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Experience of Using "GIS" Technology in the Development of Geoecological Maps

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Abstract

The article discusses the experience of using 3D maps developed on the basis of geographic information systems (GIS) data for determining and recommending geoecological indicators of sustainable development.

Keywords: Map, geoecology, sustainable development (SD), indicator.

1. INTRODUCTION

To implement this program on a national scale using the example of desert territories occupying 3/2 of the total territory of the Republic of Uzbekistan, On October 20, 2018, the Cabinet of Ministers adopted Resolution №841 "On measures to implement national goals and objectives in the field of sustainable development for the period until 2030" [SDG, 2018, p 1]. The decree indicated the need to develop research on "... promoting the rational use of desert territories, combating desertification, ending and reversing the process of land degradation and biological diversity." In this regard, studies aimed at clarifying, evaluating geoecological indicators of SD in the Lower Zeravshan physico-geographical district, and optimizing the ecological state within geosystems using GIS technologies are of particular relevance.

The selection and systematization of indicators resulting from 17 goals and 169 tasks of the UN is carried out depending on the political and environmental situation, economic potential and social opportunities. The geoecological indicators of SD are systemic in nature, and cover geosystems from the geographic crust of the globe (global) to landscape (local) taxonomic units. Based on a systematic geo-ecological approach to this problem proposed by the World Bank on a global scale, 550 indicators of SD by the organization of the United Nations Environment Development Program (YUNEP) 132 environmental indicators were selected as environmental indicators. UNIC (Unique Identification Code Methodology) and 118 environmental indicators proposed for Central Asia. On a national scale, in particular, for Uzbekistan, 91 indicators were recommended as environmental indicators (68 core and 23 additional). However, local indicators of SD indicators and their geoecological features have not yet been disclosed.

The system of geoecological indicators of local area SD`s coincides precisely with the physical-geographical taxonomic units of geographical zoning at the district, group of districts, district, and landscape levels. Therefore, it is advisable to consider this issue in geosystems at the level of the largest physical-geographical taxonomic unit throughout the republic. Since the geographical components in the physical-geographical district are mutually close and are reflected in close connection.

2. MATERIALS AND METHODS

In the research process, field, basic, experimental, cartographic, paleographic, geographic-comparative, medical-geographical, statistical and mathematical modeling methods, landscape-geochemical methods were used.

3. RESULTS AND DISCUSSION

Lower-Zeravshan physical-geographical district is manifested as a local taxonomic unit of the SD, because there are geoecological problems in it, arising under the influence of natural and anthropogenic factors, are manifested in the following peculiar indicators: excess of the level of mineralization and pollution of water resources of Maximum permissible concentration (MPC) in the republic by 2-3 times; salinity of subsurface waters to the level of 10,000-15,000 mg/l; low provision of the population of the republic with high-quality drinking water (in rural areas, centralized water supply does not exceed 79.1%); salinity at different levels of more than 90% of irrigated land; excess of the area with groundwater at a depth of 1.5 m above the soil level of 50% of the total area of irrigated land; mortality of children under the age of one year 32.4% 0 for every 100,000 people; the incidence rate of cancer is 2 times higher than in the country; in patients with acute intestinal, respiratory, urinary tract diseases - 2 times; the threat of desertification processes of 199.6 thousand ha of irrigated land of the geosystems of the Bukhara-Karakul and Korovulbazar oases, etc [Nigmatov et al, 2015, p. 119], [Rasulov A.B., Nigmatov A.N., 2013, p. 77-83].

The geoecological situation in the object of study was reflected in a three-dimensional (3D) "Geoecological electronic map of the Lower Zeravshan physical-geographical district" compiled on the basis of the GIS method on a scale of 1: 200000 (Fig. 1). Unlike traditional two-dimensional maps, it is a new electronic tool for a clear representation of geosystems and their variable feature, reception, storage, processing and transmission of geo-information data. The layout of this map was developed in electronic form using the "Panorama GIS" program based on a topographic map of Uzbekistan with a scale of 1: 200,000. From this map you can get the physical-geographical, environmental, social, institutional and data on the biodiversity, inherent in the Lower Zerafshan physical-geographical district. The map can be applied in a direct assessment of the geoecological situation, determining indicators of sustainable development, organizing tourist routes, and increasing the effectiveness of geographical education.

