Features of land inventory in water protection zones of small rivers of the Oryol region

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Abstract. The paper considers aspects of land inventory in the territories adjacent to water bodies. The object of the study is the land resources of the Oryol region, the territory of water protection zones and coastal protection belts of 28 small rivers of the Oryol region, which need environmental rehabilitation due to prolonged anthropogenic pollution. The need for water protection zones and coastal protection belts on the basis of a thorough land inventory was justified. The land inventory of water protection zones significantly differs from other types of inventory due to the fact that the boundaries of water protection zones may include lands of various categories, types of property, they may belong to different owners. The paper gives suggestions on the sequence of land management measures in these cases. As a result of the study, the paper presents the analysis of the performed land inventory, which forms the basis of the working project on the formation of water protection zones and coastal protection belts of small rivers of the Oryol region. On the basis of the completed land inventory for the Lipovets River, the need for restrictions on human economic activity in water protection zones and coastal protection belts was determined in the following cases: placement of cemeteries, implementation of aviation measures to combat harmful organisms and placement of specialized storage facilities for pesticides and agrochemicals by agricultural enterprises, placement of gas stations, fuel and lubricant warehouses, maintenance stations on roads, discharge of sewage, including drainage water from residential buildings. This experience may be used in practice of regional land administration bodies of the constituent entities of the Russian Federation.

1. Introduction
The development of anthropogenic activity provoked a significant deterioration in the state of surface water bodies acting as water supply sources, recreation facilities, and the natural environment of ichthyofauna on the territory of the Russian Federation [1]. The regulation of the use of land adjacent to water bodies is justified for the improvement of water quality, the functions of which the scientists are currently considering from two perspectives. The first: it is necessary to strengthen control over economic activities in the territories adjacent to water sources, to increase the budget costs of all levels for environmental measures. Thus, for the successful development of economic activities in the region it is necessary to establish the boundaries of water protection zones and organize the use of land on their territory taking into account legal restrictions.

The water legislation of the Russian Federation is based on this perspective. According to Article 65 of the Water Code of the Russian Federation, water protection zones are territories that adjoin the coastline of water bodies, and on which a special regime for carrying out economic and other activities in order to prevent pollution is established. Within the boundaries of water protection zones, coastal
protection belts are established, in the territories of which additional restrictions on economic and other activities are introduced.

The width of the water protection zone of the rivers is set depending on their length, the width of the coastal protection belt is set depending on the slope of the water body coast.

A special regime for carrying out economic and other activities within the boundaries of water protection zones and coastal protection belts is defined by the Water Code of the Russian Federation.

The second: to carry out environmental measures not within the narrow limits of water protection zones of water sources, but throughout the catchment area.

This view correlates with the practice of European countries, many of which (Iceland, Norway, Sweden, etc.) establish protection zones only for sources of drinking water supply, the policy on other water sources implies voluntary compliance with the rules established by the municipality.

Most Russian and foreign specialists [2–7] propose to use a combined approach in the framework of territory management: environmental measures on the watershed with restriction of anthropogenic activities near water sources in order to prevent their pollution, as well as regulation of water sources themselves. This perspective involves the system of measures: construction of accumulating channel ponds and reservoirs, reconstruction of hydroelectric units in emergency condition, rehabilitation of dams of small hydroelectric power plants, clearing springs, construction of treatment facilities, storm sewers, reconstruction and restoration of local treatment facilities in industrial and agricultural enterprises, control of surface runoff from areas of livestock complexes and farms, erosion control measures, including restoration of forestry on the catchment area, placement of protection forest belts.

Thus, the need to establish zones in which a number of restrictions on economic activities and environmental protection measures will be imposed on the territory of Russia is justified both from the point of view of the legislator and the scientific community. In this regard, the authors analyzed the structure and content of preparatory work – preparatory works (Table 1).

Table 1. Structure and content of preparatory works in the formation of water protection zones and the establishment of boundaries of coastal protection belts of water bodies

| Design and survey stage | Structure | Content |
|-------------------------|-----------|---------|
| 1. Preparatory works    | 1. Geotechnical Survey | 1. Reconnaissance survey of areas falling into water protection zones (land inventory); 2. Determination of the average long-term water levels of a river and the position of a coastline; 3. Clarification of the length of rivers. |
|                         | 2. Design assignment development | 1. Clarification of the order of land management measures; 2. Establishment of performers and deadlines of works. |

Taking into account the above, this paper sets the following tasks – to identify the features of the land inventory in water protection zones and to determine ways to improve the structure of the working project on the formation of water protection zones and coastal protection belts of water bodies.

