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CALCULATION AND ASSESSMENT OF ECOLOGICAL-ECONOMIC BALANCE IN THE GEOINFORMATION SYSTEM
(ON THE EXAMPLE OF FERGHANA REGIONS)

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Abstract: The article discusses the main issues of the ecological-economic balance of the territory. A comprehensive assessment of the ecological-economic balance of the Ferghana region was carried out by the ratio of the main land use categories characterized by varying degrees of anthropogenic pressure. The coefficient of natural security of the territory is determined and the typification of the municipal regions and urban districts of the region is carried out according to the degree of tension of the ecological-economic condition of the territory.

Keywords: ecological-economic balance, anthropogenic pressures, environmental assessment, spatial typology, GIS, natural security of the territory, ecological nets.

РАСЧЕТ И ОЦЕНКА ЭКОЛОГО-ХОЗЯЙСТВЕННОГО БАЛАНСА В ГЕОИНФОРМАЦИОННОЙ СИСТЕМЕ (на примере Ферганской области)

Аннотация: В статье рассматриваются основные вопросы эколого-хозяйственного баланса территории. Проведена комплексная оценка эколого-хозяйственного баланса Ферганской области по соотношению основных категорий землепользования, характеризующихся различной степенью антропогенной нагрузки. Определен коэффициент естественной защищенности территории и осуществлена типизация муниципальных районов и городских округов региона по степени напряженности эколого-хозяйственного состояния территории.

Ключевые слова: эколого-хозяйственный баланс, антропогенная нагрузка, эклогическая оценка, пространственная типизация, ГИС, естественной защищенности территории, экологик каркас.

Assessing the ecological and economic state of the territory helps to develop the most effective land use options and link socio-economic development with the protection and improvement of the environment, thereby contributing to the sustainable development of the region. To successfully apply the concept of ecological-economic balance, it is necessary to first determine the structure of the territory under study, i.e. way of organizing it. The purpose of

applying this methodology is to organize rational land use, which is carried out by improving the management of human economic activities [3, 4].

The concept of sustainable development has found wide application in the economic, social and environmental sphere of public activity. An environmental and economic assessment of the territory is aimed at identifying the most favorable land plots for the goals set by the company or production, as well as, if necessary, monitoring the process of restoration of depleted zones. For the successful creation of programs and their implementation within the framework of the concept of sustainable development, new approaches are needed aimed at organizing an environmentally compatible society. One of such approaches is the concept of ecological-economic balance (EEB) of the territory, which establishes and maintains harmonious relations between nature and human economic activity [1].

The concept of the ecological-economic balance of the territory includes the following conditions: organization, arrangement and arrangement of territories of different administrative levels on a landscape-ecological basis; preservation and maintenance of natural and slightly modified landscapes that perform important environmental and resource-forming functions in full; rational use and maintenance of the natural potential of the territory, a reasonable distribution of natural resource rents; governance, self-government and territorial justice; achieving an acceptable quality of life and products and maintaining a healthy lifestyle; development of innovative processes [2].

In the process of studying the existing experience in assessing EEB, it was noted that, depending on the chosen research unit, its physical and geographical features and economic development, the components used for the assessment are different, and the development of geographic information technologies allows you to create cartographic products, which reflects each stage of the assessment, as well as the synthesis of the results. Against the background of the successful application of the EEB assessment, the completion of which is the creation of

recommendations on the sustainable development of territories, the problem of uniformity and themes of the used and obtained cartographic material is relevant. Modern cartographic works, the purpose of which is an analysis of the ecological-economic condition and its assessment, are based on the techniques proposed by B.I.Kochurov and V.A.Lobkovsky. Today there are two concepts that overlap with each other and complement this ecological-economic condition (EEC) and the ecological-economic balance (EEB). Methodological approaches to the analysis of the EEC and balance of the territory were developed by B.I.Kochurov, Yu.G.Ivanov, V.A.Lobkovsky, and were first tested on example of the territories of the Moscow region and the Republic of Altai. B.I.Kochurov devoted his work to the concept of EEB [3, 5, 7].

