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USE OF GEOSPATIAL DATABASES IN RURAL AREAS OF KAZAKHSTAN

ҚАЗАҚСТАННЫҢ АУЫЛДЫҚ АУДАНДАРЫНДА ГЕОКЕҢІСТІКТІК ДЕРЕКТЕР БАЗАСЫН ПАЙДАЛАНУ

ИСПОЛЬЗОВАНИЕ ГЕОПРОСТРАНСТВЕННЫХ БАЗ ДАННЫХ В СЕЛЬСКИХ РАЙОНАХ КАЗАХСТАНА

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Abstract. The stable development of rural areas largely depends on the availability of up-to-date spatial information that ensures effective management of land resources and territorial planning. In Kazakhstan, characterized by vast rural territories, uneven population distribution, and demographic changes, the use of modern digital tools that enable the integration of topographic and statistical data becomes particularly important. *The objective* is to analyze the use of GIS-based databases in rural areas and assess their role as an analytical basis for geographical research, monitoring, and management of transformation processes in rural districts. The study emphasizes the integration of population indicators and land use indicators into a unified geoinformation archive. *Methods* include landscape analysis and cartographic modeling with the implementation of geoinformation systems in the processing and visualization of land management materials and geospatial documentation. GIS methods were used to calculate the density of the rural population and to identify spatial and temporal fluctuations in demographic parameters. *Results* – a GIS database was formed, providing the ability to analyze the degree of settlement of rural localities and its dynamics. GIS-based mapping identified regions with high and low concentrations of rural population, as well as territorial units showing trends toward decline or relative stability in the number of rural residents. The developed structure of the GIS database contributes to the synthesis of demographic, land, and spatial digital values into a unified information environment. *Conclusions* – the use of GIS-based databases increases the accuracy and effectiveness of management in rural regions. They should be considered a priority direction for modernizing the system of land regulation and ensuring balanced economic growth of rural areas of the republic.

Аңдатпа. Ауылдық жерлердің тұрақты дамуы көбінесе жер ресурстарын тиімді басқару мен аумақтық жоспарлауды қамтамасыз ететін өзекті кеңістіктік ақпараттың болуына байланысты. Кең ауылдық аумақтармен, халықтың біркелкі бөлінбеуімен және демографиялық өзгерістермен сипатталатын Қазақстанда топографиялық және статистикалық мәліметтерді біріктіруге мүмкіндік беретін заманауи цифрлық құралдарды

қолдану ерекше маңызға ие. ***Мақсаты*** **– ауылдық жерлерде ГАЖ технологияларының дерекқорларын пайдалануды талдау және олардың ауылдық округтерді трансформациялау процестерін географиялық зерттеу, мониторинг және басқару үшін аналитикалық негіз ретіндегі рөлін бағалау. Жұмыста тұрғындар санының көрсеткіштерін және жерді пайдалану индикаторларын бірыңғай геоақпараттық мұрағатқа біріктіруге баса назар аударылды.** ***Әдістер*** **– жерге орналастыру материалдары мен геокеңістіктік құжаттаманы өңдеу және визуализациялау кезінде геоақпараттық жүйелерді іске асырумен ландшафттық зерттеу, картографиялық модельдеу. ГАЖ әдістері ауыл контингентінің тығыздығын есептеу және демография параметрлерінің кеңістіктік-уақыттық ауытқуларын анықтау үшін қолданылды.** ***Нәтижелер*** **–ауылдық елді мекендердің қоныстану дәрежесін және оның динамикасын талдауға мүмкіндік беретін ГАЖ мәліметтер базасы құрылды. ГАЖ-технологияларға негізделген картаға түсіру ауыл халқының жоғары және төмен шоғырланған аймақтарын, сондай-ақ ауыл тұрғындары санының азаюына немесе салыстырмалы біркелкілігіне бейімділігі бар аумақтық бірліктерді белгіледі. Ақпараттық массивтің ГАЖ-базасының әзірленген құрылымы демографиялық, жер және кеңістіктік цифрлық мәндерді бірыңғай ақпараттық ортаға синтездеуге ықпал етеді.** ***Қорытындылар*** **- ГАЖ технологияларының дерекқорларын пайдалану ауылдық аймақтардағы басқарудың дәлдігі мен тиімділігін арттырады. Оларды жерді реттеу жүйесін жаңғыртудың және республиканың ауылдық аудандары экономикасының теңгерімді өсуінің басым бағыты ретінде қарастырған жөн.**

