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ZONING OF KURSK MAGNETIC ANOMALY REGION ON THE BASIS OF SUSTAINABLE DEVELOPMENT INDICATORS

Kazakow S. G., Czernyszew A. A. **Regionalizacja obszaru Kurskiej Anomalii Magnetycznej na podstawie wskaźników zrównoważonego rozwoju.** Omawiany jest problem opracowania regionalnych wskaźników zrównoważonego rozwoju obszaru na podstawie wybranych czynników. Obiektem badań jest region Kurskiej Anomalii Magnetycznej, leżącej w granicach dwu jednostek administracyjnych Federacji Rosyjskiej: obwodu kurskiego i bielgorodzkiego. Obszar ten jest od dawna zagospodarowany i cechuje się wieloma problemami ekologicznymi, związanymi z przemysłem wydobywczym oraz intensywnym rolnictwem. Opracowany przez autorów integralny wskaźnik zrównoważonego rozwoju, łączący wskaźniki społeczne, ekonomiczne i ekologiczne, pozwolił na przeprowadzenie regionalizacji badanego obszaru.

Казаков С. Г. , Чернышев А. А. **Районирование региона Курской магнитной аномалии на основе индикаторов устойчивого развития**. Рассматривается проблема разработки региональных индикаторов устойчивого развития и районирование территории на основе выделенных факторов. В качестве объекта исследования выступает регион Курской магнитной аномалии в пределах двух субъектов Российской Федерации: Курской и Белгородской областей. Данная территория является староосвоенным регионом с рядом сложных экологических проблем, вызванных деятельностью горнодобывающей промышленности и высокоинтенсивным сельским хозяйством. Разработанный авторами интегральный индекс устойчивости, включающий социальные, экономические и экологические показатели, позволил провести районирование и типологию изучаемой территории.

Key words: sustainable development, Kursk magnetic anomaly, sustainability index
Słowa kluczowe: rozwój zrównoważony, Kurska Anomalia Magnetyczna, wskaźnik zrównoważonego rozwoju
Ключевые слова: устойчивое развитие, Курская магнитная аномалия, индекс устойчивости

Abstract

The authors review the issue of developing a set of regional sustainable development indicators and propose zoning based on the selected factors. The object of research is the region of Kursk Magnetic Anomaly within the two subjects of the Russian Federation: Kursk and Belgorod regions. The area is a long ago developed region with a number of complex environmental problems caused by mining activities and high-intensity agriculture. An integral index of sustainability, including social, economic and environmental indicators, that was developed by the authors, allowed us to conduct zoning and typology of the area under consideration.

INTRODUCTION

Since 1992, after a conference in Rio de Janeiro, which adopted the strategy of transition to a new way of development of the world community, international organizations have developed and proposed a variety of approaches and indicators to measure sustainable development at different territorial levels. At the international (global) level, the most methodically designed, in our view, is the project of indicators by the Commission on Sustainable Development of the UN which includes 134 indicators (*Indicators of Sustainable Development*..., 1996). Nationwide indicators have to be aligned with the strategic objectives of sustainable development and take into account its specificity (the political situation, geographical features, use of natural resources and other development priorities). Among many indicators there stand out the most important ones characterizing the dynamics of the transition to sustainable development (SD) and enabling some course corrections to ensure achievement of the objectives of this development. The structure of SD factors can be summarized as follows:

- The economic potential, which includes a resource component (the volume of reserves and their extraction), a manufacturing component (percentage

of the gross regional product) and an investment component (amount of investment and the overall "investment climate" in the region, based on various factors and risks).
- The social potential is determined by a number of indicators that characterize the quality of life of the population. Primarily these include natural growth, life expectancy, health, and education level of the population, as well as the average wage as an indicator of the consumption level.
- The ecological potential includes climatic factors (especially the level of environmental comfort and possibilities for farming and production); the level of anthropogenic load, which can be deduced from the emissions of various sources and the amount of arable territory; and the environmental framework elements (this includes indicators such as the proportion of protected and strictly protected areas, as well as the extent of forest cover in the region).

One of the main objectives of this study was to determine the level and the extent of sustainability in a specific territory. We chose to analyse the region of the Kursk Magnetic Anomaly (KMA) – the most powerful iron ore basin in the world. Its territory can be defined not only in the geological sense of the term, i.e. according to the boundaries of iron ore deposits, but as the entire territory of Kursk and Belgorod regions of Russia. This is due to the presence of very close cooperation between the iron ore quarries and the adjacent areas, especially ecologically, but also taking into account the administrative and economic subordination of these areas.

