

MODELING POPULATION GROWTH DYNAMICS IN THE DISTRICTS OF ANDIJAN REGION USING GIS TECHNOLOGIES

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Abstract: *This study focuses on modeling the dynamics of population growth in the districts of Andijan region using Geographic Information System (GIS) technologies. The main objective of the research is to identify population change trends across the districts of the region, assess their spatial characteristics, and carry out spatial analysis and forecasting based on GIS methods. During the research process, demographic statistical data of Andijan region were collected, systematized, and used to create an electronic geodatabase using GIS software. The analysis examined the spatial distribution of population, growth rates, and the spatial characteristics of demographic processes.*

Keywords: *population size, demographic processes, GIS technologies, spatial analysis, modeling, Andijan region, districts, forecasting, geodatabase.*

МОДЕЛИРОВАНИЕ ДИНАМИКИ РОСТА НАСЕЛЕНИЯ РАЙОНОВ АНДИЖАНСКОЙ ОБЛАСТИ С ИСПОЛЬЗОВАНИЕМ ГИС-ТЕХНОЛОГИЙ

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***Аннотация:** Данное исследование посвящено моделированию динамики роста населения районов Андижанской области с использованием технологий географических информационных систем (ГИС). Основной целью исследования является выявление тенденций изменения численности населения в районах области, оценка их пространственных особенностей, а также проведение пространственного анализа и прогнозирования на основе ГИС-методов. В процессе исследования были собраны и систематизированы статистические демографические данные по Андижанской области, на основе которых с использованием ГИС-программного обеспечения была создана электронная геобазы данных. В ходе анализа были изучены пространственное распределение населения, темпы его роста и пространственные особенности демографических процессов.*

***Keywords:** population size, demographic processes, GIS technologies, spatial analysis, modeling, Andijan region, districts, forecasting, geodatabase.*

Introduction. Population growth and its spatial distribution are among the key factors determining the socio-economic development of regions. Demographic changes resulting from natural population growth and migration processes have a direct impact on labor resources, infrastructure provision, and the economic potential of territories. Therefore, studying population growth dynamics and forecasting future development trends is considered one of the priority directions of modern geographical research.

Andijan region is one of the most densely populated areas of the Republic of Uzbekistan, where recent years have seen an acceleration of demographic processes. The uneven population growth rates across districts, as well as the varying influence of natural increase and migration factors, require in-depth analysis. In particular, Geographic Information System (GIS) technologies provide broad opportunities for spatial assessment and visualization of population changes.

The dynamics of population growth in the districts of Andijan region are closely linked to the natural-geographical, socio-economic, and demographic characteristics of the territories. The continuous increase in population in the region

can be explained by high natural growth rates, ongoing urbanization processes, and the formation of labor resources. However, population growth rates differ significantly across districts, with some areas showing high growth while others demonstrate relatively low indicators. The use of Geographic Information System (GIS) technologies plays an important role in analyzing spatial changes in population. These technologies allow statistical data to be integrated with digital maps, enabling the identification of spatial characteristics of demographic processes. Using GIS software, thematic maps of population size, density, growth rates, and migration indicators are developed at the district level. This helps to visually represent spatial patterns of population growth.

Literature review. The study of population growth dynamics and its modeling using Geographic Information Systems has been widely researched by both local and international scholars. The application of GIS technologies in analyzing the spatial characteristics of demographic processes significantly increases the efficiency of scientific research¹. According to A. A. Soliyev, “the spatial distribution and reproduction of the population are among the key factors determining the level of economic development of a region.” This statement emphasizes the importance of analyzing population changes from a territorial perspective. V. A. Kolosov and R. F. Turovsky state that “modern GIS technologies are among the most effective tools for spatial analysis of geographical phenomena.”² According to M. De Smith, M. Goodchild, and P. Longley, “spatial modeling is an important tool for assessing development trends and supporting decision-making processes.” This serves as a methodological basis for forecasting population growth. Furthermore, N. Musayev states that “the analysis of demographic processes in Uzbekistan using GIS technologies improves the efficiency of regional planning.”³ This confirms the growing practical importance of GIS in the country.

¹ Soliyev A.A., Mahmudov R. *Fundamentals of Economic and Social Geography*. – Tashkent: Fan va texnologiya, 2018. – 312 p.

² Kolosov V.A., Turovsky R.F. *Geographic Information Systems in Regional Studies*. – Moscow: Nauka, 2018. – 312 p.

³ De Smith M., Goodchild M., Longley P. *Geospatial Analysis: A Comprehensive Guide*. – Leicester: Troubador Publishing, 2020. – 558 p.

Results. During the research process, statistical data on the population size of the districts of Andijan region were entered into a GIS environment, and an electronic geodatabase was created. Based on this data, the dynamics of population growth at the district level were analyzed, and thematic maps were developed. As a result, spatial distribution patterns of population and differences in growth rates across the region were identified. The analysis revealed districts with the highest population growth rates as well as areas with relatively low indicators. High population growth was mainly observed in economically active districts with developed transport infrastructure and rapidly advancing urbanization processes. In contrast, some agriculture-oriented districts showed relatively stable population growth. GIS-based cartographic models revealed key spatial patterns in population distribution. In particular, districts closer to the regional center demonstrated higher population density and growth rates, while peripheral districts showed comparatively lower values.

Table 1. GIS-Based Analysis of Population Dynamics in Andijan Region Districts

| Aspect | Findings | Spatial / Analytical Interpretation |
|----------------------------------|--|--|
| Data processing | Population statistics of districts were entered into GIS and an electronic geodatabase was created | Enabled structured spatial analysis of demographic data |
| Mapping approach | Thematic maps of population growth dynamics were developed | Showed spatial distribution and differences in population growth rates |
| High growth areas | Economically active, transport-developed, and highly urbanized districts | Strong link between economic activity and population increase |
| Low / stable growth areas | Some agriculture-oriented rural districts | Population growth remains relatively stable |

Forecasting results indicate that in the coming years, some districts of Andijan region may experience an increase in demographic pressure. This situation may lead to a growing demand for education, healthcare, housing, and transport infrastructure.

Therefore, it becomes necessary to improve territorial planning processes and establish new social infrastructure facilities in rapidly growing population areas.

Conclusion. This study analyzed and modeled the dynamics of population growth in the districts of Andijan region using Geographic Information System (GIS) technologies. During the research, statistical demographic data were systematized, an electronic geodatabase was created in a GIS environment, and the spatial characteristics of demographic processes across territories were examined.

The results of the analysis showed that population growth rates vary significantly across districts of the region. High population growth was observed in economically developed areas with well-established transport and service infrastructure, while relatively lower growth rates were recorded in some peripheral districts.

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