Аннотация. Стабильное развитие сельской местности во многом зависит от наличия актуальной пространственной информации, обеспечивающей эффективное управление земельными ресурсами и территориальное планирование. В Казахстане, характеризующемся обширными сельскими территориями, неравномерным распределением населения и демографическими изменениями, особую значимость приобретает применение современных цифровых инструментов, позволяющих интегрировать топографические и статистические сведения. ***Цель*** **– анализ использования баз данных ГИС-технологий в сельских районах и оценка их роли как аналитической основы для географического исследования, мониторинга и менеджмента процессами трансформации сельских округов. В работе сделан акцент на интеграцию показателей численности жителей и индикаторы землепользования в единый геоинформационный архив.** ***Методы*** **– ландшафтное изучение, картографическое моделирование с реализацией геоинформационных систем при обработке и визуализации материалов землеустройства и геопространственной документации. Способы ГИС применялись для расчёта плотности сельского контингента и выявления пространственно-временных колебаний параметров демографии.** ***Результаты*** **–сформирована ГИС-база данных, предоставляющая - возможность проанализировать степень заселенности сельских поселений и ее динамику. Картографирование на основе ГИС-технологий обозначило регионы с высокой и низкой концентрацией сельского населения, а также территориальные единицы, обладающие тенденцией к сокращению или относительной равномерностью количества сельчан. Разработанная структура ГИС-базы информационного массива способствует синтезу демографических, земельных и пространственных цифровых значений в единую информационную среду.** ***Выводы*** **– использование баз данных ГИС-технологий повышает точность и действенность управления в сельских регионах. Их следует рассматривать как приоритетное направление модернизации системы регулирования земель и сбалансированного роста экономики сельских районов республики.**

Keywords: rural territories, geospatial database, geoinformation technologies, land use, land resource management, territorial planning, cartographic modeling.

Түйінді сөздер: ауылдық аумақтар, геокеңістіктік деректер базасы, геоақпараттық технологиялар, жерді пайдалану, жер ресурстарын басқару, аумақтық жоспарлау, картографиялық модельдеу.

Ключевые слова: сельские территории, геопространственная база данных, геоинформационные технологии, землепользование, управление земельными ресурсами, территориальное планирование, картографическое моделирование.

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Introduction

Rural territories play a key role in ensuring food security, sustainable socio-economic development and territorial integrity of the Republic of Kazakhstan. The agricultural sector remains one of the most important components of the national economy, providing employment for a significant part of the rural

population and forming the basis for regional development. At the same time, effective management of rural territories requires scientifically grounded approaches based on reliable, up-to-date and structured spatial information.

Kazakhstan has vast rural territories characterized by significant differences in natural and climatic conditions, land use structure and levels of economic development. The total area of agricultural land exceeds 200 million hectares, which creates both considerable opportunities and serious challenges for rational land management. Fragmentation of land parcels, inefficient use of land resources, limited monitoring and insufficient systematization of spatial data hinder sustainable development of rural territories.

In recent years, rural areas of Kazakhstan have faced a number of complex problems, including land degradation, soil erosion, desertification, irrational land use and weak coordination of territorial planning processes. These issues are largely associated with the lack of integrated geospatial databases that ensure the accumulation, storage and analysis of land-related information necessary for effective decision-making.

Under these conditions, the use of geographic information system (GIS) databases becomes a key element of modern land management and rural development. GIS databases allow the integration of spatial, statistical and attribute data into a unified information environment, providing comprehensive analysis of land resources, monitoring of land use changes and assessment of territorial development processes. The availability of structured geodatabases significantly increases the accuracy and reliability of land management decisions.

