Geoecological passport for small and medium river basins

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Abstract. The paper presents the main provisions characterizing the geoecological passport of small and medium-sized river basins and its significance as a scientific and technical document. The paper highlights the need to create geoecological passports to assess the modern geoecological state of water bodies on the basis of reliable data and develop a set of measures for ecological recovery and minimization of anthropogenic impact in river basins. The novelty and uniqueness of the study is determined by the creation of an individual geoecological passport of the water body using an integral approach, which includes a combination of classical and modern analyses for geoecological assessment of the anthropogenic impact on the Osetr river basin.

1. Introduction

The river basin is a system of landscape formations that differ in structure and function and are combined with a landscape aquatic ecosystem. There is a close link between the geographical structure of the river basin and the functioning of the hydrographical network.

Small and medium-sized river basins in close proximity to large settlements reflect the geoecological state of the environment.

The studies of the modern state of small and medium-sized river basins are especially important both from theoretical and practical perspectives and are becoming ever more relevant due to increased anthropogenic impact.

The study by A.V. Krylova, Yu.Yu. Dgebuadze [1] notes that due to a number of characteristic features (high dynamism, close association with the landscape, perennial flow, etc.), small and medium-sized rivers have long become model objects of environmental research.

K.M. Berkovich, A.Yu. Sidorchuk [2], A.V. Levin [3], D.C. Tsibudeeva, I.D. Rybkina [4], N.A. Kurganovich, A.V. Shalikovsky [5], D.A. Domnin [6], B.P. Tkachev, V.I. Bulatov [7] et al., in the study of the problems of small and medium-sized river basins and their geoecological assessment note that the growing interest in the problems and features of small and medium-sized rivers is caused by their landscape-forming and ecological characteristics. Water quality in small and medium-sized rivers presents the area of concern due to significant anthropogenic impacts. Small and medium-sized rivers with the lowest self-healing potential are more sensitive to various anthropogenic and natural factors. As a result, they react quickly thus changing abiotic and biotic parameters.

A.S. Zavadsky, G.V. Lobanova, L.N. Petukhova and et al. [8] believe that the issues related to the use, protection and restoration of small and medium-sized river basins are critical. In addition to their main role in the formation of runoff and bottom sediments, watercourses of the first orders differ
significantly in their hydrological and morphological characteristics. The standardization of channels in Moscow Region made the authors identify the sections of small and medium-sized rivers with a high anthropogenic impact as a result of a change in the nature of land use, which made it possible to take into account the main component of the channel network of the studied area.

Thus, the measures to monitor the current state and transformation of the water body are one of the most important functions of geoecological assessment of anthropogenic impact in the river basin. Geo-environmental assessment should include compare the actual or predicted state with predefined criteria (baseline indicators) and identify the existing problems.

G.M. Barenboim [9] in the “Modern trends in the monitoring of water bodies” draws attention to the fact that the quality of water in rivers directly depends on the state of their basins. A large number of small and medium-sized rivers do not participate in environmental surveillance programs carried out by state bodies, but are of great economic importance and form the basis of the river basin area.

When describing the scientific and technological problems of designing, creating and functioning of water bodies monitoring systems, the author notes that the existing water bodies monitoring systems are multisectoral, poorly coordinated and do not meet modern requirements for technology and technical equipment.

E.A. Abramova [10] during the geocological assessment of the anthropogenic impact on the surface waters of the Oka River basin draws attention to the fact that active economic activities require integrated environmental monitoring and geoecological assessment, as this will allow tracking the change in water quality in small and medium-sized river basins and determining its impact on larger reservoirs, as well as giving a comprehensive geoecological assessment of the anthropogenic impact in general.

In the context of an annual increase in the anthropogenic impact on the geosystem components of small and medium-sized rivers, the geocological passport of a river basin, which takes into account a comprehensive geocological assessment of the anthropogenic impact, is an urgent land management and water management task in solving the issues of sustainable development of the territory.

