

# Project of basin nature management of the Vorskla River within the boundaries of Prokhorovsky district

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**Abstract.** The Belgorod region, which occupies 0.2% of the country's territory, is among the leading subjects of the Russian Federation in the production of agricultural products. The river network of the region has undergone significant changes: over the past century, its length has decreased by 35% from its original state. The noted trends in the development of degradation processes determine the need for geo-planning solutions to ensure the soil conservation organization of nature management in the Belgorod region. In the current situation, it is necessary to scientifically substantiate the transformation of agricultural landscapes into sustainable agroecosystems. At the same time, an integrated geoecological approach should be used to organize the landscape shell with a rational spatial combination of natural and economic components. This idea formed the basis of a new synthetic direction of socio-economic geography - geoplanning. The geoplanning approach will make it possible to implement the geoecological aspects of ecosystem functioning through a set of design solutions. The results of the research work on the project: certification of the natural and economic conditions of the Vorskla River basin within the boundaries of the Prokhorovsky district of the Belgorod region was carried out; measures for ecological improvement and rational economic use of river basins were developed, including measures for biologization of arable land, allocation of areas for natural self-restoration, a plan for rational economic and recreational use of water bodies was developed, optimal network of dirt roads; calculation of environmental, economic and social outcomes of the project; proposed organization of control and supervision over the progress of the project.

## 1 Introduction

In order to restore and maintain the environmental sustainability of agro-landscapes and adjacent lands, the operational and territorial unit of geoplanning at the regional and municipal levels should be an integral natural and economic system. The basin approach to the organization of nature management most fully reveals cause-and-effect relations between the economic situation in the watershed and the state of its water resources through

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the commonality and unidirectionality of hydrofunctioning processes, which reflect the intensity of surface runoff and water erosion of soils. Therefore, geoplanning of territories on the basin principles is a systematic and the most rational way of soil and water conservation optimization of erosion-dangerous agro-landscapes.

The object of the study is the territory of the river basin of the river Razumnaya within the boundaries of Prokhorovsky district of Belgorod region.

The subject of the study - erosion-dangerous agro-landscapes of the region in a variety of natural and economic activities.

To achieve the goal it is necessary to solve the following tasks:

- Using the basin approach, define the boundaries of the ecoregion - an integral natural-economic formation within the Belgorod region.
- Carry out a passportization of the natural and economic conditions of the Razumnaya River basin within the boundaries of Prokhorovsky District of Belgorod Oblast.
- Develop measures for ecological rehabilitation and rational economic use of river basins, including measures for biological arable farming, allocation of areas for natural self-restoration, a plan for the rational economic and recreational use of water bodies, and the development of an optimal network of unpaved roads.
- Perform functional typology and assessment of basin landscape structures by the most informative indicators of environmental sustainability and erosion hazard of agrolandscapes.
- Propose ways of rational land and water use through the introduction of a differentiated set of ecological and economic solutions [1, 2].

In the context of increasing anthropogenic pressure on the natural environment, the guarantee of sustainable development of territories is the organization and control of the rational use of natural resources. The modern concept of sustainable development implies achieving a dynamic balance between environmental, socio-demographic and economic factors. Approaches to the regulation of nature management problems should be based on a comprehensive account of the consequences of human impact on the ecosphere as a result of the transformation of natural landscapes and be aimed at finding the best combination of anthropogenic and natural components of the environment. Human activities must be organized in such a way as to minimize the destabilizing impact on the natural environment and compensate for negative consequences, taking into account the mechanisms of self-regulation and restoration.

The key instrument of state regulation of spatial optimization of anthropogenic load distribution on the natural environment with simultaneous solution of ecological, legal and socio-economic problems is spatial planning. The object of spatial planning are modern landscapes - complex hierarchically organized natural and anthropogenic spatial and temporal systems. The purpose of landscape planning is the spatial organization of human activities in a particular landscape, which would ensure sustainable development and preservation of the basic functions of this landscape as a life support system. The use of landscape planning elements in territorial planning is a way of ecologization of nature management in order to improve the quality of life of the population.

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## 2 Materials and methods

In geoplanning, the choice of approaches and criteria for isolating territorial divisions of space as operational units of assessment, design and monitoring is important. Traditionally, the mechanism of natural resource management has an administrative-territorial nature. Administrative units of different hierarchies act as operational-territorial units: a subject (in the federal structure of the country), a municipal entity, a rural settlement. This approach has priority due to the well-established system of information receipt about the territory for making managerial decisions and assessing the economic efficiency of economic activity [3].

