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Assessment of Anthropogenic Load on the Land and Landscape of Cherkasy Region Using GIS Technologies

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SUMMARY

The article proposes a methodological approach to a comprehensive assessment of anthropogenic load on lands and landscapes of Cherkasy region based on the analysis of the land use structure and using GIS technologies (QGIS). The need to use an integral indicator that takes into account the varying degrees of influence of natural and anthropogenic factors on the ecological state of the territory is substantiated. The assessment system includes indicators of agricultural development, plowing, the ratio of destabilizing and environmentally stabilizing lands, soil quality, the share of forests, water bodies, built-up areas, unsuitable lands and lands of the nature reserve fund. The results of the study showed that the highest level of anthropogenic load is characteristic of Uman, Zvenigorod and Zolotonish districts, while Cherkasy district has the lowest integral indicator. An average level of anthropogenic load was established for the region as a whole. Based on the results obtained, clustering of administrative districts and zoning of the territory by the level of anthropogenic load were carried out. It has been established that the decisive factor in the anthropogenic transformation of landscapes in the Cherkasy region is intensive agricultural land use – primarily the high proportion of plowed land and an unbalanced agricultural land-use structure. The proposed approach can be used for environmental monitoring, land-use optimization, and the development of regional sustainable development strategies.

Keywords: Anthropogenic load; Land use; Landscapes; Integral indicator; Clustering; Zoning; Cherkasy region; Sustainable development; GIS technologies.

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Introduction

Intensive land use is one of the main factors of anthropogenic transformation of natural landscapes, which leads to deterioration of the ecological state of lands, soil degradation and disruption of ecological balance. This problem is especially relevant for regions with high agricultural development, where a comprehensive assessment of the level of anthropogenic load is necessary as a basis for optimizing the structure of land use. (Sajikumar et al., 2015). The purpose of the study is to assess the anthropogenic load on the lands and landscapes of the Cherkasy region using an integral indicator, conduct clustering of administrative districts and zoning of the territory using GIS technologies (QGIS) to substantiate the directions of environmentally balanced land use.

Method and Theory

The methodological basis of the study is a systematic approach to assessing anthropogenic load on land and landscapes, which involves a comprehensive analysis of the structure of land use using an integral indicator. The assessment was carried out on the basis of indicators of agricultural development, plowing, the ratio of destabilizing and environmentally stabilizing lands, soil quality, the share of forests, lands under water, built-up areas, unsuitable lands and lands of the nature reserve fund using the weighted coefficients method (Sonko, 2018; Parakhnenko et al., 2021). Spatial analysis, clustering of administrative districts and zoning of the territory by the level of anthropogenic load were performed using geographic information systems (QGIS), which ensured the integration of statistical and spatial data, automation of calculations, cartographic display of results and identification of territorial patterns of distribution of anthropogenic load.

Results

Rational land use requires a comprehensive analysis of the structure of the land fund and an assessment of the factors that determine its formation. (Shevchuk et al., 2025). At the same time, there is currently no generally accepted integrated approach to assessing anthropogenic load on land and landscapes, since the impact of natural and anthropogenic factors is not the same and has different ecological significance. In particular, intensive agricultural land use intensifies erosion processes and causes degradation of natural components, while the ratio of destabilizing and environmentally stabilizing lands largely depends on the effectiveness of land use management. (Denysyk et al., 2022).

It is advisable to assess anthropogenic load based on a systematic approach using GIS technologies (QGIS), which provide integration of statistical and spatial data, automation of calculations, spatial analysis and cartographic visualization of results. (Sopova et al., 2024). The proposed methodology is based on a comprehensive analysis of natural and anthropogenic components of land use, their integral assessment, clustering and zoning of the territory, taking into account the unequal contribution of individual factors to the formation of the ecological state. Since the leading type of land use in the Cherkasy region is agriculture, its indicators form the basis of an integral assessment of anthropogenic load, and the use of GIS technologies (QGIS) allows you to increase the accuracy of the analysis, identify spatial patterns and substantiate the directions of ecologically balanced land use (Kravtsova et al., 2023; Sopova et al., 2025).