During environmental certification of urban reservoirs G.S. Rosenberg, D.B. Gelashvili [11], T.D. Zinchenko et al. [12] note that the existing methods and information systems for a comprehensive assessment of the ecological state of urban reservoirs and the subsequent creation of an environmental passport were developed by the scientists from the Nizhny Novgorod University and the Institute of Ecology of the Volga Basin of the Russian Academy of Sciences in the second half of the 1990s. The certification of urban reservoirs of Nizhny Novgorod and Togliatti confirmed the need to develop ecological passports, which allowed local governments assessing the modern geoecological state of water bodies on the basis of reliable data and developing a set of measures for environmental recovery and minimization of anthropogenic impact.

When developing the structure of the ecological passport of the city river on the basis of the system methodology T.P. Devyatkova and E.V. Knyazeva [13] indicate that the content of existing ecological passports of rivers does not fully meet the set tasks for a number of reasons, namely: complete or partial absence of hydroposts, lack of observations in the river basin, study of only the water protection zone and the coastal protection belt, insufficient study of the hydrological regime of the watercourse, incomplete information, its distribution in different sections, repeatability, etc. Due to the fact that most ecological passports do not contain information on the forecast of potential deterioration of the aquatic environment and proposals to prevent the negative consequences, this document may be conditionally equated with the ecological feasibility.

N.M. Mingazova, O.Yu. Derevenskaya, O.V. Palagushkina et al. [14] draw attention to the fact that the inventory and certification of water bodies is an effective way to preserve and optimize the state of small and medium-sized lakes, rivers and wetlands and their biodiversity.

Oset is a river in the European part of Russia, in Moscow, Ryazan and Tula regions. It belongs to medium-width rivers in length and area of the river basin and represents one of the largest southern tributaries of the Oka river.

The relevance of the planned studies is caused by the annual increase in the anthropogenic impact
on the geosystem components of small and medium-sized river basins due to the dense location of populated, cultural, agricultural and industrial centers.

The studies of the current state of the Osetr river basin are presented in the work on the study of the methodology of geocological screening of the state of small and medium-sized river basins to assess the impact of measures for the operation of hydraulic structures and the anthropogenic impact on the Osetr river basin. The novelty of the study is determined by the creation of an individual geocological passport of the water body using an integral approach, which includes a combination of classical and modern analyses for geocological assessment of the anthropogenic impact on the Osetr river basin [15].

2. Materials and methods
The studies on the creation of a geocological passport include comprehensive hydrological, hydrochemical, hydrobiological, ecogeochemical, radiation, landscape-ecological and sanitary-bacteriological surveys, as well as data from long-term field measurements using GIS technologies and mathematical modeling.

The paper proposes an integrated approach using a combination of classical and modern methods of analysis to geocological assessment of anthropogenic effects on the Osetr river basins, for which a literary review on the problem under study was prepared; data on the water management situation and environmental situation in the studied area were collected and analyzed; laboratory-field work with sampling, primary processing of collected samples, sample preparation and analysis of surface waters to determine hydrochemical and sanitary-microbiological indicators; impact of industrial discharges on water quality, as well as on the biodiversity of the river network was studied; calculations were made to establish the level of pollution of the reservoir (water pollution index (WPI), specific combinatorial water pollution index (SCWPI)), the share of anthropogenic impact and the degree of anthropogenic impact (point-rating method) with the identification of 5 categories of sections of the river bed based on the intensity of the anthropogenic impact and the state of ecosystems [15].

The materials obtained as a result of the study in 2015-2020 will make it possible to comprehensively assess the influence of anthropogenic factors on the geocological state of the river basin, to study the modern ecological state of the studied area, to identify the main impact factors, as well as to assess the degree of pollution, to conduct zoning of the studied area according to the degree of the anthropogenic impact and to develop a detailed geocological passport of the Osetr river basin.

Due to the fact that the geocological passport is at the stage of development, the territory of the Osetr river basin within the Moscow Region from Serebrovnye Prudy village to Akatievo village is taken as the area for study, the middle and lower section of the Osetr river basin from Zaraysk village to the river mouth zone/area (confluence with the Oka river – Akatievo village) – as the screening area. The dates of additions and changes to the river geocological passport are 2020-2022.