Kursk Magnetic Anomaly region covers an area of 56.9 thousand sq. km of which 29.8 thousand sq. km belong to Kursk region, and 27.1 thousand sq. km to Belgorod. The area is located on the Central Russian Upland in the forest-steppe zone. An important role is played by the presence of the richest iron ore reserves and fertile black soil lands combined with favorable agricultural and climatic conditions and convenient economic and geographical position. The region borders with the leading industrial region of the country – the Central one, and it is conveniently located in relation to the resource bases of Volga and the North Caucasus. After the collapse of the Soviet Union, this territory became the state border, which due to today's political crisis in Ukraine turned into new risks and challenges, primarily of social character.

The main environmental problem in the region is a conflict of interests between the mining industry enterprises (which alienate for their needs vast areas of land not only for ore open-pit quarries, but also for "tailing" – refuse heaps) and the high-value agricultural production sector, which is short of cultivated land and uneroded land at the level of tilled area of more than 70%. Some authors have described cases where the land taken out of agricultural use for hydraulic mine dumps became distinctive elements of the ecological framework of the territory (phot. 1), but such precedents are rare and do not reduce the level of environmental problems in the region (CHERNYSHEV, KAZAKOV, 2009).

Photo 1. Hydraulic mine dumps near the Mikhailovka Mining and Processing Plant. Water is supplied through pipes to flood the waste rock. Otherwise aeolian processes can lead to contamination of the territory. After a while, water birds can settle in these wetlands (phot. by A. A. Chernyshev)
Fot. 1. Zwałowiska hydrauliczne (wodne) pola górniczego koło Michajłowki. Woda jest tu dostarczana rurociągiem w celu „zatopienia” skały płonnej. W przeciwnym przypadku procesy eoliczne mogą prowadzić do zanieczyszczenia obszaru. Po pewnym czasie ptaki wodne mogą zasiedlić ten obszar wodny (fot. A. A. Czernyszew)
Фот. 1. Гидроотвалы Михайловского ГОКа. Вода по трубам подается для того, чтобы затопить пустую породу. В противном случае эоловые процессы могут привести к загрязнению территории. Спустя некоторое время водоплавающие птицы могут заселять эти водные угодья (фот. А. А. Чернышева)

We define sustainable development of the studied areas we as "controlled balanced ecological, social and economic development, the priority of which is the maintenance and restoration of natural systems and their vital functions subject to rational use of natural resources to meet the needs of present and future generations, which ensures environmental security and improvement of living conditions in the region" (URSUL, 1998; GLAZOVSKY, 2002).

To effectively assess the sustainable development of the KMA region and ensure prompt strategic management decisions we developed an integral indicator – sustainability index, which is a synthetic indicator deduced from the sum of the development sustainability values for separate administrative districts or regions in general, established due to the basic priority indicators in the environmental, economic and social spheres (KAZAKOV, KAZAKOVA, 2008).

RESEARCH METHOD

As the initial data for the development of a stability index for administrative districts of Kursk and Belgorod regions we took the statistical indicators of socio-economic development, the results of the population census, the unemployment rate, the average wage, the environmental performance of industry and transport, medical statistics (the spread of social diseases, the main causes of death, average life expectancy), and others. The identified parameters are representative of Kursk and Belgorod regions, and there have been only a few insignificant fluctuations in the recent years, which makes them relatively constant for all administrative regions and excludes randomness of their choice.

The initial figures were translated into points on the principle of "relying on the better". Reliability of the integrated model was analyzed visually on the basis of its comparison with the cartograms on individual indicators. Data obtained after automated processing were expressed in relative units (points) to give an idea of territorial differentiation of sustainable development indicators for Kursk and Belgorod regions.

The authors examined 49 administrative districts of the KMA region, calculating indicators of sustainable development (R1, ..., Rn). For each area a set of parameters of comparison (16 items) has been defined. There were three groups of parameters: economic – E_{i1}, …, E_{ik}; environmental – P_{i1}, …, P_{im} and social – H_{i1}, …, H_{is}. (where k is the number of economic parameters, m – number of environmental parameters, s – number of social parameters, respectively, i is the area number.

These parameters have been normalized, i.e. translated from their original units into certain universal units – virtual "scores" ranging from 1 to 5.

Based on the information above, the formula for the calculation of sustainable development is:

$$R_i = \frac{C_E}{k}\sum_{j=1}^{k} E_{ij} + \frac{C_P}{m}\sum_{j=1}^{m} P_{ij} + \frac{C_H}{s}\sum_{j=1}^{s} H_{ij}$$

where C_E is the weight of the group of economic parameters, C_P – environmental parameters, C_H – social parameters.

Sustainability of administrative regions development was assessed in 4 categories. We introduced their classification according to resistance to anthropogenic loads and suitability for human habitation and economic activities:

– highly stable;
– relatively stable;
– hardly stable;
– unstable.