It is also important to note the role of GIS in assessing the environmental and economic balance, as a promising tool that makes it possible to analyze calculated indicators and identify spatial patterns. GIS makes it possible to conduct queries on the values of the coefficients (K_a, K_r, K_{ns}), visualize them for comparison and analysis of dynamics, as well as build thematic cartograms that allow you to identify areas with both favorable and unfavorable nature management structures that need more in-depth research.

The assessment of the EEC of the Ferghana region was based on the National Report of the State Committee on Land Resources, Geodesy, Cartography and State Cadastre of the Republic of Uzbekistan on the state of land resources and the data on land balance of cities and districts of the Ferghana region. To assess the current geoecological situation caused by the use of natural and natural resources of the Fergana region, the level of environmental and economic stresses of urban and district territories is studied. For this purpose, anthropogenic load (AL) indicator by city and county is analyzed.

The grouping of lands by the degree of anthropogenic load makes it possible to evaluate the anthropogenic transformation of the territory in

comparable terms. They are the coefficients of absolute (K_a) and relative (K_o) tension of the EEC of the territory, calculated by the formulas (1)–(2): coefficient of absolute tension of the EEB of the territory (K_a); coefficient of relative strength of the EEB of the territory (K_r); coefficient of natural security of the land fund (K_{ns}); ecological fund of the territory (P_{ef}); the area of the study area (P_t) (table 1).

Table-1

Coefficients evaluate the ecological-economic balance of the territory (B.I.Kochurov, 1999, 2003).

Name of coefficient	Formula	Used data	Change characteristic values
Absolute ecological tension coefficient	$K_a \frac{AL6}{AL1}$	Areas with high and low anthropogenic loads are taken into account	K_a - the higher the coefficient value, the tighter the situation
Relative environmental stress ratio	$K_r \frac{AL4+AL5+AL6}{AL1+AL2+AL3}$	Areas of various types of anthropogenic load are taken into account.	$K_r \leq 1$ - tension of the EES of the territory of the balance is balanced To - the higher the value of the coefficient, the tense the situation
The coefficient of natural security of the territory	$K_{ns} \frac{P_{ef}}{P_t}$	Is used P_{ef}= AL1+0,8AL2 +0,6AL3+0,4AL4 and P_t – the area of the studied territory	K_{ns} – the higher the coefficient value, the better the situation $K_{ns} < 0,5$ – critical level of territory security

The concept of the EEB allows the inclusion of criteria for assessing anthropogenic load in a particular order across specific regions, ie administrative units. Calculation of computers for administrative units of Fergana region is carried out in several stages. The first phase of the calculation focused on the anthropogenic load for all land categories and types, and the appropriate score (Table 2). At the initial stage of the study, the coefficient of absolute tension of the EEB of the territory (K_a) for cities and districts of Ferghana region was calculated. The ratio of land categories and types of AL1 and AL6 categories

was determined. The absolute environmental load is 10.2 in the Fergana region. The lower the coefficient values, the more favorable the geoecological state and EEB of the area under study. In terms of administrative and territorial units, the most favorable EEB by K_a is observed in the Dangara (1.5), Yazyavan (2.2), Besharik (3.4), Furkat (6.2), and Soh (16.6) districts. lower than that of the province. These areas are characterized by large areas of protected areas, underwater (rivers, streams and lakes), protected forests and reserve lands. Indicator of K_a is most critical in Rishtan (154.3), Oltiariq (199.3), Uchkuprik (388.6) and Baghdad (493.6) districts (Table 3).

Table -2

The structure of the land fund of the Ferghana region, taking into account the anthropogenic load index (AL).

