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Paper

PAPER

OBTAINING DATA ON THE RELIEF OF THE CITY OF BUKHARA IN REAL TIME IN THE ”GEOANALYZER-2.0” PROGRAM

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Abstract

This article examines the issues of obtaining, processing, and analyzing data on the terrain of the city of Bukhara in real time using the ”GEOANALIZATOR-2.0” software package. The relevance of the research is explained by the growing need for accurate and operational terrain data in the design of engineering and communication systems, territorial planning, and effective infrastructure management in urban areas. In the research process, geoinformation technologies, digital terrain model (DEM) data, and spatial analysis methods were used. Based on the functional capabilities of the ”GEOANALYZER-2.0” software package, algorithms for receiving, processing, storing, and visualizing real-time terrain data of the territory of the city of Bukhara have been developed. Also, the morphometric indicators of the terrain relief - height, slope, exposure, and other parameters - were determined, and their significance in the design of engineering and communication systems was analyzed.

Key words: relief, geometric modeling, GEOANALYZER-2.0, geoinformation system (GIS), digital relief model (DEM), real-time mode, relief modeling, relief morphometry, spatial analysis, engineering and communication systems.

PURPOSE

The main goal of the ”GEOANALYZER-2.0”software package is to develop methods for obtaining, processing, and analyzing real-time data on the terrain of any area, for example, the territory where I live, using a Google map, the terrain of the city of Bukhara, and to substantiate their effectiveness in the process of designing and managing engineering and communication systems.

The article also examines the issues of determining the morphometric indicators of the terrain based on the digital terrain model (DEM), their spatial analysis, and the formation

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of a geodatabase that is updated in real time. Another important goal of the research is to improve the functionalities of the ”GEOANALYZER-2.0”program, to ensure the receipt of prompt and accurate information on the relief of the city of Bukhara, and to substantiate the possibilities of effective use of this information in the processes of planning urban infrastructure, placement of engineering and communication networks and territorial monitoring, as well as the development of methods for obtaining, processing, and analyzing real-time information on the relief of the city’s territory, and their effectiveness in the process of designing and managing engineering and communication systems.[1,2,3,4]

Methodology: The proposed methods and software solutions are of practical importance in the processes of digital modeling, monitoring, and management of engineering and communication systems within the territory of the city of Bukhara. The research results indicate that integrating real-time terrain data with geographic information systems enhances the efficiency of processes for the rapid assessment of geomorphological features of urban areas, optimal placement of engineering networks, and infrastructure planning. Based on the results of the test-1 and test-2 experiments, the models and algorithms developed in the scientific research were applied to the territory of the city of Bukhara. Obtaining real-time information on the relief of the city of Bukhara in the ”Geoanalyzer-2.0”program.

Based on the aforementioned input parameters, the altitude data of 500 points belonging to the relief of Bukhara city were exported to the ”Geoanailzator-2.0”program, and an isoline map of the Bukhara city relief—a geometric model—was obtained in real-time (Fig. 1).

Figure 1. Isoline geometric model of the relief of Bukhara city.

When visualizing the morphometric indicators of the city of Bukhara based on the complexity cartogram (Fig. 2a) and the slope cartogram (Fig. 2b), it was clearly demonstrated that the territory of the Ark fortress on Registan Square consists of a surface with the highest level of complexity and slope.

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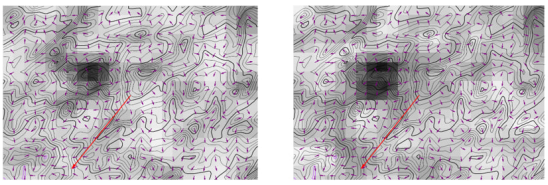


a) complexity cartogram b) slope cartogram

Figure 2.a-b. Morphometric analytical geometric model of the relief of the city of Bukhara.

As a result of the rain that fell in Bukhara on February 24, 2025, some of the city’s streets were flooded and large puddles were formed. For example, at the intersection of Ibragim Muminov and Mustakillik streets, one of the central intersections of Bukhara, the intersection was flooded (Fig. 3a-b). It was decided to conduct a morphometric analysis of the intersection of I. Muminov and Mustakillik streets in the city of Bukhara based on the ”Geoanalizator-2.0”program. Input data for morphometric analysis: M = 10; N = 10; $\Delta X = \Delta Y = 10$; $\Delta H = 0.5$ was obtained. Total number of points: $m \times n = 10 \times 10 = 100$ (Fig. 3b).

a) rain puddle at the intersection b) general view of the intersection

Figure 3.a-b. Intersection of I. Muminov and Mustakillik streets in Bukhara.

A morphometric analysis of the relief at the intersection of I. Muminov and Mustakillik streets in Bukhara showed that the local slope vectors from the adjacent areas of Mustakillik Street toward it and along this street are directed opposite to each other, and the street is located in a depression (Fig. 5a). The relief slope cartogram confirmed that both sides of

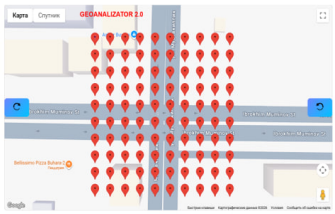
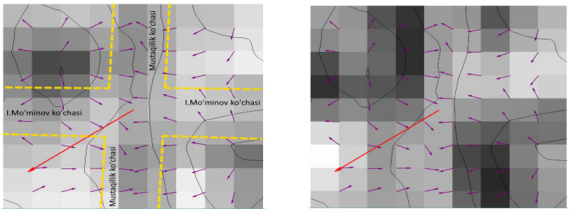


Figure 4. Obtaining real-time terrain data at the intersection of I. Muminov and Mustakillik streets in the city of Bukhara.

Mustakillik Street consist of areas with high slopes (Fig. 5b).



a) Complexity chart b) Slope chart

Figure 5. Morphometric analysis of the relief at the intersection of I. Muminov and Mustakillik streets in the city of Bukhara.

As a result of the research, scientific and practical recommendations can be developed for the design of engineering and communication systems based on the geometric model of the relief of the city of Bukhara. The proposed approach serves to increase the accuracy of engineering structure design, reduce construction costs, and ensure the sustainable development of urban infrastructure while taking into account the natural features of the terrain.[11]

Conclusion

In the scientific article on geometric modeling of the Earth's relief for engineering and communication systems, the following general conclusions were formulated regarding the results obtained from the research work, the created models and algorithms, the "Geoanalizator-2.0"software package developed on their basis, and its practical implementation:

1. For the first time, morpho-typological analyses of 11 types of buildings and structures in the city of Bukhara were conducted, and scientifically grounded conclusions were drawn for the design of urban engineering and communication systems.

2. Morphometric indicators of the relief surface were analyzed, among which the local complexity coefficient of the relief surface and the local average slope of the territory, which are important in engineering and design practice, were applied to engineering and communication systems.

3. Models and algorithms for integrating the Cartesian coordinate system into the geographic coordinate system have been developed, and the "Geoanalizator-1.0"program has been reprogrammed to create the "Geoanalizator-2.0"software package, for which a certificate of official registration of the program created for the computers of the Republic of Uzbekistan was obtained (dated April 10, 2025). No. DGU 49469). As a result, it was possible to obtain preliminary information about the relief in real time directly from the GoogleMaps interactive-online map.

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