The types were distinguished as follows.

Based on the given formula we calculated the maximum theoretically possible sustainability index, taken as 100%. Unstable assigned administrative regions, where the index rate was less than half that of the theoretically possible. Indicators of the sustainability index with a value of more than 50% of the maximum possible were divided into three equal parts, making it possible to identify *hardly stable* (50–66.5%), *relatively stable* (66.5–83%) and *highly stable* (over 83%) areas (fig. 1).

Location analysis of certain types and combinations of key sustainable development indicators allowed the authors to identify areas within Kursk and Belgorod regions which reflect the basic characteristics of sustainable development in this territory.

RESEARCH RESULTS

As a result of zoning, we distinguished 11 districts (combined into 4 groups), two of which are unstable (depressed), 2 hardly stable, 3 relatively stable and 4 highly stable (fig. 2).

In general, the types can be characterized as follows:

A – Unstable depressed areas

Areas of this type are located in the North-West (A1) and North-East (A2) of Kursk region. The density of the rural population in these is small (about one-third below the regional average), and citizens live in small mono-functional urban settlements. The level of depopulation is quite large, primarily because of the extremely high mortality and intensive migration of people of working age.

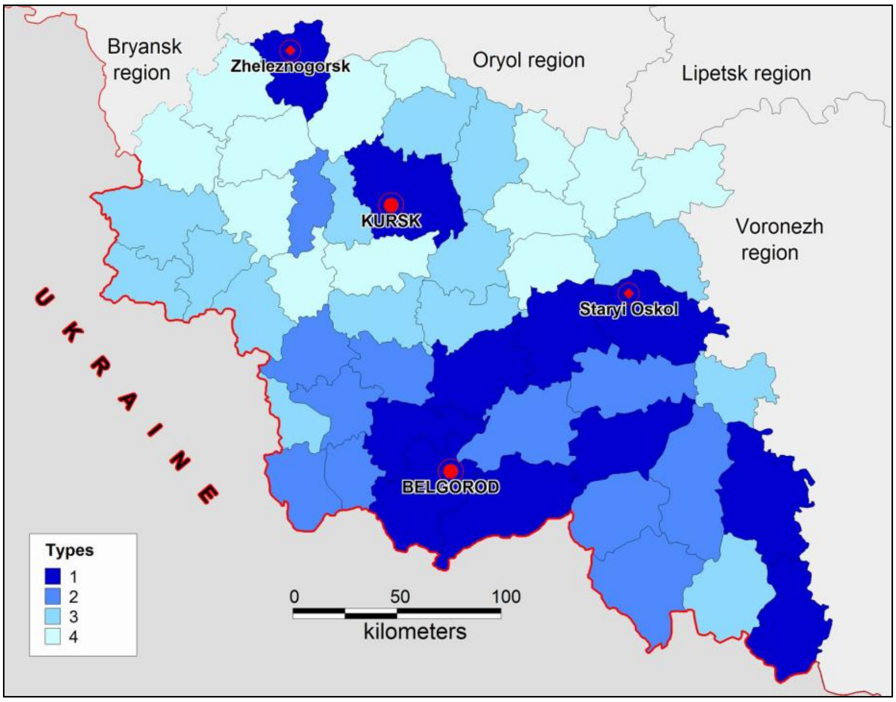

Fig. 1. Sustainability of KMA administrative regions development:
1 – highly stable, 2 – relatively stable, 3 – hardly stable, 4 – unstable
Rys. 1. Stopień zrównoważonego rozwoju rejonów administracyjnych Kurskiej Anomalii Magnetycznej
1 – względnie wysoki, 2 – średni, 3 – słaby, 4 – niezrównoważony
Рис. 1. Устойчивость развития административных районов КМА:
1 – относительно устойчивые, 2 – среднеустойчивые, 3 – слабоустойчивые, 4 – неустойчивые