In order to comprehensively assess the efficiency of land use, it is necessary to consider the factors that determine the formation of the land use structure, among which the main ones are agricultural and construction (residential and industrial). In particular, in the context of agricultural land use, we take into account the ratio of agricultural land to the total area of the territory (agricultural development), the share of arable land in the composition of agricultural land, the ratio of destabilizing land (arable land) to stabilizing land (primarily perennial plantations and hayfields), soil quality, as well as the share of unsuitable land (without vegetation cover or with insignificant vegetation cover) in the structure of the land fund. (Ecological Passport of Cherkasy Region, 2023; Chornomorets et al., 2021). In addition, in terms of anthropogenic load on land and landscapes, we consider built-up land. In our opinion, forestry and water management land use, as well as the conservation of territories (the share of lands in the nature reserve fund) have an environmentally stabilizing effect. (Shevchuk et al., 2024).

The coefficient of anthropogenic load on the lands and landscapes of the Cherkasy region was calculated by us as the result of adding estimates of the manifestation of various directions of land use according to the formula:

$$\boldsymbol{Ka}\text{н} = \sum_{\text{i}=1}^{\text{п}} \frac{Shk_1+Rk_2+\frac{Bdst}{stk_3}+Pnk_4+Zbk_5}{Bk_6+Lk_7+Pzfk_8+Wk_9} \quad (1)$$

where $K_{ан}$ – anthropogenic load coefficient, *Sh* – agricultural development, *R* – poverty, *Bdst/st* – balance of destabilizing and environmentally stabilizing lands, *B* – soil quality, *L* – share of forests, *W* – share of land under water, *Pn* – share of unsuitable land (land without vegetation cover or with little vegetation cover), *Zb* – share of built-up land, *Pzf* – share of lands of the nature reserve fund, *k* – coefficients of components.

The integral indicator of anthropogenic load on the lands and landscapes of Cherkasy region based on a set of factors was also calculated using the weighted score method with the establishment of appropriate coefficients, since the parameters are not of equal significance (Kravtsova et al., 2022).

Based on the significance of certain indicators for determining the level of anthropogenic load on land and landscapes, as well as the prevalence of various categories of land and related areas of land use, we set a coefficient of 4 for indicators of plowing, balance of destabilizing and environmentally stabilizing lands, as well as soil quality, for forest cover – 3, for agricultural development, the share of built-up land and lands of the nature reserve fund – 2, for shares of unsuitable land and land under water – 1. Below we present calculations of integral indicators of anthropogenic load on land and landscapes of each district of Cherkasy region.

For Zvenigorod district:

$$\text{К}_{\text{ан}} = \frac{80.79\times4+89.55\times4+8.57\times4+0.54\times1+3.51\times2}{55\times4+12.7\times3+1.1\times3+1.44} \approx \mathbf{2.75} \quad (2)$$

For Zolotonosha district:

$$\text{К}_{\text{ан}} = \frac{73.95\times4+89.3\times4+8.35\times4+0.3\times1+3.5\times2}{55\times4+6.4\times3+2.34\times3+13.62} \approx \mathbf{2.67} \quad (3)$$

For Uman district:

$$\text{К}_{\text{ан}} = \frac{83.65\times4+93.05\times4+13.39\times4+0.43\times1+4.32\times2}{60\times4+7.9\times3+1.6\times3+1.89} \approx \mathbf{2.85} \quad (4)$$

For Cherkasy district:

$$\text{К}_{\text{ан}} = \frac{56.47\times4+80.23\times4+4.05\times4+1.27\times1+4.48\times2}{50\times4+28.5\times3+2.2\times3+8.2} \approx \mathbf{1.91} \quad (5)$$

For Cherkasy region as a whole:

$$\text{К}_{\text{ан}} = \frac{71.09\times4+87.66\times4+7.1\times4+0.74\times1+4.04\times2}{55\times4+16.1\times3+1.72\times3+6.49} \approx \mathbf{2.40} \quad (6)$$

To determine the levels of anthropogenic pressure on land and landscapes, a three-point scale was applied: one point corresponds to an anthropogenic pressure coefficient below 2, two points to values between 2 and 2.5, and three points to values exceeding 2.5. These points also correspond to territorial clusters identified based on the level of anthropogenic pressure on land and landscapes.