It is a well-known fact that the position of modern administrative boundaries in most cases is arbitrary and does not correspond to the boundaries of natural territorial systems. Generalized average environmental indicators absolutely do not reflect the spatial differentiation of the assessed indicators within the administrative boundaries. In the search for a solution to the problem of combining administrative boundaries with natural boundaries, the basin concept of nature management is becoming increasingly attractive. Relying on the natural laws of the river basin as a geosystem, the basin concept allows to establish effective spatial forms of interaction between the subjects of nature management.

Under the river basin we understand a part of earth surface with a thickness of soils and subsoils adjacent to it, from where there is a flow of surface and underground waters in the separate river or river system. River basins belong to a certain type of organization of natural systems - cascade systems-integrators. These systems have a clear hierarchical structure of co-subordinated basins of different orders: the lower link integrates the phenomena that occur in the upper links.

Identification of the spatial structure of watersheds takes place by determining their order based on certain signs of watercourse branching. The method of determining the order of rivers was first proposed by the founder of the basin approach. In this system, elementary watercourses without tributaries are assigned the first order. A transition to a higher order is made when watercourses of the same order merge.

The objectivity and relative simplicity of basin boundaries allocation increases the representativeness of territorial units, and the possibility of "constructing" the territorial unit in the transition to different scales allows the use of basins as a topological unit in a consistent transition from local to regional and higher levels of research, as well as the organization of rational nature management [4, 5].

The river basin meets all the conditions inherent in geosystems (properties of integrity, uniqueness, hierarchy, stability, self-regulation, etc.). Basins form complex natural-economic systems, the functional integrity of which is determined by the presence of vertical and horizontal connections and the establishment of a certain balance between them. This property makes a river basin an ideal object of environmental monitoring. Besides, basins with the maximum reliability allow modeling the processes of flow and water erosion with the use of both traditional methods and geoinformation systems.

The basin approach can be successfully used at the state level of environmental management, primarily in the development of territorial planning schemes. When linking basin and administrative approaches, it is advisable to compare the taxa of basin organization of territories with the levels of spatial planning. In Russia, the prospects of global restructuring of administrative entities on the basis of the basin concept are only considered so far. The main purpose of the concept of the idea of basin-administrative territorial organization is to improve the current mechanisms of state management in the rational use, protection and restoration of soil, land and water resources [6, 7].

### 3 Research Questions

The Vorskla River basin within Prokhorovsky District of Belgorod Region is part of the Dnieper River basin and is located on the Srednerusskaya Upland. It is partially located in the Luchkovskoye rural settlement (Figure 1). The total area of the basin (within the oblast borders) is about 1508.9 km<sup>2</sup>, 3.41 km<sup>2</sup> of which is located in Prokhorovsky District.

The basin is located in the forest-steppe natural zone. The climate of the Vorskla basin within the borders of Prokhorovsky district is temperate continental, characterized by rather mild winters with snowfalls and thaws, and long summers. There is no river network in the basin area. In fact, only a small part of the river watershed is represented in the area. The area of the Vorskla river basin within the Prokhorovsky district is 3.41 km<sup>2</sup>, which is about 0.24% of the district area and 0.25% of the total area of the Vorskla basin within the oblast borders. There are no settlements on the territory of the basin.



**Fig. 1.** Spacefoto map of the Vorskla river basin.

The area is dominated by arable land, occupying 260.8 ha. It is unevenly distributed on the territory of the basin. The second place is occupied by natural forage lands, occupying 27.6 ha and confined mainly to river valleys and ravine and gully network. The third place is occupied by wood and shrub vegetation - 24,1 ha, forest lands - 18,6 ha, building lands are absent. There are no inhabitants on the territory of the Vorskla river basin within Prokhorovsky district.

The Vorskla river basin is located in the Central Srednerussky soil district. Natural vegetation was represented by sod-cereal steppes and oak groves. The steppes were plowed, oak groves were preserved on the right bank of the rivers. Soil-forming rocks are loess-like clays and loams, Tertiary clays, chalk, limestone, marl, alluvial deposits, Jurassic clays, in some cases clay loam. The most common of them are loess-like clays and loams. On the territory of the basin the main subtype of soils are leached and solonetzic-carbonate chernozems.

