Development of GIS for assessment of ecological stability of land

V. Zatserkovnyi, *P. Trofymenko, A. Amelyanets, N. Trofimenko (Taras Shevchenko Kyiv National University), V. Mykytyuk, T. Kotkova (Polissya National University)

SUMMARY

The article provides a comprehensive assessment of the ecological status of the territory of Chernihiv region in relation to the main types of land, characterized by varying degrees of anthropogenic load. The ecological stability of the territory was determined and the anthropogenic load of the territory was assessed. The level of plowing and agricultural development of the territory was established. It is established that the Chernihiv region is characterized by intensive use of land in agriculture. The share of arable land in the structure of agricultural land for the period from 2000 to 2016 increased by 1.2%, which led to an increase in plowed land to 44.5%. The magnitude of the ecological stability coefficient of the territory (0.48) of the Chernihiv region indicates that the territory of the region as a whole is ecologically unstable and unstable.
Introduction

It is known that the following characteristics are used to determine the ecological condition of the territory: the ratio of land by species and categories, the degree of anthropogenic transformation of natural landscapes, the load of ecological and economic condition. To analyze the structure of land use can be carried out on the basis of land cadastre units, taking into account expert scores of individual land plots. In view of the above, conducting an assessment of the ecological and economic balance of the territory by the degree of load on the territory of the region is an important scientific problem.

Agro-landscape optimization, comprehensive assessment of their ecological status, development of mechanisms and practical measures to improve the ecological status of land and increase the economic efficiency of its use were studied by such scientists as Medvedev V.V. (Medvedev V.V., 2002), Tretyak A. M. (Tretyak A.M., 2005), Dobryak D.O. (Dobryak D.O., 2009), Buligin S.Yu. (Bulygin S.Yu., 2005), Danylyshyn B.M. (Danylyshyn B., 2006), Furdychka O.I. (Furdychko O. I., 2010) and others.

Methods of investigation

The purpose of this article is to conduct an environmental assessment of anthropogenic transformations in the Chernihiv region. Based on this goal, the following tasks were envisaged: to carry out an assessment of the ecological status of the lands by the ratio of the main types of lands, to evaluate the ecological status and to assess the anthropogenic load of the territory, based on certain indicators; to conduct a comprehensive expert evaluation of the territory and to develop thematic mapping schemes in the context of administrative districts of Chernihiv region. The source database was the statistical directories of the Chernihiv Statistics Service, data on the structure of land in the region by 22 districts of the region. The assessment of the territory of the region was carried out in accordance with the methodological recommendations for the assessment of the ecological stability of agricultural landscapes and agricultural land use (according to Tretyak A.M. et al., 2001). For a comprehensive assessment of the structure of the land fund such indicators of as the degree of agricultural development of the territory, plowed land, coefficients of anthropogenic load and ecological stability of the lands were calculated. The complex evaluation was carried out by expert means.

Results of investigations

Chernihiv region is located within two physical-geographical zones - mixed forests and forest-steppe. It caused the conditional division of the territory of the region into two parts: northern - Polissia and southern - forest-steppe. The area of the region is 3190.3 thousand hectares or 5.3% of the area of Ukraine. The total land area of the forest fund is 741.22 thousand hectares, including 575,785 thousand hectares covered with forest vegetation (20.9% of the total area of the region). The percentage of areas covered by forest in different areas of the region varies: the forested areas of the northern regions are 37 - 41% of the total area of the district, the southern ones - 8 - 11%. Areas occupied by water bodies make up 68,023 thousand hectares (According to the State Geocadastre of Ukraine)

As can be seen from Table 2, the structure of the land fund of the Chernihiv region is dominated by agro-landscapes (66.8%) of the territory of the region. A positive trend is the increase of forest area and wooded area by 28.3 thousand hectares.

The area of open wetlands has increased by 11.5 thousand hectares and by 0.5 thousand hectares, the area under water bodies has increased. There is a slight decrease (by 0.5 thousand hectares) of the area of built-up lands and the area of other lands (by 0.5 thousand hectares), although in percentage terms this was not reflected. Changes in the structure of the land fund occurred due to the transformation of one land into another.
If we consider in more detail the structural changes of agricultural lands, during 2000-2016, the area of arable land increased by 75.9 thousand hectares. The area of all other agricultural land tends to decrease, the area of pastures and hayfields decreased by 37.1 thousand hectares, the area of perennial plantations - by 1.8 thousand hectares. Optimizing the ratio of arable land, hayfields and pastures is of great importance because it is the cheapest way to reconcile the relationship between man and land. Based on the results of calculations in the software ArcMap 10.4.1, maps were built which reflect the differentiation of the region by the level of environmental load (Figure 1, 2, 3, 4). The territorial differentiation of agricultural development of the Chernihiv region in the section of districts is shown in Figure 1.

