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Features of research of hydrological conditions and hydrogeochemical regime of the river basins

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SUMMARY

This work aims to evaluate hydrogeological conditions and the hydrogeochemical regime of the Styr River. In order to achieve this goal, we collected and analyzed literary sources and fund materials on the research subjects, introduced modern methods of assessing the quality of water in the Styr River Basin and carried out a geochemical assessment of the Styr River Basin.

The main results of the work enabled us to identify the direction of migration of individual chemical elements by water flows, to show how changes in one component of the Basin system lead to changes in the system as a whole. The practical recommendations suggested in this work to reduce the anthropogenic influence on the Basin systems can be used to plan measures to optimize nature management in the Styr River Basin.

Introduction

One of the most critical problems nowadays is minimizing people's negative impact on nature, particularly on the water environment. Since human economic activity traditionally is closely related to water sources, rivers and other water bodies are affected by the most significant anthropogenic pressure. Flow regulation and water pollution cause changes in their water regime and water quality.
The economic activity leads to significant changes in the ordinary course of natural processes, disrupting the balance of water bodies, which negatively affects the development and functioning of inhabitants of reservoirs. Furthermore, significant long-term technogenic pressure (Trubenko and Dubei, 2019) leads to a decrease in the ability of aquatic ecosystems to self-regulation, the contamination of water resources of anthropogenic origin. As a result, the ability of water to self-purification decreases and deteriorates the quality of water.

Presentation of the main research material

Styr River Basin is characterized by the significant variation of natural conditions from river source to the river mouth; within its boundaries can be distinguished five modal areas: I - Podolian Upland (Voroniaky), II - Volynske Opillia, III - Peredopillia, IV - Peredpolissia, V - Volynske Polissia, - each characterized by the specificity of the geochemical flow of substances (Gerenchuk, 1975; Gerenchuk, 1981).
The historical and geographical analysis of the Basin system has shown that the most intensive anthropogenic impact of the Basin has occurred in the last two centuries, especially as a result of the construction of reservoirs and water reservoirs, meliorative works, deforestation, ploughing of lands and urbanization. For example, the area of swamps in the Basin has decreased by over six times in the last century, from 12% to 1.8%, forests - from 42.5% to 29.3%, and the part of arable lands has increased from 32% to 44%. Nearly 800 thousand people now live in the Styr River Basin, there are over 500 settlements, of which 98 are located directly on a coastal strip of the Styr River. Urbanization leads to the destruction of natural systems and the creation of artificial urbanization landscapes. The creation of the artificial ponds and reservoirs has a significant impact on the hydrological regime of the Styr River and its tributaries and the landscape of the Basin, somewhere (in flooded areas), ultimately reducing them (Zuzuk et al., 2021). The artificial water reservoirs are created for regulation of river flow, they are able, due to water accumulation, to reduce the risk of floods and due to water transmission - to reduce the harmful effects of dryness. In addition, water reservoirs are created for the needs of water supply to the population and industry and the purpose of cheap energy production (Petlin, 2006).
The hydrochemical flow of reagents indicates the current state of the Basin system, its state of economic development, which significantly changes the natural processes of reagents migration. Under these conditions, the ionic composition of the river's water legitimately indicates not only the natural features of the Basin but also its chemotransformation as a result of anthropogenic influence, which, foremost, is indicated in a direct change in the background characteristics.
It was found that the surface water in the Styr Basin belongs to the third (class II) and fourth (class III) category of quality, i.e. excellent and good water, which corresponds to the level of purity to be relatively clean or slightly polluted. Therefore, in terms of general surface water quality, the Basin can be conditionally divided into two parts (Gritsenko et al., 2012) - slightly polluted source (modal areas of Voroniaky and Male Polissia), the middle part of the Basin (Volynske Opillia) and relatively clean downstream (Predpolissia, Polissia) (Fig. 1).
More significant differences in the quality of surface water of the Basin can be seen in some groups of hydrochemical indicators.
The salt composition of surface water within the Basin's boundaries is characterized by its good quality (according to the purity level, they are slightly polluted), but only in the source of the Styr River and tributaries of the Slonivka, Hnyla Lypa and Chornohuzka Rivers water are good quality (relatively clean). The primary indicator, which influences such differentiation is Sulphate concentration. Sulphates

are present practically in all surface waters and come there mainly due to the weathering of minerals and the use of mineral and organic fertilizers containing Sulphur and Sulphide oxidation processes. Sulfates also accumulate in surface water in the process of dying of plant and animal organisms, which is typical for the surface water in the Styr River Basin. The quality of the Styr River's water in terms of sulphate concentration varies from very good (class II) to the poor (class IV) accordingly.

