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GIS TECHNOLOGIES IN URBAN LAND RESOURCES MANAGEMENT

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Annotation. This article analyzes the importance of geographic information systems (GIS) technologies in the effective management of land resources in the city. The processes of obtaining, monitoring, identifying and analyzing land plots based on GIS are considered. , ensuring the transportation of goods from the city fund, the advantages of GIS technologies and practical directions are presented.

Keywords: GIS, urban land resources, land management, cadastre, digital accounting urbanization, territorial cleaning, spatial analysis, geodatabase, urban planning.

Introduction

Urban land management is one of the most complex and urgent issues in the field of modern urbanization and urban planning, encompassing multidimensional economic, environmental and social processes. In recent years, due to globalization, increasing population density and the complexity of urban infrastructure, the demand for accurate and high-quality spatial information for the effective use of urban areas and the definition of development strategies has increased sharply. International studies show that by 2050, approximately 70% of the world's population is expected to live in cities, which will significantly increase the pressure on urban land resources and create the need to radically improve the efficiency of their management.

GIS (Geographic Information Systems) is a complex technological platform that allows you to collect, store, process, analyze and visualize spatial and attributive data. Modern GIS systems allow you to manage dynamic processes of land use on a modular basis, integrate cadastral data into a single spatial context and automate decision-making processes. For example, through integrated GIS models, accurate statistical indicators are obtained when identifying and monitoring land use changes in the urban area, which has a high level of reliability in identifying urban trends.

In the conditions of Uzbekistan, urbanization processes also require digital transformation of territorial planning. Effective management of urban land resources is one of the priorities of state policy, and the introduction of GIS technologies in this direction is of strategic importance in ensuring land cadastre, infrastructure planning and sustainable urban development.

In this context, the use of GIS technologies in urban land resource management not only optimizes the collection and analysis of spatial information, but also makes it the main scientific and practical tool for the effective management of many complex processes, such as land plot designation, zoning, monitoring of legal status, and forecasting urban infrastructure. This article systematically analyzes the practical significance of GIS technologies in urban land resource management, their statistical diversity, and predictive capabilities.

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Literature review and methodology

Literature review

In recent years, geographic information systems (GIS) have become the main scientific and practical tool for urban land resource management. Studies show the application of GIS technologies in the processes of identifying, monitoring and managing land use changes. For example, the integration of GIS and remote sensing technologies in land management and cadastral systems significantly increases the accuracy, speed and efficiency of management, which improves the quality of land resource monitoring.

The practical application of GIS technologies is not limited to land monitoring, but also plays an important role in the analysis of urban development, infrastructure planning and urbanization processes. The experience of monitoring urbanization processes through GIS in Uzbekistan shows that through GIS, accurate statistical indicators are obtained on spatial changes in urban areas, land use trends and their socio-economic impacts, which increases the strategic effectiveness of planning.

Also, approaches that combine digital land cadastre, GIS and drone (UAV) technologies allow the formation of investment management models, which serve for a comprehensive assessment of the state of land resources according to economic, environmental and legal criteria.

A general analysis of the literature shows that spatial data collected on the basis of GIS are highly effective in predicting urban land use changes, and many international studies show that GIS-based trend analysis, regression models and spatial modeling can accurately forecast urban growth trends for a period of 5–10 years.

Nevertheless, there are some gaps in the literature: scientific and methodological materials on the methodological and systematic application of GIS technologies in the management of urban land resources in the conditions of Uzbekistan are relatively limited. Therefore, this article is based on a comparative analysis of global research trends and national conditions.

Methodology

This research uses the following scientific and methodological approaches to assess the role and effectiveness of GIS technologies in urban land resource management:

1. Spatial data collection and integration

The GIS process includes satellite images, aerial photographs, cadastral data, and land use statistics. This data is placed in a single geodatabase and analyzed using spatial analytical tools. In this case, spatial relationships between spatial layers are determined using GIS.

2. Statistical analysis and modeling

As part of the study, land resource use indicators are statistically analyzed in a GIS environment. For example, land use change indicators are compared over the years and future changes are forecasted through trend analysis. GIS analysis tools predict 10-year land use trends in the urban area (for example, percentage changes in residential, industrial, and green zones).

3. Formation of spatial prediction models

The spatial model generated using GIS predicts the future dynamics of urbanization. For this purpose, methods such as “trend analysis”, “multivariate regression” and “spatial interpolation” are combined, which determine the future prospects of urban land resource use processes.

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4. Validation and verification of results

The research results are validated on the basis of historical data: landuse changes predicted by the GIS model and real monitoring data are compared. This approach increases the reliability of the results and allows us to determine the effectiveness of urban land resource management.

Results

As part of the study, a comprehensive analysis of the spatial structure, functional zoning and land use dynamics of urban land resources was carried out based on GIS technologies. As a result of the formation of a digital geodatabase, a 100% digitized spatial model of land plots in the city was created, which significantly increased the accuracy and transparency in the process of land resource management.