The high level of agrarian load is characteristic of the Bakhmatsky, Talalaev and Nizhyn districts; the second group with a high level of agrarian load includes Mensky, Kulikovsky and all other areas of the Forest-steppe zone of the Chernihiv region. Temperate and minimal agrarian load is typical for the administrative districts of the northern part of the Chernihiv region (Novgorod-Siversky, Snovsky, Kozeletsky, Semenovsky, Ripkin, Koryukivsky). These are areas of the Polissia part of the region with large areas of forests. It is known that the degree of land plowing characterizes the environmental sustainability of land resources. The most unstable are those areas where plowed land is much more prevalent over relatively stable lands. A negative factor in these conditions is that the plowed area of Chernihiv region in 2016 compared to 2000 increased by 2.4%, and the share of arable land relative to the area of agricultural land increased by 4.9%. The constructed map shows the territorial differentiation of the region. Thus, the territory of Koryukivka and Ripkin districts is ecologically stable by the total number of assessment points. Forests, wetlands and surface water occupy a significant area of these districts. Other areas of the Polissya zone are characterized by medium stability of the territory, except for Kulikiv and Minsk regions, whose territory is poorly stable due to high agricultural development and low share of forests and wooded areas.
Within the oblast, the level of plowed territory ranges from 22.4% (Koryukovsky district) to 67.1% (Varvinsky district) (Figure 2). The most vulnerable to heavy land use due to their plowing (index> 0.50) are the 10 districts of the southern part of the region, which are classified as high and plowed. Moreover, the most plowed territory is Barvinsky (0.67), Sribnyansky (0.65), Bakhmatsky (0.65), Prylutsky (0.64), Bobrovycyky (0.64) districts. The two districts of Koryukivskyi and Ripkinsky with plow coefficient of 0.22 and 0.24 respectively have a minimum arable land area and are the least vulnerable to heavy use. It is known that the coefficient of anthropogenic load characterizes how much influence human activity has on the environment, including on land resources (Tretyak A.M. et al., 2001). As a result of the classification according to the anthropogenic load factor of the region for the period from 2000 to 2016, it increased by 0.18 and amounted to 3.25.

Territorial differentiation by the degree of anthropogenic load is shown in Fig. 3. The value of this coefficient in 2016 in the Chernihiv region indicates that four Polissia districts (Koryukovsky, Ripkin, Snovsky, Semenovsky) belong to the territory with average anthropogenic load. The rest of the districts of the region belong to the area with high anthropogenic load. The assessment of the impact of the composition of the land on the ecological stability of the territory, the sustainability of which depends on the agricultural development of the land, plowed land and the intensity of land use, development of the territory, is characterized by the coefficient of ecological stability.

In 2016 compared to 2000, the environmental stability factor in the Chernihiv region as a whole has changed by 0.02. The breaking of the fallow debris became the main cause of the worsening environmental situation in the region. In 2016, the environmental stability factor of Chernihiv Oblast was 0.48 in the region, which refers to territories with low level of resilience. The calculations made it possible to identify four groups of districts with different degrees of environmental sustainability in the Chernihiv region (Figure 4). The northern Polissya part of the oblast (Koryukivka and Ripkin districts (first group)), (Snovsky, Semenovsky, Kozeletsy, Gorodnyansky, Sosnytskyi, Koropsy, Novgorod-Siverskyi, Chernihiv (second group)) are ecologically stable and the area with average stability. The third and fourth groups with low stability and environmentally unstable areas are the southern and central parts of the region.

The zoning of the territory of Chernihiv region was investigated according to the above indicators. For each of these groups of grades, scores are assigned, groups with better conditions are assigned a higher score with worse conditions - lower. As a result, the entire territory of the region is divided into four groups (Figure 5).

Borzynsksky and Nosovsky districts, which are located on the border of two natural zones (Polissya and forest-steppe) have the status of poorly stable. All other transition and forest-steppe areas are ecologically unstable. Thus, in the spatial aspect, the decrease in the magnitude of the ecological stability of the territory of Chernihiv Oblast can be traced from the north to the south by the total value of the selected indicators.

![Figure 5](image)

**Figure 5. Comprehensive assessment of the ecological stability of the Chernihiv region in terms of administrative districts**
Recommendations and conclusions

Based on the results of the conducted research, it is established that the Chernihiv region is characterized by intensive use of land in agriculture. The specific weight of arable land in the structure of agricultural land for the period from 2000 to 2016 increased by 1.2%, which led to an increase in plowed land to 44.5%. And this reinforces the destabilization of the agro-landscape in the region.

The magnitude of the ecological stability coefficient of the Chernihiv region indicates that the territory of the region as a whole is ecologically unstable and unstable (0.48). In order to remedy the situation, it is necessary to develop and implement state programs to optimize the structure of the land fund of Chernihiv region.

In order to ensure ecological balance in the region, it is necessary to stop attracting additional agricultural land for intensive use. It is necessary to introduce the withdrawal from the farmland of low-productive lands.

References