№	Administrative districts	Overall area, thousand, km²	The degree of anthropogenic transformation, point of AL*					
			1	2	3	4	5	6
1	Besharik	0.78	1572	36010	4332	7292	24019	5309
2	Baghdad	0.42	10	7752	4624	3828	20946	4936
3	Buvayda	0.32	144	5141	1486	2403	19065	4323
4	Dangara	0.45	3157	12001	1438	3863	20584	4759
5	Yozyavon	0.35	1524	7965	1127	2957	18983	3381
6	Quva	0.43	41	8641	6729	3977	19336	4954
7	Oltiariq	0.40	26	9379	2542	2795	20166	5182
8	Qoshtepa	0.39	136	4013	2141	5372	23467	4818
9	Rishtan	0.42	37	7963	4456	4218	19796	5708
10	Soh	0.22	81	15718	1878	607	2445	1345
11	Toshloq	0.28	132	3720	2180	1985	16319	3704
12	Uzbekistan	0.77	62	43648	7601	3371	16906	5423
13	Uchkuprik	0.37	11	9129	2241	2766	18804	4275
14	Ferghana	0.61	162	22378	9470	3092	19678	6490
15	Furqat	0.30	539	5860	459	3478	16772	3324
	Total:	**7.0**	**7752**	**209868**	**61106**	**54153**	**288614**	**78965**

*1–AL1, ha (Very low); 2–AL2, ha (Low); 3–AL3, ha(Average); 4–AL4, ha (Very High); 5–AL5, ha (Higher); 6– AL6, ha (Highest).

In the Fergana region, the number and categories of protected areas (PA), which constitute the main elements of the ecological nets, are insufficient for both elevation zones and administrative and territorial units. To optimize the overall environmental stresses in these areas, it can be achieved by expanding the protected areas categories of the I-IV or creating new ones.

Table-3

Indicators of the main coefficients of the ecological-economic state of the territory of the Ferghana region (2019)

№	Administrative districts	K_r	K_{ns}	At the expense of P_{ef} %
	In the Fergana region			
1.	Besharik	0,9	0,5	45,7
2.	Baghdad	2,4	0,2	25,0
3.	Buvayda	3,8	0,2	18,8
4.	Dangara	1,7	0,3	33,1
5.	Yozyavon	2,4	0,3	27,1
6.	Quva	1,8	0,3	28,8
7.	Oltiariq	2,3	0,2	25,4
8.	Qoshtepa	5,3	0,2	17,0
9.	Rishtan	2,4	0,2	25,5
10.	Soh	0,2	0,6	63,5
11.	Toshloq	3,6	0,2	18,5
12.	Uzbekistan	0,5	0,5	53,0
13.	Uchkuprik	2,2	0,3	26,2
14.	Ferghana	0,9	0,4	40,8
15.	Furqat	3,4	0,2	22,6
	Total:	**1,5**	**0,3**	**33,4**

Relative coefficient of relative strength of the EEB of the territory (K_r) for each administrative district of Fergana region were calculated. In the analysis of the results, the districts with a value of one K_r are selected. This is an indication of the optimal environmental and economic balance in the districts. If the value of K_r exceeds one, it indicates an increase in the ecological stress in the area. In areas with such an index, sustainable environmental balance can be achieved by expanding protected areas or the areas of ecological reserve lands.

Due to the presence of K_r 1 in Soh (0.2), Uzbekistan (0.5), Besharik (0.9) and Fergana (0.9) districts of Fergana region, the relative environmental stresses are the best. In all other districts, K_r is greater than 1, indicating an increase in voltage. The highest value of K_r was found in Furkat (3.4), Tashlak (3.6), Buvaida (3.8) and Kushtepa (5.3) districts.