2. Materials and methods
The theoretical basis of the study was the scientific works of domestic and foreign scientists and specialists [8–11], official reports, records and decisions, methodological manuals, legislation of the Russian Federation and its constituent entities.

The object of the study is the land reserves of the Oryol region, the territory of water protection zones and coastal protection belts of small rivers of the Oryol region. The land reserves of the Oryol
region amounted to 2465.2 thousand hectares. Of all categories of land, 2111.9 thousand hectares (85.7%) prevail on its territory, the lands of the forest fund occupy an insignificant area — 97.4 thousand hectares (4%), the lands of the water fund — 1.0 thousand hectares.

The Oryol region is the area of numerous rivers, here the surface run-off of the Volga, Don and Desna basins is formed. The water fund of the region has 2100 watercourses, and over 1900 rivers belong to the category of small rivers. 28 small rivers and streams of the Oryol region were taken as the object of study. The rivers under study belong to two adjacent basins — Oka and Don. The rivers Lipovets, Dolzhanka, Lesnaya Livenka, Fshnya are located in the Don River basin. The rivers Orlitsa, Zalegoshch, Ozerna, Mezenka, Rog, Ors, Rydan, Malaya Rybnitsa, Rakitnya, Nezhivka, Ruda, Lubna, Panikovets, Tskan are located in the Oka basin. The largest of the considered rivers is the Lipovets River — 41 km, the smallest — the Plota, Zelenka, Droskovo, Korobets, Trosenka (11 km), the average length of the rivers is 23.7 km.

The following main sources of anthropogenic pollution of water bodies and adjacent areas were identified:
  - industrial enterprises (production waste water, production waste, dust and gas emissions, surface runoff from industrial sites);
  - agriculture (removal of fertilizers and pesticides from fields, waste water from livestock farms);
  - transport (exhaust gases, sewage waters, water drain from highways, oil seepage);
  - settlements (consumption waste, municipal wastewater, surface runoff from residential buildings).

The prevailing water management situation demonstrates the need to implement a set of water conservation measures, among which the development of water protection zones and coastal protection belts based on a carefully conducted land inventory is of paramount importance.

3. Results and discussion
Having studied the Russian legislation and the content of the working project on the formation of water protection zones and the establishment of the boundaries of coastal protection belts of water bodies, it was established that the initial task of the land inventory in water protection zones is to determine the water levels of the river, for this purpose morphosts are divided and leveled on the calculated sections of the river, and then the average long-term water levels are determined (for the period when they are not covered with ice).

The justification of the average long-term water level of water bodies for the period when they are not covered with ice is made on the basis of data on water levels contained in the Unified State Fund concerning data on the state of the environment, its pollution, as well as on the basis of hydrological calculations. These calculations are necessary to determine the position of the coastline (boundary of the water body) in the calculation patterns. Indeed, the boundaries of water bodies that are visible and clearly distinguished on photo images are often not actually such, since the water level in the water body is not constant and at the time of shooting, as a rule, is outside the mark at which it corresponds to the “normative” value established by the Water Code of the Russian Federation.

In addition to monitoring water levels in rivers, a number of tasks are being solved during land inventory in water protection zones.

The physical inventory is usually carried out in three main stages. At the first stage, all available materials containing information on the inventory area are collected. For this purpose, requests are drawn up in the administration of municipalities, agricultural and other organizations, the state fund of data obtained as a result of land management and other state organizations, Land, forestry, soil, cadastral, administrative and other maps are collected as source cartographic material. All cartographic material is digitized and brought to a single scale. At the second stage, field work is carried out to produce an inventory map. Considering that certain sections of water protection zones may be difficult to access, it is not advisable to use the geodetic measurement method. Satellite measurement method and photogrammetric method are most suitable for these works [12, 13]. Moreover, unmanned aerial vehicles are most effectively used to obtain initial orthophotomaps. For each contour or area in the
course of field works, an act of land survey must be formed, in which it is necessary to indicate the area, uses (actual and according to the documents), revealed violations and other information. Each act must be accompanied by cartographic material and a photo report of the territory under study. At the third stage, the source and the map material obtained during the field stage are compared. Based on this analysis, all violations in water protection zones are detected and recommendations for their further use are developed.