The map was compiled using the flat equal projection Gauss-Kruger method. The map is compiled on the basis of a generalization and image of the peculiar geoecological features of the district and 13 types of geosystems are identified in it. A map based on an innovative approach can be used in mathematical modeling of the geoecological situation, operational data analysis with high accuracy, in navigation, tourism, urban planning, geoecology, landscape design, scientific research and the educational process [Nigmatov, Rasulov 2011, p.12-14].

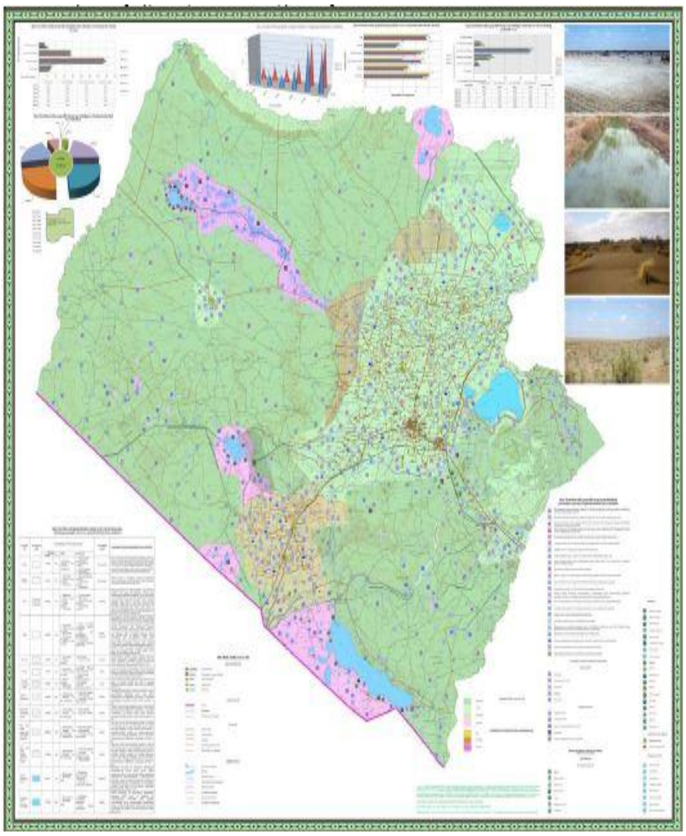

Fig. 1. Geoecological map of the Lower Zeravshan natural and geographical district.

(Original map compiled at a scale of 1: 200 000)

An analysis of the geoecological situation in the physico-geographical district from the point of view of SD and assessment of the geoecological situation was carried out based on 29 primary (basis) and 26 secondary (additional) indicators 5 groups of indicators, in particular 11 summer data on 3 and 6 *atmospheric air* indicators, respectively (see table 2). In the north-eastern geosystems of the district, the geoecological situation requires an assessment through indicators: dust and solid particles (0.15–0.16 mg/m³ in relation to MPS); nitrogen dioxide (0.049–0.04 mg/m³ in relation to MPS); ammonia (0.049–0.04 mg/m³ in relation to MPS). In the geosystems of the southern and south-eastern geosystems of the district, the geoecological situation requires assessment through indicators of dust particles (2.2 times higher than DN) and carbon monoxide (2.4 mg/m³ in relation to MPS). When assessing the district's *water resources*, the SD points of view analyzed 11 primary and 11 secondary indicators, which over the past 10–11 years have led to changes in the geoecological situation in the negative direction by 1.2–1.5 times [Rasulov, 2014,.p. 140-143].

There are only 12 recommended indicators of sustainable development in assessing the land resources of the Lower Zeravshan District, 6 of them are primary and 6 are secondary. The data show that the soil has undergone degradation under the influence of anthropogenic and natural factors. Fertility of the soil is low, and the effectiveness of mineral fertilizers used to increase productivity are seasonal in nature and have a negative impact on the geo-ecological situation. Pasture degradation in 70-75% of the district takes place with medium and sharp intensity. The increase in soil salinity is directly proportional to 2 out of 6 indicators indicated in Figure 2, that is, the location of ground and seeping waters, and the level of mineralization [Kulmatov et al., 2015, p. 956-971].