The relevance of GIS databases is further enhanced in the context of digital transformation and the implementation of state programs aimed at the development of agriculture and rural territories in Kazakhstan. Modern geospatial databases contribute to improving transparency of land relations, optimizing land inventory and supporting evidence-based management at national, regional and local levels.

Thus, the study of the use of GIS technology databases in rural territories of Kazakhstan is of significant scientific and practical importance. The development and application of geospatial databases create prerequisites for rational land use, effective territorial planning and sustainable socio-economic development of rural areas. In this regard, the present research focuses on the role of GIS databases as an information basis for improving the management and planning of rural territories in Kazakhstan.

Literature review

In modern conditions, the sustainable development of rural territories is closely associated with the digital transformation of land management and spatial planning systems. A key role in this process is played by geographic information systems and, in particular, GIS databases, which ensure the accumulation, structuring and analysis of spatial information necessary for effective territorial management.

International studies emphasize that GIS databases significantly improve the efficiency of land use planning and territorial management by providing a unified information environment. According to Malczewski J., Jankowski P. [1], the use of structured geospatial databases enables the identification of spatial patterns in land use systems and supports evidence-based management decisions. Similar conclusions are presented by Campi M., Dueñas M., Fagiolo G. [2], who highlight the importance of GIS databases for analyzing complex territorial systems, especially in regions characterized by large land areas and heterogeneous land use structures.

Recent research demonstrates the growing importance of GIS databases in agriculture and rural development. Bielecka E. [3] notes that GIS-based multi-criteria analysis relies on well-structured spatial databases to optimize land allocation and assess land suitability under varying natural and socio-economic conditions. Iban M.C., Aksu O. [4] emphasizes that geodatabases serve as the basis for land use change modeling and spatial monitoring, which is particularly relevant for rural territories undergoing transformation.

A number of authors associate the application of GIS databases with the achievement of sustainable development goals. Barzegar M., Rajabifard A., Kalantari M. [5] underline that integrated spatial data systems contribute to balancing agricultural productivity and environmental protection. Studies by Liu L., Liu B., Song W. et al. [6] show that the use of GIS databases improves transparency in land governance systems and enhances the effectiveness of territorial planning at regional and local levels.

In Kazakhstan, the relevance of GIS databases for rural territories is determined by the vast land area, diversity of natural conditions and the need for rational land use. Recent studies indicate that traditional land management approaches are insufficient to address current challenges related to land degradation,

inefficient land use and limited monitoring capabilities. Liu Y., Ke X., Wu W. et al. [7] emphasize the importance of developing geospatial databases for land monitoring and management in Kazakhstan. Other domestic researchers note that the use of GIS databases can significantly improve land inventory, zoning and cadastral assessment in rural areas (Koeva M.N., Bennett R.M., Persello C.) [8].

Thus, the analysis of scientific literature shows that GIS databases are widely recognized as an effective information basis for managing rural territories worldwide. However, despite the growing number of studies, the application of GIS databases in rural areas of Kazakhstan requires further scientific justification, taking into account national land use characteristics and institutional conditions. This determines the relevance and scientific novelty of the present study.

Materials and methods

The study is based on a system approach and methods of spatial, database and analytical analysis, since rural territories represent complex socio-economic and land-use systems characterized by the interaction of natural, economic and territorial factors. Special attention is paid to the role of GIS databases as an information basis for land management and rural development.

Within the framework of the research, materials from open and official sources were used, including scientific publications, statistical data, cartographic materials and geospatial datasets related to land use and rural territories of Kazakhstan. A unified GIS database was created to organize and integrate spatial, attribute and statistical information.

Spatial data processing and analysis were carried out using geographic information system software. GIS tools were applied to structure geospatial data, analyze land use composition, assess territorial differentiation of rural areas and identify spatial patterns in land resource utilization. Cartographic modeling was used to visualize the spatial distribution of rural territories and land use categories.

In addition, methods of statistical analysis were applied to summarize and interpret quantitative indicators of land use and rural development. Regulatory and legal documents governing land relations and land management in Kazakhstan were analyzed to assess the institutional framework for the formation and use of GIS databases in rural territories.