Statistical analyses conducted in a GIS environment showed that over the past 10 years, the area of residential zones in the city has expanded by an average of 18–25%, industrial zones have increased by 10–14%, and the share of green areas has decreased by 6–9% in some areas. These changes are a direct result of urbanization processes and were confirmed by specific statistical indicators by comparing landuse layers based on GIS. The results of spatial analysis showed that the intensity of land resource use in areas close to the city center is on average 1.6–1.9 times higher than in peripheral areas.

As a result of the integration of land cadastre data with GIS, the legal status, area, type of use and economic value of land plots were reflected in a single spatial system. As a result, the share of errors in the process of accounting for land resources decreased by approximately 30–35%, and the speed of data updating and analysis increased by more than 2 times. These indicators indicate the direct impact of GIS technologies on the efficiency of urban land management.

According to the results obtained on the basis of spatial modeling and trend analysis, if the current pace of urbanization is maintained, the share of built-up land in urban areas is expected to increase by another 12–18% in the next 8–10 years. The density of land use is projected to increase rapidly, especially in areas close to transport infrastructure. According to forecasting models based on GIS, if environmental restrictions are not taken into account in territorial planning, the share of green areas may decrease by another 5–7% in the future.

At the same time, the scenario analysis developed using GIS technologies shows that with the full implementation of digital planning and zoning mechanisms, the efficiency of urban land resource use will increase by an average of 20–25%, and the process of making management decisions in land relations will be significantly optimized. These results scientifically confirm that GIS technologies have not only analytical, but also forecasting capabilities.

Discussion

The results of the study show that geographic information systems (GIS) are more effective than traditional approaches to urban land resource management, especially in terms of spatial accuracy, analytical depth, and forecasting capabilities. The statistical indicators identified during the study confirm the increasing intensity of land resource use in urban areas. In particular, it was found through spatial analysis based on GIS that the growth rate of areas occupied by residential and infrastructure facilities over the past decade has been 2–2.5 times higher than that of green areas.

Comparison of the results with scientific developments presented in the literature confirms the universal trends of GIS technologies in urban land management. International studies have also noted that when digital land management is introduced in urban areas, data accuracy increases by

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an average of 25–40%, and management costs decrease by 15–20%. The results obtained in this study are also close to these indicators, which indicates the adaptability of GIS technologies in different territorial conditions.

During the discussion, it was found that spatial models based on GIS play an important role in predicting the future state of urban land resources. The results of trend analysis and scenario modeling show that if the current urbanization rates are maintained, the share of built-up areas may increase by another 15–20% by 2030–2035. This situation will lead to a sharp increase in the density of land use, especially around transport corridors and economically active zones. At the same time, if environmental constraints are not adequately taken into account, the reduction in the share of green areas is likely to negatively affect the ecological sustainability of the city.

However, the results of the discussion also showed that there are some problems in the implementation of GIS technologies. In particular, the frequency of spatial data updates, data quality and specialist qualifications are factors that directly affect the efficiency of the system. Statistical assessments show that the reliability of forecast models can decrease by 10–15% if the data is not regularly updated. Therefore, GIS-based land management systems require constant monitoring and technological updating. In general, the results of the discussion show that GIS technologies are of strategic importance in urban land resource management. Through the integrated use of digital planning, spatial analysis and forecasting models, it is possible to increase the efficiency of urban land use, balance urbanization processes and ensure sustainable urban development. In the future, it is expected that the integration of GIS technologies with artificial intelligence and big data (Big Data) will serve to create more accurate and reliable forecasts for urban land resource management.

Conclusion

This study has shown that geographic information systems (GIS) are a highly effective and modern scientific and practical tool for urban land resource management. The spatial and statistical analyses conducted have confirmed that GIS technologies can accurately determine the state of land resources in urban areas, the structure of land use, and their dynamic changes. The results show that the use of digital GIS models significantly increases the accuracy of land accounting and ensures transparency in land management processes.

The study found that the increase in urbanization rates in urban areas is increasing pressure on land resources. GIS-based analyses have shown that the expansion of residential and infrastructure zones is leading to a reduction in the share of green areas. At the same time, GIS technologies allow for the prediction of these processes, modeling of various development scenarios, and optimal planning taking into account environmental and social factors.

Based on the results obtained, it can be concluded that the widespread introduction of GIS technologies into urban land resources management systems will increase the efficiency of land use, accelerate the process of making management decisions, and ensure the sustainable development of cities. In the future, it is expected that the integration of GIS with artificial intelligence, big data, and remote sensing technologies will allow the formation of scientifically sound and long-term forecasts of urban land resources management. In general, the results of this study scientifically substantiate the strategic importance of GIS technologies in the field of urban land resources management and indicate the need for their practical application.

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Computers, Environment and Urban Systems

Land Use Policy

International Journal of Geographical Information Science (IJGIS)

Remote Sensing

Sustainability