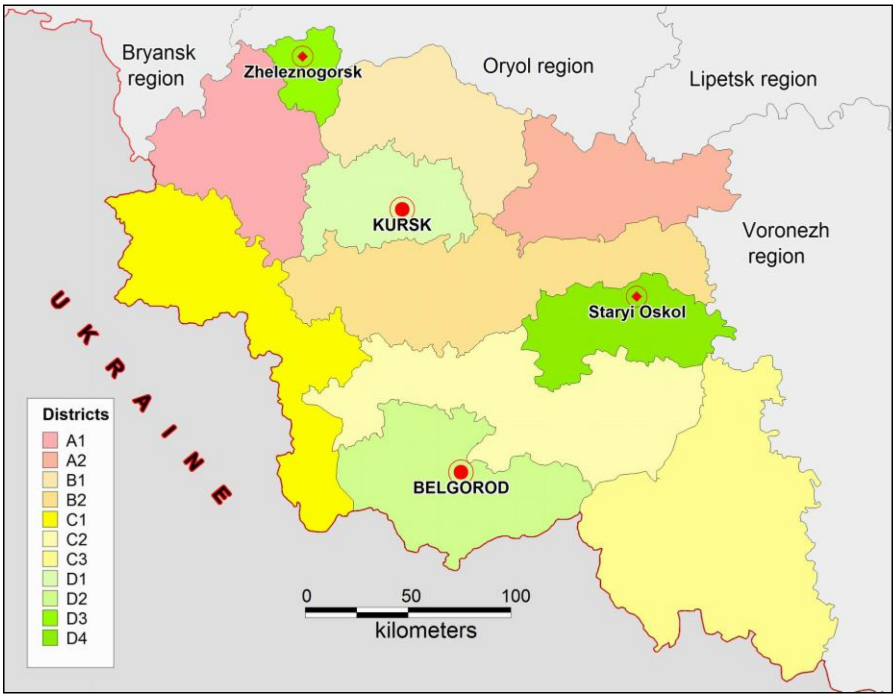

Fig. 2. Zoning of Kursk Magnetic Anomaly region on the basis of sustainable development indicators
(the explanations of the legend in the text)
Rys. 2. Rejonizacja obszaru Kurskiej Anomalii Magnetycznej na podstawie wskaźników zrównoważonego rozwoju
(objaśnienia legendy w tekście)
Рис.2. Районирование региона Курской магнитной аномалии на основе индикаторов устойчивого развития
(объяснения легенды в тексте)

The North-Eastern part of this territory type is characterized by over-plowed areas with virtually no environmental framework. In the North-Western part of Kursk region, despite a higher percentage of forest cover, the situation is complicated by environmental contamination with cesium-137 from the "Chernobyl trace".

B – Hardly stable areas

Areas of this type are located in the North (B1) and South (B2) of Kursk region and have a sufficiently dense network of gullies and ravines, valleys and rivers. Plowing the area is above the average regional index, which in turn affects the intensity of water erosion.

The Southern part of Kursk region is the agricultural region within the KMA with urbanization rate of less than 25%. Even some regional centers are rural settlements.

In this regard, the area clearly experiences a shortage of social infrastructure development, which is reflected in such important sustainability indicators as infant mortality, life expectancy and the natural population increase. The migration of people of working age due to unemployment even further exacerbates the depopulation of the area.

However, a small number of industrial enterprises and the presence of several departments of the Central Black Soil Biosphere Reserve with areas of pristine wilderness have a beneficial effect on the environmental dimension of development in the area.

C – relatively stable areas

This type includes all of the administrative districts of the studied area bordering with Ukraine (C1), as well as areas in the North (C2) and the South-East (C3) of Belgorod region. A feature of the population of the area is the increased share of Ukrainians in the national structure. Large rural areas prevail, the proportion of citizens is small, but small towns, located relatively evenly over the area, successfully perform the function of "central places" in the social field and act as centers for the processing of agricultural raw materials.

Numerous broad river valleys and a low percentage of tilled area, even with a large share of row crops (sugar beet and maize) within the arable area, provide low levels of soil erosion.

However, the development of processing industry has caused a number of environmental problems. First of all it concerns the increase in the share of polluted waste water (especially from sugar mills) discharged into the water bodies of the region.

D – Highly stable areas

These areas are confined to the agglomerations around the regional centers (D1 and D2) or to the centers of iron ore and metallurgical industries (D3 and D4). This group of regions, on the one hand, is characterized by significant environmental problems caused by industrial activities in the regional centers and their satellites, or methods of open (pit) iron ore mining.

Nevertheless, it is this group of districts which is characterized by the lowest rates of depopulation (or even stable population growth in Kurchatov) and the lowest infant mortality rate – thanks to good health care. There is a maximum of investment which can be observed and the highest level of wages that allows the investigators to attribute these areas to highly stable developing regions, where high economic potential has been able to minimize the effect of a sufficient number of pressing environmental issues, providing a relatively high level of development in the social sphere.

CONCLUSION

Thus, the study helped us conclude that sustainable development, above all, should be determined by the level of development of social indicators. This group of indicators has the advantage over the others because they reflect the "desirability" and "comfort level" of habitation in the area. Favorable trends in terms of natural movement and "quality of life" of the population, despite the presence of certain environmental and economic problems, in our view, are crucial in determining the sustainability of the territory. And, on the contrary, good environmental conditions are certainly important for the sustainable development of future generations, but due to significant problems in social development they cannot be the only determinant factor.

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