The combination of system, database, spatial and analytical methods ensured the reliability of the research results and allowed a comprehensive assessment of the role of GIS technology databases in the management and development of rural territories of Kazakhstan.

Results

The results of the study demonstrate that the use of GIS technology databases significantly enhances the analysis of rural territories by providing a unified spatial representation of demographic and land-use characteristics. The developed GIS database made it possible to integrate statistical population data with spatial administrative boundaries, allowing an assessment of the spatial distribution of rural population across the territory of Kazakhstan.

International studies confirm that geospatial databases are an essential component of modern rural development and land administration systems. According to Chen X., Chen F., Cui F. et al. [9], GIS-based demographic analysis supports evidence-based planning of rural territories and improves the efficiency of land resource management. Similar conclusions are presented by Biljecki F., Chow Y.S. [10], which emphasizes the role of spatial data infrastructures in analyzing population distribution and supporting territorial development policies.

In the context of rural territories, GIS databases enable the identification of spatial differences in population density, settlement patterns and demographic pressure on land resources. Chen J., Zhang L., Zhao S. et al. [11] studies highlight that spatial analysis of population indicators is particularly important for managing rural territories characterized by large land areas, dispersed settlements and uneven infrastructure development. The United Nations also recognizes geospatial population data as a key element for sustainable territorial development and effective land governance (Junye W., Michael B.) [12].

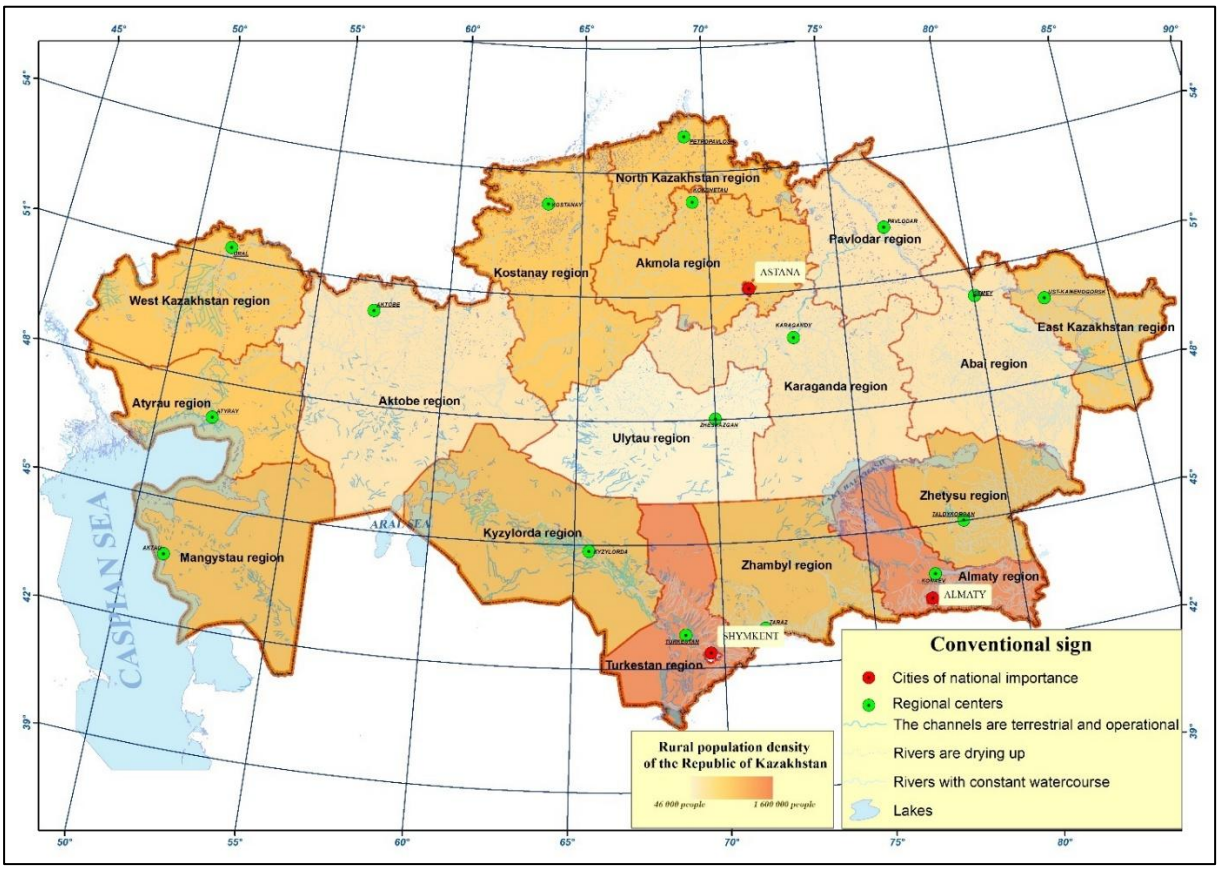
The application of GIS databases allows revealing significant regional differentiation in rural population density. Research by Zhumatayeva Z., Onalbayeva D., Mukaliyev Z. et al. [13] demonstrates that GIS-based demographic assessment provides reliable results for identifying territorial imbalances and assessing the efficiency of rural land use. Advances in geospatial technologies further expand the analytical capabilities of GIS databases, enabling large-scale spatial analysis of demographic and land-use dynamics (Ashimkhan N., Rafikov T., Zhildikbayeva A. et al.) [14].

