015; USGS, 2019). Satellite imagery from Sentinel-2 and Landsat, together with drone-based topographic surveys, was used to update and verify land boundaries. GIS technologies were applied to integrate spatial and legal datasets into a unified geodatabase. This system enables land classification, parcel identification, and environmental monitoring (Burrough & McDonnell, 1998; Longley et al., 2015). Spatial analysis techniques were used to evaluate land-use distribution, ownership structure, and ecological indicators (Haining, 2003).

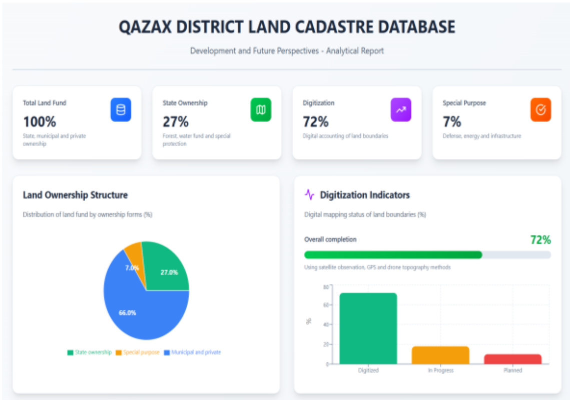

Figure 1

Land cadastre database of the Qazakh District

Results

In recent years, more than 70% of land boundaries have been digitized through the application of digital cartography, satellite observation technologies (Sentinel-2 and Landsat), and drone-based topographic surveying methods. Although this approach has significantly improved the accuracy and transparency of the cadaster system, the comprehensive integration of spatial and legal data remains a priority area for further development (European Space Agency, 2015; USGS, 2019; Weng, 2012).

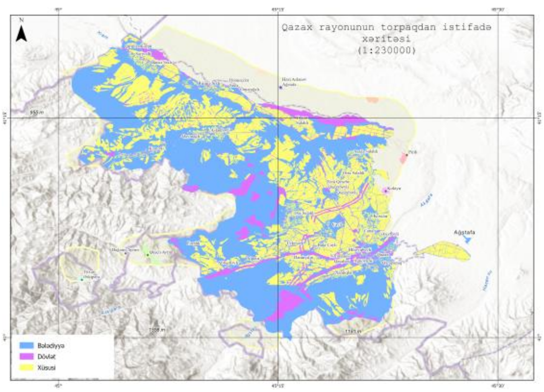

Figure 2

Analysis of land ownership structure in the Qazakh District

The cadastral map presented in Figure 2 illustrates the distribution of land ownership categories within the territory of the Qazakh District. According to the spatial analysis, municipal lands occupy the largest share of the district and are widely distributed throughout both lowland and foothill areas. Private lands are concentrated mainly in agricultural zones and settlement surroundings, reflecting the dominant role of agriculture in the local economy. State-owned lands are primarily located in environmentally sensitive territories, water protection zones, infrastructure corridors, and areas designated for strategic public purposes. The spatial distribution of ownership categories demonstrates the importance of maintaining an up-to-date cadastral database for effective land administration. Digital mapping allows authorities to identify ownership boundaries accurately, reduce land-related disputes, and improve the management of state and municipal assets (Dale & McLaughlin, 1999; Williamson et al., 2010). The integration of ownership information with GIS technologies further enhances transparency and supports sustainable land-use planning (Burrough & McDonnell, 1998; Longley et al., 2015).

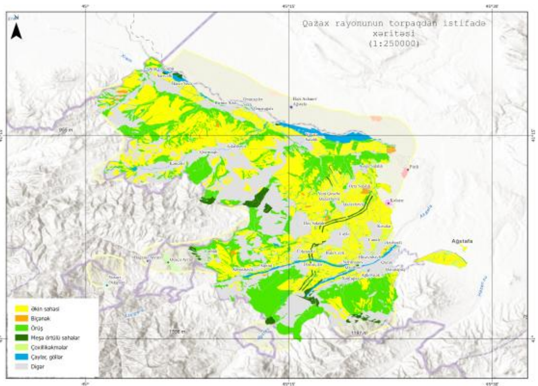

Figure 2
Spatial distribution of land use types in the Qazakh District

Land Use Analysis Based on GIS Mapping. Figure 3 presents the land-use structure of the Qazakh District derived from GIS-based spatial analysis. Agricultural lands constitute the dominant land-use category, with extensive areas occupied by arable fields and pasturelands. These territories form the foundation of the district's agricultural production and significantly contribute to regional economic development. The map also indicates the presence of forest-covered areas, perennial plantations, water bodies, and other land-use categories. The spatial distribution of these resources highlights the diversity of land functions within the district and emphasizes the necessity of balanced land management practices. GIS-based land-use mapping provides valuable information for assessing environmental conditions, monitoring land degradation processes, and planning future agricultural development. Furthermore, the integration of satellite imagery and remote sensing data into the cadastral database enables continuous monitoring of land-use changes. Such an approach supports evidence-based decision-making and contributes to the sustainable utilization of natural resources in the Qazakh District.

