Dependence of health conditions of population on the level of environment pollution

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Abstract. This article presents a comprehensive assessment of the ecological condition of landscapes of the Orel region. Factors affecting the state of contaminated territories, in turn, affect human health. The effect of industrial waste and motor vehicle emissions on the geochemical features and environmental sustainability of soil, plants, surface water and the atmosphere in the study area is shown. The dependence of the level of exposure to toxicants on the health of the population of the Oryol region is established. Based on the assessment of the parameters of ecosystem pollution, we identified areas of ecological disadvantage in the Oryol region. It is shown that human activities and anthropogenic impact on the environment lead to loss of properties, providing a normal life and safety of human health. The degree of influence of soil degradation factors on the biogeochemical characteristics of the landscapes of the Oryol region is shown. The influence of anthropogenic factors on the concentration and form of chemical compounds of ecosystem components in the studied territories is established. The anthropogenic influence of sources of soil pollution by heavy metals and radionuclides is proved. Special zones of environmental catastrophe in the Oryol region, where the anthropogenic impact leads to a violation of human health safety, have been identified.

1. Introduction

Territories with a tense environmental situation or with a special regime of environmental management and economic activity are distinguished in connection with the real technological transition of most of Russia. Oryol is a city located 368 km southwest from Moscow in the Oryol region on the Central Russian Upland on both sides of the Oka River and a tributary of the Orlik River. The city is a part of the Central Federal District, the Central Economic Region and the administrative center of the Oryol region. The Oryol region was formed on September 27, 1937. Currently, the Oryol region is a constituent entity of the Russian Federation. It is also a part of the Central Federal District and the Central Economic Region of Russia. The population is 754,816 people; the share of urban population is 66.72%. On the territory of the Oryol region, there is 24,652 km². Oryol is the administrative center. The whole region is divided into 24 districts. The region is located in the central part of the Central Russian Upland in the forest-steppe zone in the south-west of the European part of Russia [1]. The climate of the Oryol region is moderately continental. In the eastern part of the region, the river Sosna flows with its tributaries. To the west of the city of Orel, the rivers Nerussa and Navlya flow [2].

The region is located in the zone of soil movement from sod-podzolic to predominantly leached and podzolized chernozemic soil [3, 4]. In addition, there are various types of soils in the region in
composition, ranging from light gray forest to alkaline and typical chernozems [4, 5]. The industrial sectors of the region are: mechanical engineering (this part of the industry branch makes up 30% of the total production), the food industry in the Oryol region is more than 25%, and the share of the construction industry is only 13% [6]. In addition to the city of Orel, where most of the enterprises are concentrated, there are separate factories that are located in Livny and Mtsensk, as well as in other towns of the Oryol region [7]. The region’s ferrous metallurgy is only 7%, which began to develop in the region in the second half of the 20th century [8]. In the city of Oryol, the Oryol Steel Rolling Plant open joint stock company is located, and in the city of Mtsensk, there are an aluminum plant and a plant for the production of metal products.

**Relevance:** the article discusses the factors of anthropogenic and man-made origin that determine the formation of disturbed areas, and also identifies areas of environmental problems among the population of the Oryol region [9]. As a result, the daily impact of the population on nature becomes significant, and the surrounding biosphere becomes not only the habitat of people, but also the sphere of their activity. In Russia, the concept of demographic policy for the period up to 2025 defines the main task of the government, which speaks of the need to reduce mortality, maintain and improve the health of the population, increase fertility [10, 11]. As a result, there is a need for scientific forecasting of environmental reactions to the impact of human activity on natural processes and the creation of anthropobiogeochemical zones representing an environmental hazard to humans [11].

**Purpose:** to determine the influence of the ecological situation on the health of the population in the administrative districts of the Oryol region and in the city of Orel.

**Task:** to identify the factors of anthropogenic and man-made origin which determine the formation of anthropogenic territories. To achieve this goal, we have chosen areas that are affected by various types of degradation changes.

2. **Materials and methods**

We selected as an object of the research pilot areas subjected to prolonged exposure to the waste slag of Mtsensk aluminum foundry plant. Area of continuous observation (PPN) was located in the village of Great Domino at different distances from the subject land pollution [12]. Soil type: light-grey forest, medium loamy soil on loess-like loam [13]. To determine the content of heavy metals in the soil, we took soil samples from the layers 0-20 cm and 1 kg each. In addition, for the analysis of 1 kg from the layer of 0-20 cm in 5-fold repetition, we took an individual mixed sample. Chemical analysis of soils was conducted on the following parameters: soil reaction (pH), gross and mobile forms of heavy metals (lead, copper, Nickel, zinc, cobalt, cadmium). The accumulation of heavy metals in soil and plants was determined by atomic absorption, fiery photometric method according to the method of the all-Union scientific-research Institute of mineral raw materials and Arinushkina E. V. [14, 15]. Granulometric analysis of soil was conducted using N. A. Kachinzynski method [16]. Total soil analysis was performed according to the method by N. I. Savvinov [17, 18]. Determination of the quantitative indicator of the humus was made using the method by I. V. Tyurin [19]. Preparation of salt extract and determination of its pH according to the method of TsINAO [20]. Determination of the amount of absorbed bases and hydrolytic acidity was made using the method by Capena Helikovice [21]. Definition of mobile forms of phosphorus and potassium was performed using Kirsanov method [20]. To determine the level of influence and nature of anthropogenic impact on the spatial variability of incidence rates, we used statistical data on the administrative districts of the Orel region over a 15-year period [22].