For Kazakhstan, the use of GIS technology databases is especially relevant due to the vast size of rural territories and pronounced regional differences in population distribution. GIS-based analysis allows identifying regions with high rural population density, as well as

territories characterized by sparse population and low settlement intensity. As noted by Ma Y., Zheng M., Zheng X. et al. [15], GIS database applications support more accurate territorial zoning and planning decisions, which are crucial for sustainable rural development.

The results of this study show that the GIS-based analysis of rural population density provides an effective analytical basis for understanding spatial disparities in the development of rural territories of Kazakhstan. The visualization of demographic indicators using a GIS database allows identifying regions with increased anthropogenic pressure on land resources and areas requiring priority management interventions.

To illustrate the spatial distribution of rural population density across the territory of Kazakhstan, a GIS-based map was developed using the created GIS database. This map reflects regional differences in rural population density (persons) and serves as a visual tool for assessing demographic patterns in rural territories (figure 1).



Note: compiled by the authors based on open-source data and official statistical information

Figure 1 - Rural population density of the Republic of Kazakhstan

The analysis of rural population density based on the developed GIS database reveals significant spatial differentiation across the territory of the Republic of Kazakhstan. The GIS-based integration of demographic statistics with administrative boundaries and spatial data made it possible to identify clear regional contrasts in the distribution of rural population and to assess the heterogeneity of rural settlement patterns.

Regions located in the southern and southeastern parts of the country are characterized by relatively higher rural population density. This pattern is largely associated with favorable natural and climatic conditions, the availability of water resources, developed irrigation systems and long-established agricultural specialization. These regions traditionally concentrate labor-intensive agricultural activities, which contributes to higher population concentration in rural areas. In contrast, the central and western regions demonstrate lower rural population density, reflecting extensive land use patterns, arid and semi-arid climatic conditions, limited water availability and a sparse settlement network.

The use of the GIS database allowed not only cartographic visualization but also detailed spatial analysis of demographic pressure on rural territories. Areas with increased rural

population density indicate higher intensity of land use and greater demand for land resources, agricultural infrastructure and social services. Such territories require careful land management planning to prevent overexploitation of land resources and environmental degradation. At the same time, territories with low population density are characterized by large land areas per capita, which influences the structure, specialization and economic efficiency of agricultural land use.

The GIS database also enables the identification of zones where demographic factors may limit sustainable rural development. Regions with declining or critically low rural population density face challenges related to labor shortages, underutilization of agricultural land, weakening of rural infrastructure and reduced accessibility of social services. These processes negatively affect the socio-economic sustainability of rural territories and require targeted management interventions. Without a unified geospatial database integrating demographic and land-use information, such spatial patterns and problem areas would be difficult to identify and assess.