Preservation of the biodiversity of the district implies an increase in the area of protected areas from 5.1% to 10% in accordance with international conventions, solving the socio-economic problems of the population, preventing the reduction of the number or extinction of any species in geosystems by further strengthening measures to ban forest felling.

The analysis of the health status of the population by indicators: average life expectancy, general morbidity, mortality of children under the age of one year showed that these indicators exceed the national average by 1.2-1.5 times. Local geo-ecological indicators in the field of public health include the following 5 indicators: population density, total morbidity, total mortality, mortality of children under one year of age, and average life expectancy.

The targeted use of environmental indicators in environmental protection activities in Uzbekistan began in 2005, despite this, a scientific assessment system has not been formed and is not scientifically substantiated for these indicators of the situation in small territories. Taking into account this state of affairs, the Lower-Zeravshan physico-geographical district from the geoecological point of view was divided into three: north-eastern, central and southeastern areas. The districts, in turn, are divided into 13 types of landscapes. Based on the specific features of each landscape, 54 local geoecological indicators have been identified.

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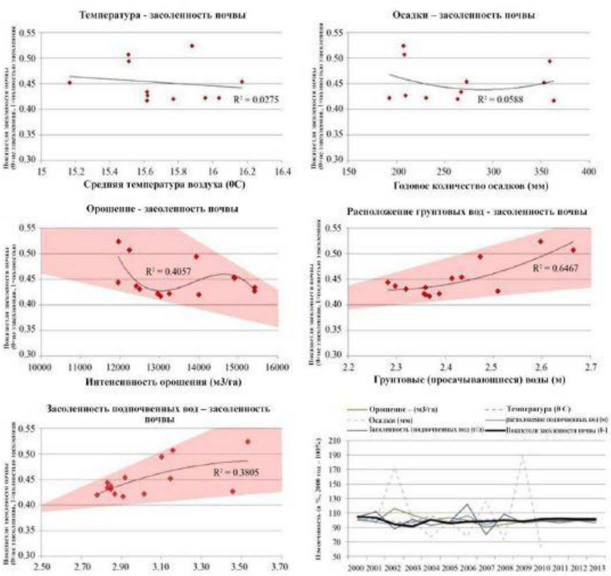

Fig. 2. Correlation dependence of soil salinity and environmental conditions to determine the degree of indicators of sustainable development

The analysis of the geoecological situation in the Lower Zeravshan physical-geographical district and the recommended indicators suggest the practical application of the following optimization measures within the framework of the landscape-tactical unit of each geosystem:

I. In sandy-clay-gypsum-gravel landscapes in the lowlands at mining enterprises, control over strict compliance with construction and activity standards, reclamation of technologically destroyed lands and their return to the land fund on the basis of environmental requirements, strict observance of the requirements for grazing, regular phyto-reclamation measures.

II. In loess-clay-gravel landscapes in low mountains at mining enterprises, control over strict observance of construction and activity standards, reclamation of technologically destroyed lands and their return to the land fund on the basis of environmental requirements, strict observance of requirements for pasture livestock breeding, continuous introduction of land reclamation measures.

III. In sandy landscapes, prevention of saxaul logs for various purposes, application of phytomelorescence methods (saxaul, wormwood or astragali, kungirbash) in the fight against dunes and moving sand, use of the “water-accumulating furrows” method, regulation of recreational and tourist activities, observance of day trips in mining enterprises, regulation of the use of geosystems.

IV. In sandy-gravel landscapes, the effective application of the phytomelioration method in the fight against wind erosion and the strengthening of moving sands, the regulation of raw materials used.

V. In clay landscapes, the use of water resources (opportunities) in phytomeliorative measures through the method of “water-accumulating walkways” (150-200 m3 per hectare), strict compliance with the normative requirements of grazing, creation of artificial formations by sowing on arable land or on furrows with enrichment with shrubs or shrubs that are significant in terms of dry food of typical takyrs, the surface of which is compacted with clay rocks, in takyrs with sandy soil in order to increase the fertility of pastures sowing shrubs and shrubs by harrowing.

