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Specific Aspects of The Analysis of The Natural-Geographical Characteristics of The Lower Zarafshan District on The Base of Gat Technologies

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Abstract: This article discusses the issues of assessing the natural components of the Lower Zarafshan physical-geographical district using geoinformation technologies (GIS). The main focus is on the interrelationships of natural components such as relief, climate, water resources, soil and vegetation cover, and their spatial analysis. GIS technologies allow for the systematization, analysis and visualization of large volumes of natural data. This article is aimed at forming scientifically based conclusions that will serve the effective use, protection and sustainable development of natural resources in the region.

Keywords: Lower Zarafshan, physical-geographic assessment, natural components, geo-information technologies, relief, climate, water resources, soil, vegetation cover, spatial analysis, geoecology, monitoring, digital map, landscape analysis, natural-geographic area, satellite data, digital elevation model, natural environment, database, geographic information system, environmental sustainability.

Introduction: Today, the issues of rational use of natural resources, ensuring ecological sustainability and environmental protection are gaining global

importance. In the conditions of Uzbekistan, in-depth study of the natural and geographical features of each region, their assessment and appropriate use for economic activities are one of the important tasks. One of such regions is the Lower Zarafshan physical and geographical district. This district is distinguished by its unique natural resources, geographical location and environmentally sensitive environment. The diversity of the relief, climatic conditions, water resources and biological diversity of the region are an important resource for human activity, and their correct assessment and management require special scientific approaches. Geoinformation technologies are emerging as an important tool in effectively solving such complex and wide-ranging tasks. Through GAT, the spatial distribution, interaction, dynamics and potential of the natural components of the region are determined. This serves to make scientifically based decisions on the rational use of the natural resources of the region and their protection. Therefore, this article analyzes the natural components of the Lower Zarafshan district using GAT technologies and discusses the issues of their comprehensive assessment.

The Lower Zarafshan physical and geographical district is located in the central part of Uzbekistan, in the middle and lower basin of the Zarafshan River, and is a region of important strategic importance in terms of its geographical location. This district is located on the territory of Samarkand and Navoi regions, and its area consists mainly of low mountains and plains. Geomorphologically, the relief of the district is characterized by medium-altitude foothills, denudation plains and alluvial valleys. The relief structure is one of the main factors determining the distribution of natural resources and economic activity (K.Z. Khamidov, 2019).

In terms of climate, the district belongs to the continental climate zone. Summers here are extremely hot and dry, while winters are mild and short. The average annual temperature is around +15°C, and in July it can rise to +38°C. The annual precipitation is around 200–300 mm, falling mainly in spring and autumn. Such climatic features directly affect the soil and vegetation cover in the district (Geography of Uzbekistan. Academy edition, 2020).

The hydrography of the region is mainly formed under the direct influence of the Zarafshan River. Zarafshan is the largest natural water source in the district, which is used for irrigation, drinking and industrial needs. At the same time, the district has a network of numerous small streams and ditches, which are mainly formed by alluvial waters. The formation of the hydrological network is also closely related to the relief and climate

(T.Kh. Tashmatov, 2017).

The soil structure is closely related to the climate and water regimes of the district. Here, mainly gray soils, saline soils and poorly drained soils are found. Gray soils, adapted for agricultural products grown on irrigated lands, occupy a large area. Due to rational irrigation and soil reclamation works, some lands give high results in terms of productivity. However, salinization processes are also observed in some areas, which requires special environmental control (S.R. Nurmatov, 2021).

In terms of vegetation cover, the district belongs to the semi-desert and steppe zones. The natural vegetation includes ephemerals, sedges, saxaul, juzgun and other species adapted to drought. At the same time, agricultural crops - cotton, grain, vegetables and melons - are widespread on irrigated lands. Although biological diversity is not high, the existing flora and fauna play an important role in ensuring the balance of the ecosystem. In some areas, plant degradation is observed, which indicates the impact of human activity (M.M. Yunusov, 2018).

The natural and geographical features of the Lower Zarafshan district are one of the main criteria determining its resource potential. A complete study and assessment of this area is of great importance not only for academic research, but also for the formation of practical projects. In this regard, modern geoinformation technologies allow for a systematic, accurate and rapid assessment of these natural components. Geoinformation technologies (GIT) are currently widely used in the fields of geography, ecology, resource management and regional development. GIT technologies play a key role in the complex analysis of natural components, determining their spatial distribution and visualizing various data. In areas such as the Lower Zarafshan Physical and Geographical District, GIT tools are very effective in assessing relief, climate, hydrography, soil and vegetation cover (N.A. Ergashev, 2020).

The main methods used for terrain assessment are digital elevation models (DEM) and slope, exposure, and erosion analysis based on them. These methods determine the height difference in the area, the steepness of mountainous areas, and the areas suitable for irrigation. For example, models based on satellite data such as ASTER and SRTM generate relief maps with a resolution of 30 meters (USGS, 2018).

Climatic data are dynamically analyzed using GAT, and the chronological changes in parameters such as temperature, precipitation, and wind direction are modeled. ERA5 or WorldClim data are used to visualize climatic conditions in the area in graphical form and

determine their impact on vegetation cover (Hijmans et al., 2005).

Hydrological modeling and spatial analysis are important in water resource assessment. The state of river networks, canals, reservoirs, and groundwater in the area is determined using GAT. The “Flow direction” and “Watershed” functions calculate water flow directions and basin boundaries. These processes are useful in planning irrigation systems and effectively organizing water distribution (T. Rajabov, 2021).

Soil maps are created using GAT technologies to assess soils, which determine parameters such as salinity, moisture, and fertility. NDVI and NDWI indices are calculated based on remote sensing (RS) data, and the state of soil and vegetation is monitored. Landsat and Sentinel images are used, in particular, to identify areas prone to salinity (Bakr et al., 2012).

Remote sensing (RS) and NDVI (Normalized Difference Vegetation Index) are used to analyze vegetation cover. This index is used to assess the health and coverage of vegetation. Serial satellite images taken during the growing season determine the dynamics of plant growth, and monitor degraded lands (K.S. Salomov, 2022).

GAT capabilities are an important tool for analyzing the location, creating thematic maps, compiling data into databases, documenting, and making accurate decisions. GAT serves as the main scientific and practical tool for ensuring the effective use of natural resources and environmental control in the Lower Zarafshan region. These technologies allow not only to assess the current situation, but also to predict future changes (E. Esri, 2019).

The Lower Zarafshan physical-geographical district is of particular importance as a region rich in natural and geographical resources, with unique climatic and geomorphological conditions. Studying and assessing its natural components, such as relief, climate, water, soil and vegetation, allows us to understand their interrelationships. Such analyzes are important for the sustainable development of the region and the rational use of natural resources. GAT technologies serve as a modern and effective tool in these processes. With the help of digital relief models, climatic data, remote sensing index, thematic maps and hydrological analyzes, it is possible to form an objective and accurate picture of natural components. This approach serves to effectively solve important tasks such as assessing the ecological state of the region, identifying risks in advance, and planning agricultural and land reclamation works. Thus, the use of GAT technologies in the complex study of the natural and geographical features of the Lower Zarafshan district is of great

scientific and practical importance..

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