Thus, the GIS-based assessment of rural population density provides a reliable analytical basis for evaluating the current state of rural territories and supports informed decision-making in land management and rural development. The obtained results confirm the importance of GIS databases as a key tool for analyzing demographic indicators, assessing spatial disparities and supporting strategic planning in rural territories of Kazakhstan.

While the spatial distribution of rural population density reflects the current demographic situation, it does not fully reveal the processes of change occurring in rural territories over time. For a more comprehensive assessment of rural development, it is necessary to analyze the dynamics of rural population and to identify long-term demographic trends.

The GIS database developed in this study allows the integration of multi-temporal statistical data on rural population into a single geospatial environment, ensuring consistency and comparability of demographic indicators across regions and time periods. This database-oriented approach makes it possible to systematically track population growth and decline, analyze the direction and intensity of demographic changes, and assess the stability of rural settlement systems at different territorial levels. In addition, the structured GIS database enables the identification of regions with persistent demographic transformations, including long-term depopulation or relative demographic stability, and supports the detection of spatial clusters characterized by similar demographic trends. By combining temporal demographic data with spatial and administrative information, the GIS database provides a reliable analytical basis for evaluating demographic dynamics and their implications for land use planning and sustainable rural development.

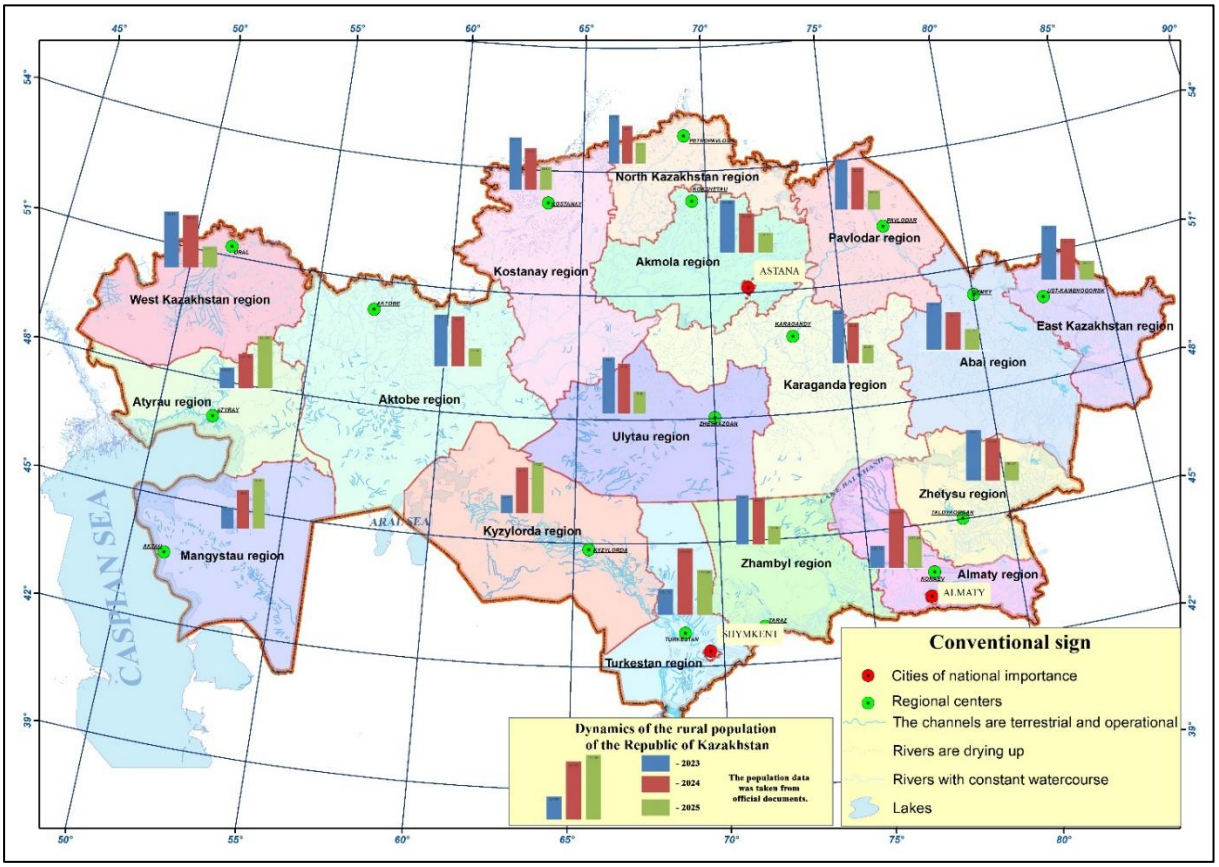
To analyze temporal changes in rural population, dynamic indicators derived from the GIS database were used. These indicators reflect changes in rural population across regions of Kazakhstan over recent years and provide additional insights into the processes of rural depopulation or stabilization. Based on the GIS database, a map illustrating the dynamics of rural population of the Republic of Kazakhstan was created. This map serves as a visual and analytical tool for assessing demographic trends, their spatial differentiation and their implications for the sustainable development of rural territories (figure 2).