The value of the K_r coefficient exceeds 1 in the regions where urbanization and high agro-landscape are high. For example, over the last 10 years, the process of fragmentation in landscapes has increased due to the

expansion of settlements in almost all districts, especially in the areas adjacent to regional and district centers. Therefore, in practice, it is not possible to form a district or territory with an ideal EEB. Most of the region's major industrial and transport infrastructure is concentrated in cities and district centers. We can see that the changes in EEB in the Fergana region are negative. For example, this indicator is related to changes in the composition of the natural landscape, which is the highest in the districts of Baghdad, Uchkuprik, Tashlak, Furkat, and Buvaida.

Also, due to the construction of new housing and industrial facilities, the anthropogenic load in the cities is significantly higher than in the administrative districts. Taking into account the recreational needs of the urban population and their role in optimizing the ecological situation, special attention should be paid to the establishment of recreational zones, micro reserves and shelter forests in the areas adjacent to the cities. Biodiversity forests between recreational areas and other land users may serve as buffer zone.

Each anthropogenic impact or their combination corresponds to its own limit of stability of natural and natural-anthropogenic landscapes. The more diverse the landscape, the more resilient it is. At the same time, the level of K_{ns} of a territory also depends on the distribution of lands according to the degree of anthropogenic load. Lands characterized by a high degree of anthropogenic load, as a rule, have low natural protection.

In the Fergana region, the areas with the natural protective coefficient (K_{ns}) above the standard range ($K_{ns} \leq 0.5$) may include Soh, Uzbekistan and Besharyk districts. Regions with relatively high K_{ns} (0.4) are Ferghana regions. In all other districts, the degree of natural protection of landscapes was found to be the most critical, ie K_{ns} 0.1 to 0.3. In some districts, the value of K_{ns} th is higher than the regional average, which is explained by the size of the reserve lands, forest resources and protected areas.

As studies have shown, the ecological-economic condition of the territory of the region is unsatisfactory. In connection with the development of agricultural production, industrialization, urbanization, it continues to deteriorate. Agricultural lands are exposed to erosion, deflation, salinization. The transition to an adaptive landscape farming system should be carried out taking into account the ecological-economic condition of the territory. Planned activities should not lead to an increase in the values of the coefficient of its relative intensity of the EES above 1.0. To recommend to the design organizations when assessing the EES of the territory to use our proposed methodology, taking into account the level of land reclamation arrangement of the territory. To carry out the general anti-erosion organization of small land holdings simultaneously on the entire catchment, regardless of the boundaries of the allotment owners.

In some districts of Fergana region, by 2019 we can see a sharp decline in the value of K_{ns}. This is due to the different development of ecological reserve lands in the districts. It can be seen that the landscape and biodiversity indicators and their sustainability are not optimal within administrative and territorial units. Therefore, it is suggested to expand the PA area and to improve the ecological nets for the conservation of natural landscapes and biodiversity conservation, and the preservation of optimal environmental conditions. These activities will enhance the region's natural defenses and provide an opportunity for optimization of the EEB.

Conclusions

One of the main tools for reducing the anthropogenic load on the natural environment is rational land use and environmental management with the regulation of areas allocated for arable land, hayfields and pasture lands for grazing in areas where livestock farming has recently become increasingly developed. To prevent the adverse consequences of the tense ecological and

economic balance of the territory, state and municipal control over the state and dynamics of land use should be strengthened.

When analyzing the data obtained, it is clear that natural landscapes, which provide natural protection of the territory, do not occupy a sufficiently large area. The territory of all administrative-territorial units (with the exception of the regions of Sokh, Besharik and Uzbekistan) is dominated by anthropogenic landscapes. Prirodnye landscapes predstavlyayut soboy obshirnye territorii v pystynyakh Tsentralnoy Fergany, na kholmakh yuzhnoy Fergany, v Shakhimardanskom rayone i v Gornom rayone Sokhskogo rayon.

The values of the coefficient (K_a) make it possible to objectively assess the degree of compliance of the intensity of anthropogenic impacts with the restoration potential of natural landscapes and justify the need to create protected natural areas (PNA) in the region with the required size of their area. The lower the coefficient value, the more favorable the geo-ecological situation in the study area.

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