3. **Results**

The reaction of any human body to the ecological situation in ecologically unfavorable areas is manifested in the form of such diseases as: microelementosis, cancer, pathology of the human cardiovascular system, as well as other common and orphan diseases. A multi-component assessment of ecosystems makes it possible to identify zones of ecological disaster [23]. Continuous monitoring of the ecological situation provides for a multi-component assessment of the state of ecosystems, with human health being the most important indicator reflecting the state of the human environment [24]. It
should be noted that in many cases it has become more convenient to divide the disease into infectious and non-infectious, the occurrence of which may be due to the influence of any physical or chemical factor.

As a result of our research, it was established that diseases of the circulatory system, oncology, and diseases of the respiratory organs, the musculoskeletal system and the genitourinary system prevail among the diseases of the population of the Oryol region. The influence of natural and anthropogenic and technogenic factors of the Oryol region increases the incidence. For example, diseases of the sensory organs, the state of the nervous system, respiratory organs, digestion, blood, skin diseases, the urogenital system and other organs in the human body can be directly associated with the pollution by aerotechnogenic toxicants; nitrogen compounds, sulfur dioxide, carbon oxides and other suspended particles prevail in their composition.

Thus, according to the regression analysis, the value of the correlation coefficient between pollution levels and environmental indicators of the territory and morbidity indicators was set in the range of 0.8-0.9. At the same time, there is no direct correlation between the phenomena studied; this is due to a different combination of natural, man-made, and social factors. It should be said that in the Oryol region, regular monitoring, continuous environmental studies and the creation of maps of the environmental situation are necessary, where the environmental situation can vary significantly within certain limits. It has been established that for the most effective point of assessing the ecological status of contaminated areas on the incidence of the population, it is necessary to take as an integral indicator of environmental impact and human health average annual indicators for the last five to ten years for various classes of diseases, which reflect the degree of radioactive and chemical influence of the environment on the level of health, for example, diseases of the respiratory and cardiovascular systems, as well as the digestive organs.

Overall, an analysis of the incidence rate on a medical-geographical basis in the Oryol region showed heterogeneity of the studied territories of the region. For example, in the Oryol region, the incidence of respiratory diseases is 1.1 times higher than the average for Russia. At the same time, in the Oryol region, this class of diseases is growing by 1.6 times, and in the city of Orel - by 1.4 times. Respiratory diseases in the region increased by 1.3 times over the fifteen-year period, with a predominance of certain nosological forms, such as chronic bronchitis and asthma. In the first place is the incidence of the circulatory system in the region. Over the fifteen-year period, this disease increased by 2.2 times and exceeded by 1.1 times the incidence level of the circulatory system in the whole country. The increase in the incidence of blood circulation in the city of Orel and the Oryol region was 1.4 times larger.

In the Bolkhovsky district of the Oryol region, there is a stabilization of the dynamics of diseases of the respiratory and circulatory organs, and in the Mtsensk district of the Oryol region, there is a slight decrease in such diseases. According to the research data, the largest share of skin diseases and subcutaneous tissue accounts for the Orlovsky district of the Oryol region; the share of diseases diagnosed with Acute Respiratory Viral Infection (ARVI) in the Bolkhovsky district of the Oryol region is 84.7%, and in the city of Orel, the share of diseases diagnosed with SARS is only 23.7%.

In the fourth place in the region are dysfunctions in the endocrine system of the population, while this figure increased by 2.3 times, due to the deterioration of the ecological situation in this period. On the territory of the Mtsensk District, the situation has somewhat stabilized due to the incidence of the endocrine system and remains at the level of 1.65-1.7 thousand people.

The urogenital system of the population also suffers and exceeds in 1.17 times the level in the country, while over the fifteen-year period, the growth of this group of diseases among the population was noted by 2.3 times, including 2.5 times in the city of Orel. However, if for the Mtsensk and Bolkhov raions, there is a slight decrease in the incidence of the genitourinary system, then for such areas as Krasnozorensk, Zalegoschensk, Znamensk and Livensk in the Oryol region, there is a significant increase in this group of diseases among the population.

Analysis of the incidence of the digestive organs of the population shows that the increase in the level of diseases twice during the study period is noted in the territory of the Oryol region, the Oryol district and the city of Oryol.
Since annually the pollution of the territory of the Oryol region with radionuclides, heavy metals and harmful emissions of gases increases and becomes the cause of oncology diseases of the population, over the fifteen-year period, an increase was noted of 1.5 times in the population diseases of this group of diseases in the Oryol region, including 1.8 times in the city of Oryol, in the Oryol district – 2.4 times, in the Mtsensk district – 1.4 times, and in the Bolkhovsky district – 1.3 times.