The analysis of rural population dynamics based on the developed GIS database reveals pronounced temporal and spatial differences in demographic processes across rural territories of the Republic of Kazakhstan. The integration of multi-year statistical data into a unified GIS database made it possible not only to assess changes in rural population size but also to identify long-term demographic trends and regional patterns.

The GIS-based analysis shows that rural population dynamics are characterized by significant heterogeneity across regions. A number of regions demonstrate relative stability or moderate growth of rural population, which may be associated with favorable agricultural conditions, availability of water resources, proximity to major urban centers and the presence of developed transport and social infrastructure. These factors contribute to the preservation of rural settlement systems and labor potential. In contrast, many rural territories are characterized by a steady decline in rural population, reflecting processes of out-migration, demographic aging, declining birth rates and structural changes in the agricultural economy.

The use of the GIS database enables the identification of regions where demographic decline is accompanied by a reduction in agricultural labor resources and increasing pressure on land use efficiency. In such territories, extensive land use practices often prevail, and the lack of labor resources limits the adoption of modern agricultural technologies. These regions require targeted management measures

aimed at stabilizing rural population, improving living conditions and optimizing the structure of land use. At the same time, regions with positive or relatively stable demographic dynamics demonstrate a higher potential for sustainable rural development and more intensive use of land resources.



Note: compiled by the authors based on open-source data and official statistical information

Figure 2 - Dynamics of rural population of the Republic of Kazakhstan (GIS-based map)

An important advantage of the GIS database approach is the ability to analyze demographic dynamics in conjunction with spatial and land-use characteristics. By linking population dynamics with land categories, settlement distribution, transport accessibility and administrative boundaries, the GIS database provides a comprehensive understanding of transformation processes occurring in rural territories. This integrated analysis makes it possible to identify territories with critical demographic trends and to assess their implications for land management and rural development.

The results of the analysis indicate that dynamic demographic indicators cannot be effectively interpreted without structured and systematized geospatial data that ensure consistency and reliability of analysis. In this context, the GIS database serves not only as a tool for cartographic visualization, but also as a comprehensive analytical platform that enables the assessment of temporal demographic changes, comparison of indicators across regions and identification of spatial trends. The use of a GIS database makes it possible to detect zones with increased demographic risk, such as areas experiencing long-term population decline or instability of rural settlement systems, and to evaluate their potential impact on land use efficiency and rural infrastructure. Moreover, the integration of demographic data within a unified geospatial database supports strategic planning by providing an evidence-based foundation for decision-making in rural development, land management and territorial policy.

Thus, the analysis of rural population dynamics confirms the necessity of creating and maintaining comprehensive GIS databases for rural territories. Such databases allow the accumulation and systematization of key indicators, including demographic, land-use and spatial characteristics, within a single information system. To ensure effective monitoring and management of rural territories, it is essential to structure these indicators in a database

format suitable for further spatial analysis, modeling and decision-making.

In this regard, the next stage of the study focuses on the structure and content of the GIS database of rural territories, which systematizes demographic and land-use data and forms the basis for analytical and management processes. The structure of the GIS database is presented in table.