The main factors determining the reduction of organic matter content in soils are water erosion of soils and biological removal together with crops. Soil dehumidification is one of the most acute agro-ecological problems. Low- and medium-humus soils prevail in the basin as a whole. Soil alkalinity is an important factor of soil fertility, which has a significant impact on the formation of crop yields. Influence of increased acidity negatively affects plant growth and manifests itself through lack of calcium.

The basin area is located in the forest-steppe zone and is characterized by forest-steppe vegetation. As far as the soil cover is concerned, mainly black earth soils prevail, but the hills in their majority have chalky deposits. There are deposits of minerals - chalk, sand, clay.

Soil-conservation organization of the territory of farms, watersheds should be the basis, uniting and mutually linking all elements of soil-protection complex on sloping lands into a single whole. Scientifically grounded organization of arable land should become the most important link in this process. Taking into account landscape peculiarities of the basin area, three types of crop rotations (field, grain-grass and soil-protective) and erosion control measures (grassed spillways, forest strips) are designed in the arable land [8, 9].

On arable lands with a mainly 0-3° slope (255 ha) it is supposed to introduce field crop rotations with sowing of perennial grasses and green manure crops totaling 114 ha, including perennial grasses for hay, haylage and green fodder on 25 ha, green manure (including catch crops) on 89 ha. On erosion-dangerous plots of arable land with a slope of 3 - 5° it is necessary to place grain and grass crop rotations, in which the share of perennial grasses will be about 50%. Out of 5 ha with 3 - 5° slope, 2.5 ha are supposed to be used for perennial grasses and not to allow cultivation of row crops.

According to the program of biologicalization, the introduction of direct seeding will reduce the cost of fuel and lubricants by 24%, the development of biological farming system will reduce the pesticide load, reducing the use of insecticides by 25%, fungicides by 20%, herbicides by 60%.

## 4 Conclusion

Strongly unstable rivers in the European part of Russia occupy the territory of the southern megaslope of the Russian Plain in the forest and forest-steppe zones. Their location here is due to a decrease in the water availability of rivers. Locally in this region may occur more stable rivers in areas of hilly terrain.

Very strongly unstable rivers in the European part of Russia are distributed in the steppe and southern steppe, their vulnerability is mainly due to the low water content of rivers, where low precipitation is combined with low river gradients. On the whole, the leading factor determining the stability or instability of rivers with respect to siltation under conditions of accelerated erosion in the watershed is the slope of watercourses. Division of unstable watercourses according to their degree of instability is mainly determined by their water availability. The current state of streams and small rivers in European Russia, especially on the southern megascale, is close to catastrophic. Intense slope and gully erosion at watersheds in the course of more than 300 years of active agricultural land use resulted in the removal of almost 100 billion tons of sediment into the gully-channel network. Only 6-7 percent of them reached the lower reaches of rivers, the bulk of them were redeposited in the channels and on the floodplains of small rivers. The thickness of deposits reaches 5.0-6.0 m and is very often 2.0-4.0 m.

The main cause of degradation of small rivers is erosion in their watersheds. The main method of struggle against degradation of small rivers should be wide spreading of soil conservation technologies of land use. It is necessary to create a state service for the protection of soils from erosion and small rivers from siltation [10].

The basin concept of nature management (basin-administrative approach) makes it possible to establish effective spatial forms of interaction between subjects of nature management. It takes into account the tendency to reallocate authority to the regional level, which allows, using the existing management structure, to organize the processes of nature management in the most cost-effective and environmentally acceptable way.

Rational use of natural resources, in addition to the completeness of use of local natural resources, should ensure the maintenance of mechanisms of their reproduction. The main natural resources (mineral, water, land, biological) have spatial confinement in the landscape in various combinations. This determines the need to search for optimal scenarios of nature management, forming the prospects for effective territorial development.

In regions of intensive agricultural production basins require not only supportive measures but also need environmental management, restoration of ecological balance, primarily through the optimization of the land fund structure. The task of land fund balance in conditions of sloping relief may become practically unsolvable if land use does not become an organic part of soil and water conservation arrangement.

Basins act as the most objective and natural territorial basis for solving many problems in the sphere of land management, organization of rational nature management and improvement of productive sustainability of agricultural landscape.

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