VI. In oasis landscapes, optimization in accordance with national building codes of sanitary protection zones of enterprises, creation of green zones around cities in accordance with the population, equipping enterprises with dust and gas traps, providing settlements with high-quality drinking water and a sewage system, providing the population with oases of medical and economic benefits, the introduction of advanced irrigation technologies, the qualitative equalization and washing of irrigated lands, the elimination of small parts gov salinity in lands reduction to optimal amounts of use of chemical fertilizers, reconstruction collectors, drains and irrigation facilities, making available to the optimum level of "green zone" around the purpose oases predostvrascheniya coating sand.

VII. In solonchak landscapes, active implementation of the phytomeliorative measures (use of tamarisk, sarsazan, kamok, shiparken, camel thorn plants), reduction of the flow of saline water that drains after irrigation in oases.

VIII. The protection of tukay landscapes, the cessation of felling of trees without special permission, the strengthening of control over hunting, the widespread use of trees in the restoration of destroyed geosystems.

IX. In waste-water landscapes, reconstruction of collectors, drainage ditches and irrigation networks, optimization of the comparative depth of drainage networks in order to reduce the groundwater level, the introduction of hydromeleotaric methods (biological treatment of water), the development of fish farming, the reduction and termination of drainage-waste water into inland waters district, etc.

X. In freshwater landscapes, control over the discharge of waste water into water bodies, covering canals and ditches (irrigation ditches) with water-impervious material, applying advanced irrigation technologies (drip, "rain"), erecting protective groves (trees) near hydrographic networks.

XI. in bog-sandy-gypsum landscapes, compliance with established livestock maintenance standards, prohibition of felling of trees and shrubs, reclamation of technogenic landscapes, adoption of phytomelioration measures, etc.

XII. In gypsum-sand technogenic landscapes, reclamation, strict adherence to requirements for grazing, adoption of phytomelioration measures (construction of moisture and sand accumulating furrows), etc.

XIII. In sandy-gravel-gypsum landscapes, strict adherence to the requirements of grazing livestock, the adoption of phytomelioration measures (the construction of moisture and sand accumulating furrows), and the restoration of technologically destroyed lands.

Three-dimensional (3D) “Geoecological electronic map of the Lower-Zeravshan physical-geographical district” compiled on the basis of the GIS method on a scale of 1: 200000, unlike two-dimensional traditional maps, is a new electronic tool for clear presentation of geosystems and their variable feature, reception, storage, processing and transmission of geographic information data. A map based on an innovative approach can be used in mathematical modeling of the geoecological situation, operational data analysis with high accuracy, in navigation, tourism, urban planning, geoecology, landscape design, scientific research and the educational process.

Based on the analysis of the geo-ecological situation in the district, from the point of view of SD and assessment of the geo-ecological situation, the expediency of using 29 primary (primary, direct) and 26 secondary (clarifying, complementary, indirect) indicators within the 5 geographical components was emphasized.

When studying 3 primary and 5 secondary indicators of atmospheric air from a territorial point of view, the expediency of assessing the geoecological situation in the northe-astern ecosystems of the district through indicators of dust and particulate matter (0.15–0.16 mg/m³ in relation to MPS) was recognized, nitrogen dioxide (0.049–0.04 mg/ m³ in relation to MPS), ammonia (0.049–0.04 mg/m³ in relation to MPS) and southea-stern geosystems - through dust particles (2.2. times more than MPS) and carbon monoxide 2.4 mg/m³ in relation to MPS).

To assess water resources from the point of view of sustainable development, the use of 22 indicators is recommended; as a result, it has been established that over the past 10–11 years, they have led to a 1.2–1.5-fold change in the geoecological situation in the negative.

4. CONCLUSION

In summary, the recommended geoecological indicators for the evaluation of land resources are 12, indicating that soil degradation is occurring. Given the adverse effects of mineral fertilizers used in agriculture on the geoecological situation, their optimal use is recommended. To optimize the existing geoecological situation in the region, the district is divided into three parts: the northeast, the central and southeastern regions, and the need to implement SD measures for 13 specific landscape types in these areas.

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