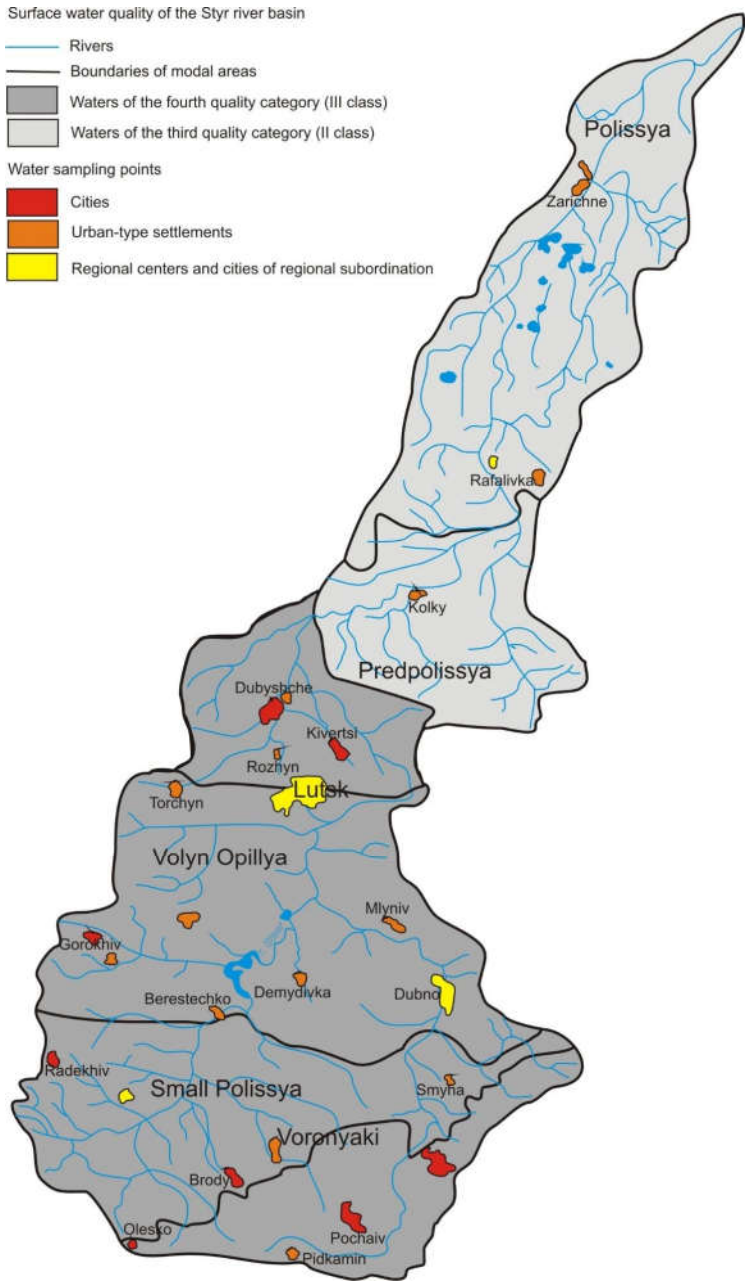

Figure 1 *Zoning of the Styr river basin by surface water quality.*

Water quality in terms of mineralization level varies from excellent (class I) in the tributaries of the Styr River to satisfactory (class III) in the tributaries of Chornoguzka and Serna rivers, Ikva and Zhabychi rivers. In general, the quality of water in the main channel of the Styr River is increasing from very good to good (class II), by the purity level from clean to relatively clean.

Another indicator of water quality in the salt group is chlorides, which is practically not changed in the Styr River Basin and belongs to the water of class III.

In the group of indicators of peat-saprobiological composition, water quality was analyzed in terms of suspended solids, ammonium nitrogen, nitrates (in terms of total nitrogen), and BOC_5. Surface water quality in the Styr River Basin is excellent or very good in terms of the content of suspended solids. However, water quality is the worst in terms of ammonium nitrogen and, especially, nitrates.

As mentioned before, ammonium nitrogen and nitrates get into the water with industrial and domestic wastewater and runoff from agricultural lands where nitrogen fertilizers are used. Since the level of agricultural development and ploughing is much higher in the upper Basin, especially within the Volhynian Upland, the quality of surface water here, in terms of nitrates, is the worst. Within the source of the Styr River, the surface water belongs to the 5th and 6th quality categories, i.e. in terms of purity, they are slightly polluted and polluted. Within the sub-Basin of the Ikva River and the Slonivka River, the water quality decreases to category 7 in some places, i.e. the water is very unclean. Downstream, in the Polissia area, the surface water quality of the Styr River Basin is better and corresponds to category 4 of quality, i.e. water is slightly polluted.

