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EVALUATION OF THE ECOLOGICAL SITUATION OF RURAL GEOSYSTEMS OF NORTHEN BUKOVINA

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Abstract. The article presents the theoretical and methodological foundations of landscape- geochemical analysis and an evaluation of Northern Bukovina rural geosystems. Based on the results of field and chemical analysis, calculations of environmental and geochemical indicators, characterizations of the degree of geochemical pollution load and the intensity of natural components, an environmental assessment of the geosystems of the study area is made.

Introduction

At the present state of society and due to high anthropogenic pressure on the environment, solving the environmental problems is one of the fundamental tasks. As a result of long-term human impact, there are significant changes in the rural geosystems. For their future management and the improvement of human activity, a detailed study and an environmental assessment are required. One of the major indicators of the environmental quality of rural geosystems is represented by their ecological and geochemical properties as discussed in this article.

The area of study is Northern Bukovina - a land with different natural, economic, social and ethno-cultural-historical types of rural geosystems, with different ecological situations. One of the urgent tasks is to study the geochemical characteristics of rural landscapes geosystems of Northern Bukovina, and make an environmental assessment to further use of these results for optimizing the human environment, for the implementation of environmental management and environmental protection.

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Findings of the research.

The territory of Northern Bukovina is situated amongst different types of natural, historical and geographical, ethnographical, industrial and commercial complexes and systems, in the area of their major interaction. Here there are the plain-platform (Prut-Dniester Rivers) and fold-mountain (Bukovina Carpathians) systems.

Between them, there is an amortizable contact structure – the Carpathian foredeep (hilly undulating plain). The result of the interaction of these structures is a considerable diversity of the geological structure and of the topography of the region. The humidity of the area (which is important for the self-cleaning of landscapes) varies from north-east to south-west, according to the increase in rainfall (from 550-700 mm to 1000 mm). The prevailing north-westerly winds affect the migration of contaminants.

In the area between the Prut and Dniester rivers, varieties of gray forest and chernozem soils are common, in the foothills - varieties of sod-podzolic and gray forest soils. Mountain soils are: brown mountain-forest, sod-brown soil, brown soil-podzolic. In these soils, the processes of accumulation and migration of macro and micronutrients occur in different ways.

Among the adverse natural processes in Northern Bukovina, landslides, karst, mudslides, windfalls and avalanches in the mountains occur. All these should be considered when assessing the landscape-geochemical environment of rural geosystems.

Northern Bukovina includes three geographical subregions of different nature: Prut-Dniester, Prut-Siret (Bucovina foothills) and Bukovinian Carpathians. A large variety of environmental conditions affect the nature of the geo-ecological conditions (natural factors).

Anthropogenic factors of pollution in the investigated territory show minor sources from industrial enterprises and agricultural manufacturing that at present tend to decrease or completely cease their operation. The main sources of pollution in the region are the exhaust gases of vehicles, the emissions of which can reach 80% of the total emissions.

The combination of the above natural and anthropogenic factors contributed to the formation of various natural and anthropogenic territorial complexes and landscapes within Northern Bukovina. Local natural systems are diverse in structure and size.

There are three types of such landscapes: steppe plains (Prut-Dniester Rivers), forest meadow elevated plains and hills (Prut-Siret Precarpathians), mountain-forest (Bukovinian Carpathians). For each of the above types of landscapes, key areas were determined and landscape maps drawn.

Based on a detailed study of materials of the field surveys and statistical geochemical data, we conducted an environmental hydro-geochemical mapping and zoning of Northern Bukovina.

We differentiated three subregions (I-III) and 11 districts: I –Prut-Dnister (districts: 1. Dnister-Repujintsy, 2. Zastavnyansikii, 3. Dobrinivsikii, 4. Priprutsko-Kitsmanskii, 5.Priprutsko-Boyanivskii), II- Prut-Siret (districts: 6. Valya Kuzminsikii, 7. Hlibotskii, 8. Cheremoshsikii, 9. Prikarpatsiko-Siretskii, 10. Bahnensikii), III- Bukovinian Carpathians (11.) (Fig.1). The zoning was made according to the geographical, ecological and geochemical features of the studied area. Zoning makes it possible to analyze and evaluate the environment of the region, to develop a model of pollution control area, consider the role of natural and anthropogenic factors, do an environmental assessment of geosystems, etc.

We concluded a conjugate (large scale) landscape and geochemical mapping of rural geosystems of Northern Bukovina. On this basis, we established territorial differences of landscape-geochemical structures and by eco-geochemical assessment of landscapes of the region, using a system of appropriate indicators and criteria, we identified the possibility of assessing the ecological state of territory, the indicators of pollution intensity (Pj) and the integral indicator of environmental safety.

Rural geosystems are natural solid formations of anthropogenic habitat estates and adjoining areas within topological level of landscapes, which function as a result of the socio-demographic, industrial and natural subsystems.