Table - Structure of the GIS database of rural territories of Kazakhstan

Data group	Database field (indicator)	Data type	Spatial reference	Source
Administrative data	Region name	Text	Polygon (region)	Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan
	District name	Text	Polygon (district)	Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan
	Rural settlement name	Text	Point / Polygon	Official administrative data
Demographic data	Rural population (persons)	Integer	Region / district	Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan
	Rural population density (persons/km²)	Float	Region / district	Calculated using GIS database
	Rural population dynamics (by years)	Integer	Region	Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan
Land use data	Agricultural land area (ha)	Float	Polygon	State land cadastre data
	Settlement land area (ha)	Float	Polygon	State land cadastre data
Spatial data	Administrative boundaries	Vector (polygon)	National	National geospatial data
	Settlement locations	Vector (point)	National	Open geospatial sources
Temporal data	Observation year	Integer	Attribute	Official statistics
Note: based on the ArcGIS program				

The presented structure of the GIS database of rural territories demonstrates that demographic, land-use and spatial indicators can be systematically integrated into a single information environment. Such a database approach ensures consistency of data, enables multi-level spatial analysis and supports the generation of cartographic products reflecting both current conditions and dynamic changes in rural territories.

The use of a structured GIS database provides a reliable basis for monitoring rural development processes, assessing demographic and land-use transformations and supporting evidence-based decision-making. Thus, the results obtained confirm that GIS technology databases are not only a tool for visualization, but also a key analytical instrument for managing and planning the sustainable development of rural territories of Kazakhstan.

Discussions

Long-term and intensive use of land resources in rural territories inevitably leads to their degradation, which necessitates the adoption of scientifically grounded organizational and management decisions. In modern conditions, such decisions cannot be effectively implemented without the use of digital technologies and structured geospatial information systems.

Current trends in socio-economic development indicate the need to apply integrated approaches to land use that combine environmental, economic and social aspects. The transition to sustainable development models is impossible without reliable spatial information, which forms the basis for assessing land resources and planning rural development. In this context, GIS technology databases serve as a key instrument for integrating heterogeneous data and supporting sustainable land use management.

The land resource potential of the Republic of Kazakhstan is one of the largest in the world; however, over the past decades, the area of agricultural land has significantly decreased, while the pressure on remaining land resources has increased. These processes are accompanied by changes in rural population distribution, transformation of land use structure and growing risks of land degradation. GIS databases allow these changes to be analyzed comprehensively in spatial and temporal dimensions.

Kazakhstan's territory is largely located within steppe, semi-desert and desert zones, where extensive agricultural development has led to land degradation and landscape deterioration. Under such conditions, the rational use of land resources and preservation of soil fertility should become a priority of national land policy. GIS databases provide the necessary information basis for identifying vulnerable areas and supporting targeted land management measures.

The results of this study confirm that the use of GIS databases significantly improves the assessment of rural territories by linking demographic indicators with land use characteristics. Such integration enables the identification of regions with increased anthropogenic pressure, declining rural population and inefficient land use patterns.

To ensure sustainable development of rural territories, it is necessary to establish a stable and transparent land management system based on reliable geospatial data. The formation and use of GIS databases contribute to improving land governance, enhancing monitoring capabilities and supporting strategic planning. Consequently, GIS technology databases should be considered a fundamental component of modern land management and sustainable rural development in Kazakhstan.

Conclusion

1. Kazakhstan has significant natural, climatic and socio-economic prerequisites for the sustainable development of rural territories; however, their effective utilization requires reliable and structured spatial information.

2. The results of the study confirm that GIS technology databases provide an effective information basis for the analysis, monitoring and management of rural territories, integrating demographic, land-use and spatial data into a unified system.

3. The use of GIS databases makes it possible to identify spatial and temporal changes in rural population and land use, supporting evidence-based decision-making in land management and rural development.

4. The application of GIS-based databases enhances transparency, accuracy and efficiency of territorial planning, contributing to the rational use of land resources and sustainable development of rural areas.

5. The formation and implementation of comprehensive GIS databases should be considered a priority direction in the modernization of land management systems and the development of sustainable rural territories of Kazakhstan.

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