Water quality in terms of biological oxygen demand for five days (BOC_5) corresponds, in general, to category 4 of quality, i.e. in terms of the level of purity, water is slightly polluted. Its quality deteriorates below the place where waste disposal of the "Lutskvodokanal" occurred in the Styr River; below waste disposal of the "Dubnovodokanal" facility in the Ikva River; below the confluence of reclamation canal in Zhabichi River, which is polluted by cannery; below wastewater of "Hnidavskyi cukrovyi zavod" in Chornohuzka River.

In general, within the group of indicators of peat-saprobiological class, the quality of surface water of the Styr Basin is evaluated as good (class II), in some places, it is satisfactory (class III), relatively clean or, in some places, it is slightly polluted.

The water quality in the Basin of the Styr River in terms of iron content is category 4 (satisfactory). However, in the area below the Kozlynychi village, the surface water quality increases and corresponds to 1 (excellent) or 2 (very good quality category). Such a change is not caused by a rapid decrease in the concentration of iron in surface water but by the location of this part of the Basin in the Polissia hydrochemical region, where the iron content is much higher due to the presence of numerous swamps. The primary sources of iron in the surface water are the processes of chemical weathering of rocks, and in our case, from the flow of iron originating from the wetlands.

The surface waters in the Styr river Basin are slightly polluted, although the situation is somewhat more complicated due to some indicators, especially in terms of nitrate content. It should be noted that the quality of water significantly deteriorated due to human activity, discharge of insufficiently treated wastewater, direct discharge of wastewater during the exit from the treatment plants, self-discharge of wastewater by private households, high level of use of wastewater in the agricultural sector, and lack of respect for the interfaces of coastal, river Basins and water protection zones (Chernyavska, 2006).

To improve the quality of surface water, especially on small rivers, we consider it necessary: to reconstruct existing or build new treatment facilities, especially in enterprises located on the tributaries of the Styr River; control and complete cessation of untreated discharges of wastewater by private households; bring the coastal water and water intake areas into proper condition; compliance with the current legislation in the sphere of protection of water objects and the natural environment in general.

Conclusion

Anthropogenic activity is becoming more intense and more varied, and today all landscape components are affected: the composition of atmospheric air and surface water is changing, the soil, flora and fauna are changing. Since the Styr Basin is located within the boundaries of different natural zones and geomorphological objects, the intensity and types of anthropogenic impact vary significantly in the downstream and source of the Basin.

The territory of the Polissia estuary of the Basin has experienced significant anthropogenic impact due to the accident at the Chernobyl nuclear power plant; the uncontrolled dewatering melioration led to the transformation of landscapes, increasing the density of the river network, alignment of the riverbeds, their siltation, reducing soil fertility and their degradation; the poor farming system has contributed to the deterioration of the ecological state of agricultural landscapes; powerful centers of local pollution, in particular, the city of Kuznetsovsk and the Nuclear Power Plant of Rivne city, are potentially hazardous objects.

The source of the Basin is characterized by the widespread of sheet wash, deep erosion, and hence a high level of surface erosion; intensive agricultural development (ploughing of the territory is up to 65%) contributes to significant degradation of soil, increasing the level of urbanization leads to the formation of powerful local centers of pollution - cities; the imperfect structure of the farm with a low level of environmental friendliness leads to an increase in emissions into the atmosphere and surface water (Klymovych, 2000).

The obtained results of the research enable us to propose certain suggestions on the types and directions of environmental management within the Basin of the Styr River; namely, to optimize the water resources management system in the Basin and improve the surface water quality in the Styr Basin. For this purpose, it is necessary to carry out reliable monitoring of the status of the Basin system by means of expansion and automation of the existing system of monitoring of hydrochemical regime of the Basin; regulate discharges of pollutants both directly to water bodies and to water intakes of small reclamation systems; fulfil requirements of the Water Code of Ukraine; and increase the area of nature protection territories up to 10-15% in order to preserve biodiversity, especially in areas with the highest level of anthropogenic transformation (Voronyaky, Volynske Opillia).

The mentioned areas of optimization of environmental management can serve as a basis for the implementation of measures related to the monitoring, use and management of water resources of the Styr Basin.

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