At the basis of our ecological and geochemical study of the area, there is the method of mapping of landscapes and landscape-geochemical systems. Catenative and cascade systems are of particular importance to the analysis because the operation of these geosystems is due to migration flows (exchange of matter, energy and information between blocks of systems).

Landscape-geochemical catena is a chain, a number of elementary landscapes that are linked by migration and located on the same hill from hilltop to the low part of the relief. Catenas are presented in basins of rivers of any order, and for each basin of watercourse, a catena can be on the left bank, on the right. Catena may be cascade (terraced valley slopes, particularly large rivers), straight (diluvial slopes of the valleys of small rivers), wavy (landslide slopes, sometimes waterlogged territories), and so on.

Cascade catenas are well expressed in the valley of Siret and Prut Rivers. They are characterized as trans alluvial - accumulative basic geochemical systems (in terms of migration), often heterogeneous. The elements here

vigorously migrate and simultaneously accumulate, sometimes forming technogenic geochemical anomalies.

Cascade landscape-geochemical system is a series of elementary landscapes that succeed each other from the local watershed to the local depressions and related with laterally directed migration flows. Every elementary landscape is a link or a block to the overall system. An example of such systems can be naturally terraced valley-territorial complexes.

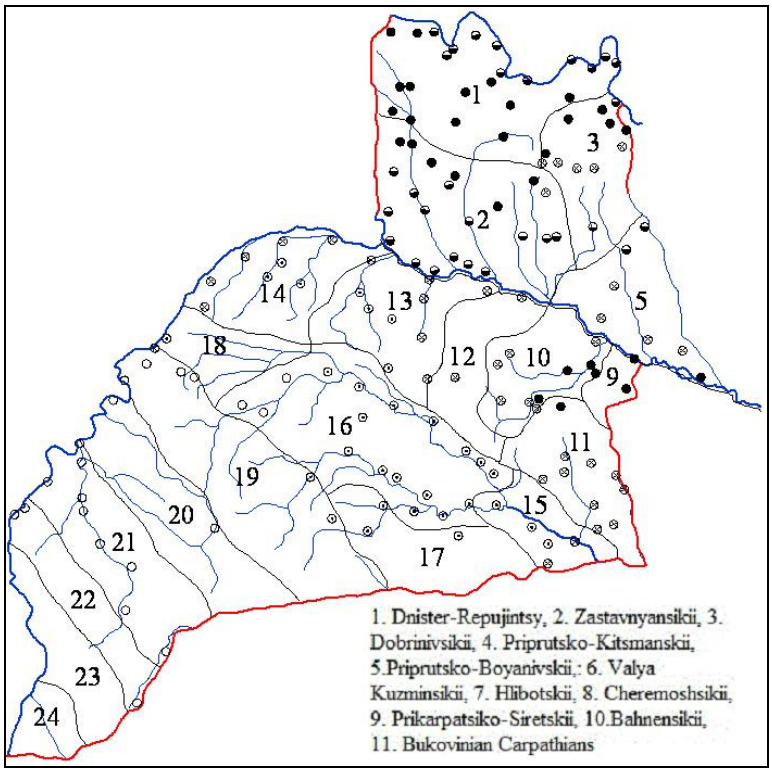

Fig.1. Ecological-hydro-geochemical zoning of Northern Bukovina

Landscape-geochemical assessment of the ecological state of territory was carried out based on the ratio of the results of chemical analysis to clarc variables, baseline values, maximum allowable concentrations.

To determine the environmental situation in the rural ecosystems of Northern Bukovina, the following geo-ecological parameters were used: concentration factor of the element (Kc), which is calculated as the ratio of

actual content of substances in the natural component (Ci) to its background content (Sf); overall pollution index of the component (Zcj) and landscape (Zcl), equal to the sum of the coefficients of concentration studied chemicals. To assess the environmental hazard of pollution of the environment relative to organisms, including humans, the risk factor of the chemical element (kN) is used, defined as the ratio of content of substances in the natural component to its MAC.

For the evaluation of the ecological state of the territory, an indicator of the intensity of pollution of the component (Pj) is applied and the integral indicator of environmental risk of landscape (Ir), expressed in arbitrary units. Pj is calculated as the sum of concentration coefficient and the hazard index (Mj). The integral indicator of ecological hazard of landscape is calculated as the sum of products of the index of intensity of pollution of the component (Pj) and translocational hazard index (Tj).

The landscape geochemical assessment of the ecological condition of the study area is given based mainly on groundwater properties (chemical composition, type of water, total hardness, salinity, pH, pollution and other ingredients), soil and vegetation.

Ground waters by their geochemical properties are neutral and slightly acid, moderately hard and fresh. Mostly, there is a calcium bicarbonate-type of water (in the subregion, sulfate-bicarbonate-calcium, bicarbonate- magnesium-calcium, sulphate sodium-calcium types and others are also found). The water is marked as good quality according to the permissible norms of chemical composition. The value of the pH ranges from 6.5 to 7.1, the most characteristic values of pH are 6,5-6,8. The total hardness of water is within 3,2-12,2 mg-equiv/dm³. The values of chloride concentration vary substantially within 10-116 mg/dm³, no more than normal. The nitrite content is less than 0.01 mg/dm³, nitrate less than 0.2 mg/dm³, ammonium lest than 0.08 mg/dm³.