The land inventory in water protection zones differs significantly from other types of land inventory. Usually, the lands of an agricultural organization, forestry, settlement or municipality are inventoried. In any case, even in the case of an inventory of an administrative facility, work is carried out regarding one category of land fund, namely, land of settlements, agricultural or forest funds. Accordingly, uniform requirements for the accuracy of determining areas, land and (or) environmental management regime, and other indicators apply to the inventory object. The boundaries of water protection zones may include lands of various categories, types of ownership and use and belong to different landowners. When processing collected materials, it is necessary to start with the formation of cartographic material showing the zoning of the inventory object by land fund categories, owners and users. The cartographic material shall be supplemented with an explanatory note with tables. In this part of the work it is necessary to establish the areas of all objects located in the inventory water protection zone. The scale of the cartographic material shall be selected according to the land category requiring maximum area measurement accuracy. Next, for each category it is necessary to establish the composition and ratio of lands. The types of land and its actual use should be compared with the types of permitted use of land and all violations should be noted. A multi-layer interactive map of water protection zone land uses is formed based on this analysis.

The experience of the inventory of water protection zones accumulated by the State University of Land Use Planning shows that the main violations of the use of such territories include the following: violation of the water use regime, non-compliance with environmental and sanitary and epidemiological requirements, placement of inappropriate facilities, non-compliance with the requirements for equipment of economic and other facilities located within the boundaries of water protection zones, improper management of production waste. Additionally, in coastal protection belts, plowing and grazing are observed. With respect to coastal zones, a typical violation is non-compliance with the condition for ensuring free access of citizens to a public water facility and its foreshore.

It was noted above that the water protection zones include lands of different categories, but the main are agricultural lands. It is the use of this category of land that should be given the maximum attention when conducting land inventory of water protection zones [14].

When describing the location of the coastline (boundaries of the water body), the following are prepared:
- list of coordinates of characteristic points of the coastline (water body boundaries);
- cartographic basis with applied coastline (water body boundaries);
- explanatory note (certificate of work on the description of the location of the coastline) containing, inter alia, information on the customer of work, used initial data and work methods.

The description of the coastline location (water body boundaries) is carried out in paper and electronic form (including in the form of files using schemes for XML documents that provide reading and control of data contained in them).

Based on the location of the coastline and taking into account the norms of the Water Code of the Russian Federation, the widths of water protection zones and coastal forest bands are established. The total length of the rivers and their tributaries under consideration is 663 km, it follows that the length of the zones to be established will be 2 times more – 1326 km. The adopted width of the water protection zone is 100 m for 27 rivers and only for the Foshnya River it will be 200 m from the coastline, since its length exceeds 50 km. The area of water protection zones will be 14440 hectares, such zones will on average occupy 0.8% of the area of the municipal region, which once again emphasizes the need for a systematic arrangement of their territory.

The width of the coastal protection belt at considered facilities is 50 m, since the slopes of the coast
exceed 3 degrees, the area of the coastal protection belts will be 6630 hectares.

Figure 1 shows a fragment of the project for the formation of water protection zones and the establishment of the boundaries of coastal protection belts of the Lipovets River in the territory of the Oryol Region.

On the basis of the completed land inventory for the Lipovets River, the need for restrictions on human economic activity in water protection zones and coastal protection belts was determined in the following cases: placement of a cemetery in Troitskoye village, implementation of aviation measures to combat harmful organisms and the placement of specialized storage facilities for pesticides and agrochemicals of the Pokrovsky agricultural complex, location of petrol stations, fuel and lubricants warehouses, maintenance stations on the Orel-Tambov highway, discharge of sewage, including drainage water from residential buildings in the villages of Alekseevka, Rodionovka, Mukhartovo, Yudinka and Pokrovskoye, Odintsovka, Lipovets, Varvarino, Trudki, Zolotoy Rog, Protasovo, Troitskoye.

![Figure 1](image)

**Figure 1.** Fragment of the project for the formation of water protection zones and the establishment of the boundaries of coastal protection belts of the Lipovets River in the Oryol Region

4. **Conclusion**

The considered aspects of land inventory in the areas adjacent to water bodies showed the need to combine cartographic and field survey methods, the importance of preliminary archival surveys and the significant relevance of such works for the ecological rehabilitation of small rivers.

The result of the study is the land inventory, which forms the basis of a working project on the formation of water protection zones and coastal protection belts of small rivers of the Oryol region. This experience may be used in the practice of regional land administration bodies of the constituent entities of the Russian Federation.

The proposed measures will contribute to the rational socio-economic and ecological development of the territories, the effective use of water bodies and the reduction of possible damage to real estate.

The inventory is the basis of any land management design. Only having the most complete and objective information on the facility it is possible to talk about economically efficient and environmentally safe land use.

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