3. Results and discussion
Geocological passport of a reservoir is a document reflecting the ecological state of the water body in accordance with generally recognized water conservation standards and requirements for recreation areas to ensure the functioning of environmental well-being, forecast ecocrisis situations and perform early detection of environmental hazards when assessing the state of the water body. The use of the “screening” method in the development will provide for an objective assessment of the geocological situation in the studied river basin as it will grant an opportunity to better analyze the state of river basins, in particular small and medium-sized river basins with high anthropogenic impact, which will allow quickly identifying environmental risks that have a negative impact on the geosystem components, and taking more effective measures to eliminate them [12, 15-16].

The geocological passport of the water body should reflect its ecological state in accordance with generally recognized water conservation standards and requirements for recreation areas to ensure proper functioning of environmental well-being, forecast ecocrisis situations and perform early detection of environmental hazards when assessing the state of the water body.
The geocological passport of small and medium-sized river basins contains comprehensive information on the modern state of nature and anthropogenic impact and may be used to assess and compare the characteristics of various basins.

The developed scheme of the geocological passport is partially tested at the screening site, which basins include settlements, industrial and agricultural enterprises. Currently, the geocological passport consists of the following sections: introductory section – results of studies on the geographical and administrative situation of the considered river basin; hydrological and hydrochemical characteristics; tourism and recreational potential; characterization of anthropogenic transformation; geocological assessment; possible measures to minimize the anthropogenic impact and stabilize the geocological state the river basin [11-13, 16].

Further measures to develop a geocological passport of the Osetr river basin will include several stages:

– analysis of the distribution of hypersensitivity to anthropogenic impacts of geosystem components in the Osetr river basin taking into account hydrological, natural-climatic and regional features;

– assessment of the quality of surface and groundwater, soil cover, bottom sediments with determination of the main chemical (integral), sanitary-bacteriological (specific), microbiological indicators, as well as physical risk factors in laboratory conditions according to the research agenda;

– assessment of anthropogenic impacts using integral indicators and indices for the assessment of the ecological state of water bodies, a system for assessing the risk of anthropogenic impacts on freshwater ecosystems, methodological recommendations for the development of unified integrated programs for the survey of river basins, water supply facilities and drinking water quality;

– development of an original methodology for estimating the river basin in conditions of increased sensitivity to anthropogenic impacts on the basis of the above methods using geoinformation and mapping methods of historical and geographical situations on different sections and GIS-modeling of natural and anthropogenic conditions with subsequent identification of high geocological risk zones, levels of water pollution, proportion and degree of anthropogenic impact, etc.;

– geocological zoning of the Osetr river basin in terms of the level of pollution, the proportion of the anthropogenic impact and the degree of the anthropogenic impact based on the proposed methods;

– creation of a geocological passport of the Osetr river basin based on the results of screening and GIS technologies.

The practical importance of the study includes the possibility of applying various methods to assess the geocological state of watersheds, results of geocological zoning, geocological passport during geocological monitoring of the environment of Moscow, Tula and Ryazan regions in order to prevent, minimize or eliminate harmful and undesirable environmental and related social, economic and other consequences and preserve the optimal living conditions of the population, and identify and plan immediate and priority water conservation measures at federal and regional levels [12-16].

4. Conclusion

In the conditions of annually increased anthropogenic impact on geosystem components of small and medium-sized river basins, the creation of the geocological passport, which takes into account complex geocological assessment of anthropogenic impact of the Osetr river basin is an actual land and water management task in solving the issues of sustainable development of the territory.

The relevance of the planned studies is caused by the annual increase in the anthropogenic impact on the geosystem components of small and medium-sized river basins.

The geocological passport of small and medium-sized river basins contains up-to-date information on the current state of nature and the anthropogenic impact and may be used to assess and compare the characteristics of various basins.

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