Over the past three years, the following situation has persisted in the Oryol region: the environment for the spread of the population diseases: (18.2–18.8%) of the circulatory system, (14.3–14.6%) of the respiratory organs, (9.5–10.5%) of the musculoskeletal system, (8.9–9.2%) of the urogenital system, (6.1–6.4%) of the digestive organs, (3.2–3.9%) of the endocrine system.

We would especially like to note that diseases of the circulatory system make up a significant proportion of the total number of diseases of the population that require expensive treatment with the help of high-tech medical equipment. For the main causes of death, 62–64% are diseases of the circulatory system, 11.7–12.3% are causes of oncology, 4.1–4.9% are respiratory diseases, and 3.4–3.9% are diseases of the digestive organs. In the system of diseases of the respiratory organs, the main share is bronchitis and bronchial asthma.

An analysis of the incidence of the population among children is carried out, which is associated with the medical and environmental status of the administrative districts of the Oryol region. Statistics show an increase in the incidence of children over the past fifteen years. The highest increase in the incidence of children can be identified in the following areas: Novosilsky, Bolkhovsky, Mtsensky, Livensky, Soskovsky, Dmitrovsky, Kolpynansky, Shablykinsky, Orlovsky and Hotynetsky. On average, in rural areas of the region, the incidence rate of children increased 1.9 times, and the incidence rate of adolescents in the city of Oryol increased 2.5 times over the observed period.

The territory of the Oryol region can be divided into four groups according to the incidence of the population of the region in comparison with the excess of the incidence of the population of the Central Federal District. The first group includes areas with an excess of the incidence rate in 1.5 - 2 times (Bolkhovsky, Dmitrovsky, Krasnozorensky, Trosnyansky areas), which are considered relatively safe in medical and environmental terms. The second group includes the districts of the region with an increase in the incidence of the population relative to the average level of the Central Federal District in 2-2.5 times. This group includes the territories of the following districts: Verkhovsky, Glazunovsky, Dolzhansky, Korosovsky, Kromsky, Maloarkhangelsky, Novosilsky, Orlovsky, Uritsky, Shablykinsky. Districts of the region included in the third group with an excess in 2.5 - 3 times the incidence rate in the Central Federal District, are environmentally tense. These are Mtsensk, Livensky, Znamensky, Khotynetsky, Novoderevenkovsky, Soskovsky districts of the region. In the fourth group, there are two districts of the region - Zalegoshensky and Kolpynansky, where the incidence rate is more than three times higher than the average level in the Central Federal District. At the same time, our studies have shown that in the areas with relative ecological well-being, loci of high environmental tension can be distinguished. For example, on the territory of the Mtsensk District, this is the village of Bolshoye Dumchino, where the incidence rate is four times higher; on the territory of the Oryol District, it is the city of Oryol, where the incidence rate exceeds the incidence rate of the Central Federal District three times, and on the territory of the Bolkhovsky District of the Oryol region with relative environmental well-being, estimated at 1.5-2 points, areas are allocated with a high level of radioactive contamination (more than 5 KU/km²) and population morbidity exceeding the average federal level by more than four times.

4. Conclusion
Analysis of medical and environmental indicators found that the incidence in the areas of the Oryol region, both children and adults, has a close relationship with the current environmental situation, as evidenced by the increase in indicators for the studied diseases. As a result, the most thorough approaches may be required, both to monitoring the health status of the population, and to organizing their forms and rebuilding methods to maintain a healthy lifestyle. Studies have shown that the incidence of the population of the village of Bolshoye Dumchino, Mtsensk District, as an area of ecological risk,
has a correlation dependency between the level of anthropogenic and technogenic pollution of the soil, air basin, water resources of the region and indicators of health of the people living in the area.

It has been established that a change in geochemical conditions at a narrow regional level, in the presence of a large source of environmental pollution, occurs so rapidly that the human body cannot adapt to extreme conditions in a timely manner. As a result, the natural biochemical processes that occur in the human body are disrupted. This manifests itself in the form of diseases of various systems of the body, and requires careful development of a system of measures for the recovery and adaptation of humans to extreme changes in ecosystems. The results of the study indicate that the health status of the population of the Oryol region reflects a change in ecosystems and may well be an indicator of the degree of anthropogenic and man-made pollution of the natural environment.

In our opinion, in order to improve the environmental situation, in addition to taking measures on environmental safety, changes in the structure of nature management are necessary. At the same time, greater attention should be paid to recreation as an alternative type of economic activity in the territory under consideration. In general, the conducted studies have shown that the geoecological situation in some districts of the Oryol region and in the city of Oryol is tense, and the medical and ecological situation is typical for the urbanized territories of the Russian Federation.

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