Therefore, our calculations show that most of the Cherkasy region (except for the Cherkasy district) is characterized by a high level of anthropogenic load on land and landscapes, these territories constitute the first cluster. Only the Cherkasy administrative district, located in the central-eastern part of the region, has a low level of load (it constitutes the second cluster). At the same time, the level of anthropogenic load in the region is generally average (Table 1; Figure 1).

Table 1. *Clustering of the territory of Cherkasy region by the level of anthropogenic load on land and landscapes*

Rank	Administrative District	Anthropogenic Load Coefficient	Load Level (points)	Cluster
1	Uman District	2.85	High (3)	1
2	Zvenyhorodka District	2.75	High (3)	1
3	Zolotonosha District	2.67	High (3)	1
4	Cherkasy District	1.91	Low (1)	2
	Region as a whole	2.40	Medium (2)	–

Based on the clustering (Table 1) using GIS technologies (QGIS), we have developed a zoning map of the territory of Cherkasy region based on the anthropogenic load on landscapes. We distinguish the west-central region with a high level of anthropogenic load on landscapes, the central-eastern region with a low level of anthropogenic load on landscapes, and the north-eastern region with a high level of anthropogenic load on landscapes (Figure 2).

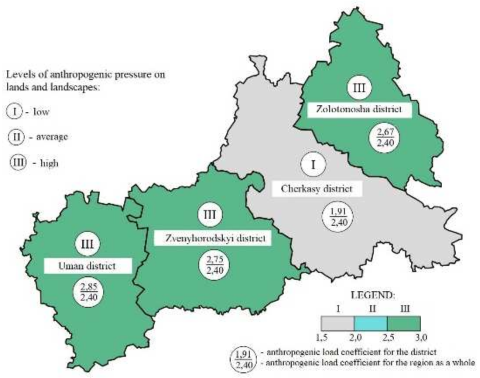

Figure 1. *Clustering of the territory of Cherkasy region based on anthropogenic load on land and landscapes*

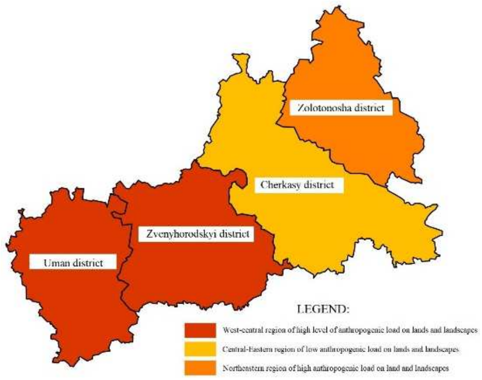

Figure 2. *Zoning of the territory of Cherkasy region by the level of anthropogenic load on land and landscapes*

Conclusions

The study showed that the level of anthropogenic load on the lands and landscapes of the Cherkasy region is determined primarily by the intensity of agricultural land use. The integral indicator was calculated taking into account agricultural development, plowing, the ratio of destabilizing and environmentally stabilizing lands, soil quality, the share of forests, built-up areas, lands of the nature reserve fund, lands under water and unsuitable lands. The use of GIS technologies (QGIS) enabled spatial analysis, the clustering of administrative districts, and the zoning of the territory based on the level of anthropogenic pressure. It was determined that the highest levels are characteristic of the Uman, Zvenyhorodka, and Zolotonosha districts, whereas the Cherkasy district exhibits the lowest level of pressure due to lower agricultural development and higher forest cover. The results confirm that agriculture is the primary driver of anthropogenic landscape transformation in the Cherkasy region.

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