The content of heavy metals in water samples has mainly the following parameters (mg/dm³): Pb 0,001-0,031 (the average value is 0.016), zinc 0,02-0,35 (average 0.11), copper ranged from 0.007 to 0.06 (with an average of 0.02), the values for cadmium in water samples of all of the key areas range from 0,001-0,002 mg/dm³. Dangerous levels of these trace elements in groundwater of the study area were undetected.

The soil surface Pb content ranges 1,05-2,8 mg / kg soil, Zinc - from 4.6 to 31.6. Analysis of Pb ccntent showed that increased rates (2.8), characteristic to superaquatic elementary geochemical landscapes, where it accumulates. Copper content varies from 2.3 to 7.07 mg / kg, cadmium-values from 0.006 to 0.09.

In general, rural geosystems of Northern Bukovina are characterized by significant geochemical diversity, because they are located in different types of landscapes, in connection with those distinctive features that affect the migration processes in them. Geochemical indicators obtained in the study allow asserting that the level of total hardness and salinity of groundwater (drinking water) in steppe landscapes of rural Prut-Dnisters subregion has partially high values that often exceed standards. Water of forest-meadow, forest Precarpathian and Carpathian subregions has the best hydro-chemical parameters.

Overall, the ecological-geochemical state of landscapes of rural geosystems of Northern Bukovina also recorded a steady pattern of their distribution in subregions in the direction of Prut-Dnister (where the highest values are met) through Precarpathians to Bukovinian Carpathians. (Table 1)

Table 1. Ecological-geochemical indicators of rural geosystems of Northern Bukovina subregions.

№	Subregion	Values	Zc	Pj	Iн	State
1	Prut-Dnister	Min.	3.69	17.67	52.47	Less (low) favorable
		Max.	17.32	93.34	252.2	
		Average	**5.54**	**36.08**	**117.16**	
2	Prut-Siret	Min.	2.23	19.44	74.88	Favorable
		Max.	6.81	48.52	165.23	
		Average	**4.13**	**32.80**	**116.45**	
3	Bukovinian Carpathians	Min.	2.07	18.19	68.96	Improving favorable
		Max.	9.06	54.82	167.54	
		Average	**3.85**	**32.43**	**113.88**	

Landscape-geochemical analysis in general represents the status of rural geosystems of the region to develop a model of the pollution control system, while considering the role of natural and anthropogenic factors.

Conclusions

The evaluation of landscape-geochemical particularities of North Bucovina showed that the geo-ecological situation varies here according to the structure of the territory - from valley to mountain subregions. Landscape complexes form a specific landscape structure due to their positioning, which is taken into consideration when assessing the eco-geochemical situation of the territory. It was found that in Northern Bukovina, acid-calcium and calcium forms of landscapes (in plain area), sour and slightly acid (in mountain area)

generally dominate; they are present in alluvial, neo-alluvial, trans-alluvial and super-aquatic elementary geochemical landscapes.

The ecological-geochemical assessment of North Bukovina (performed on the basis of geochemical indicators) showed a quite significant regional differentiation. Generally favorable environmental conditions increase in the direction from the Prut-Dnister subregion through the Precarpathians to the Carpathians. Such changes of optimal environmental conditions are evidenced by the indicators of geochemical parameters (drinking water, soil, biomass).

In the Prut-Dnister area, the environmental conditions of rural geosystems can be estimated as less favorable or unfavorable (some areas in the valley of the Dniester, where rates of groundwater hardness are beyond the standards, as well as upland agro-ecosystems with contaminated soils from excess of chemical fertilizers).

Bucovinian Precarpathians (which are in the middle of Northern Bukovina) have favorable environmental conditions for human life and rural tourism. Prevalence of wash water regime geosystems (adequate rainfall) and significant woodlands contributed to the rehabilitation of landscapes from various anthropogenic pollutions. In addition, there are favorable conditions for the formation of high-quality groundwater (drinking) water, which should be considered (as an important factor) for the medical-geographic assessment area.

The Carpathian sub-region, in terms of geo-ecological estimates, is the most original. Here there is a more complex set of environmental conditions (vertical differentiation landscape complex). Valleys, terraced landscape complexes (with chain or mosaic scattered settlements) have increased favorable ecological and geochemical conditions.

Recreation and tourism in this subregion have optimum conditions. Among the geo-ecological factors in their development, it is worth noting the sufficiently high quality groundwater (drinking) water, which despite the excess rainfall, is sufficiently rich in biologically important macro and trace elements, which have mostly normal levels of hardness (Ca + Mg) and mineralization. All these contribute to water migration, the solubility of the respective rocks, the decomposition of biomass and others.

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