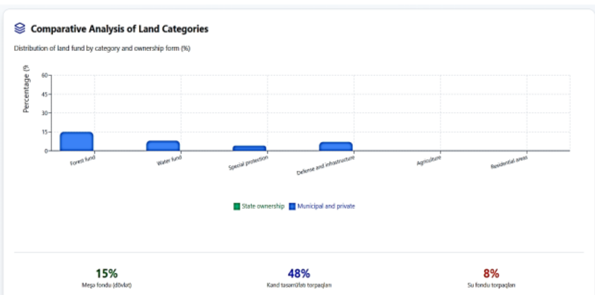

Figure 3
Comparative analysis of land categories in the Qazakh District

Discussion

Application of GIS Technologies in the Land Cadaster System

The implementation of Geographic Information Systems (GIS) has become one of the most significant factors in the modernization of land cadaster databases. GIS technologies facilitate the collection, storage, analysis, and visualization of spatial information related to land resources (Burrough & McDonnell, 1998; Longley et al., 2015). Within the territory of the Qazakh District, the application of GIS enables the integration of cadastral maps, satellite imagery, topographic surveys, and legal documentation into a unified digital environment.

One of the primary advantages of GIS-based cadaster systems is the ability to update land information in real time (Weng, 2012). Through geospatial databases, specialists can identify changes in land use, detect unauthorized occupation of land parcels, and monitor environmental conditions more efficiently than with traditional paper-based systems. In addition, GIS technologies support decision-making processes by providing analytical tools for land-use planning, agricultural development, infrastructure expansion, and environmental protection. The creation of digital cadastral layers also contributes to reducing administrative costs and increasing institutional efficiency. Landowners, municipal authorities, and governmental agencies gain faster access to reliable information, thereby minimizing bureaucratic procedures. Furthermore, GIS technologies improve transparency in land management by ensuring that spatial information is accessible and verifiable. For the Qazakh District, where agricultural production constitutes an important component of the local economy, GIS applications can significantly improve land productivity assessments and resource allocation (FAO, 1993). The integration of remote sensing data with cadastral records allows for the identification of suitable agricultural zones, the monitoring of crop conditions, and the evaluation of environmental risks affecting land resources (Mather & Koch, 2011; Smith & Jones, 2010).

Detailed Table of Land Categories

Detailed statistical indicators from the cadastre database

Land Category	Share (%)	Characteristics	Cadastre Status
State ownership - Forest fund	15%	Aghstafachay reservoir area, forest massifs	Digitized
State ownership - Water fund	8%	Jandargol, water channels and irrigation systems	Digitized
State ownership - Special protection	4%	Reserves, national park territories	In Progress
Special purpose - Infrastructure	7%	Defense, energy, transport, industrial facilities	Being clarified
Municipal and private - Agriculture	48%	Arable lands, gardens, pastures	Digitized
Municipal and private - Residential	15%	Residential areas, individual construction	In Progress
Municipal and private - Other	3%	Recreation, commercial and other purposes	Planned
TOTAL	100%	*Qazax district land fund*	

Note: The digitization process was conducted based on Sentinel-2, Landsat satellite imagery and drone topography. NDVI index, soil moisture and erosion indicators are monitored in a unified GIS-based system. Integration of data with "e-Land" and "Farmer Portal" is ongoing.

Source: State Land Cadastre of the Republic of Azerbaijan | 2026

Figure 4

Detailed table of land categories in the Qazakh District

Future development of agricultural lands should be oriented toward digital integration, agroecological mapping, bonitet zoning, and the automation of land valuation processes. Through satellite- and drone-based monitoring, the assessment of NDVI indices, soil moisture levels, and erosion indicators will transform the land cadaster from a purely legal registry into an analytical and predictive management system. At the same time, the integration of land-related data with electronic government platforms such as "e-Torpaq," the "Farmer Portal," and other digital governance systems will enhance transparency in land circulation processes while optimizing taxation and subsidy mechanisms (Mather & Koch, 2011). In conclusion, the establishment and modernization of the land cadaster database in the Qazakh District are of strategic importance in terms of strengthening legal reliability, increasing economic efficiency, and ensuring environmental sustainability. As a result of digitalization and enhanced institutional coordination, land administration within the district is expected to evolve into a more systematic, transparent, and scientifically grounded management model (Dale & McLaughlin, 1999; Williamson et al., 2010).

Conclusion

Socio-Economic Benefits of a Digital Land Cadaster

The establishment of a comprehensive digital land cadaster database generates substantial socio-economic benefits for both governmental institutions and local communities. Accurate cadastral information contributes to the development of an effective land market by ensuring legal certainty in property ownership and facilitating secure real estate transactions. As a result, investment opportunities increase, and land-related disputes are significantly reduced. From an economic perspective, the availability of reliable cadastral data improves the efficiency of land taxation systems. Local authorities can calculate land taxes more accurately, while state institutions can better assess land values and manage public assets. Digital cadastral systems also support agricultural subsidy programs by enabling the verification of land ownership and land-use patterns. Environmental sustainability represents another important benefit of modern cadastral databases. By integrating ecological indicators, soil quality assessments, and monitoring data, decision-makers can identify environmentally sensitive areas and implement appropriate conservation measures. Such an approach supports sustainable land management principles and contributes to the long-term protection of natural resources (FAO, 1993; Williamson et al., 2010). In the context of regional development, the digitalization of land administration strengthens cooperation among governmental agencies, municipalities, and private stakeholders. The use of interoperable databases and electronic services accelerates information exchange and enhances the quality of public services. Consequently, the land cadaster evolves beyond its traditional registration function and becomes an essential component of modern territorial governance and sustainable development policies.

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