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SOME ENVIRONMENTAL AND ECONOMIC PROBLEMS OF LARGE RIVER POOLS

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Abstract

Actual problems of water use in a large river basin (bio-indication, rationing, invasion processes, biodiversity conservation, etc.) were discussed. Some measures were proposed to implement the concept of sustainable development of the Volga basin. An example of a comparative analysis of the power supply ship system of the Volga basin and countries of Western and Central Europe was considered. Using the EIS REGION, the human development index (HDI) and the ecological footprint (EF) for the main territories of the Volga basin were calculated. The authors noted the similarity of the outline of one of the most popular tourist routes in Europe and the outlines of the Volga basin. It was decided to conduct a comparative analysis of these territories. It was concluded that in the HDI (except for Moscow, the republics of Tatarstan and Bashkortostan and the Vladimir region), all the territories of the Volga basin "lag behind" European countries. In terms of the EF (in fact, in terms of its impact on ecosystems), the territories "mixed up" more evenly, although for the Volga basin regions the "ecological footprint" is larger (the maximum [from the analyzed European countries] was noted for Belgium, and it is almost two times less than for the Moscow region - the maximum EF for the Volga basin). The study allows identifying the most relevant environmental and economic problems in a large river basin (using the Volga basin as an example), and also indicating some solutions to these problems.

Keywords: HDI, water use problems, bio-indication.

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1. Introduction

The reason for conducting the study was the national project “Ecology” (Passport of the national project "Ecology", 2018) - one of the national projects in Russia for the period 2019-2024 and the priority project “Conservation and Prevention of Pollution of the Volga River” (Passport of the priority project “Conservation and Prevention of Volga River Pollution”, 2017). The national project “Ecology” is being implemented as part of the May decree of President V.V. Putin’s national goals and strategic development goals for Russia and it includes 11 areas: “Clean Country”, “Integrated Solid Waste Management System”, “Infrastructure for Waste Management of I and II Hazard Classes”, “Clean Air”, “Pure Water”, “Volga Restoration”, “Conservation of Lake Baikal”, “Conservation of Unique Water Bodies”, “Conservation of Biological Diversity and Development of Ecological Tourism”, “Conservation of Forests ”and “Introduction of the Best Available Technologies” (BAT).

The Volga is the longest and most full-flowing river in Europe, the national symbol of Russia, which largely determines the economic development of the country's largest region. Unfortunately, coastal enterprises use the river as a free wastewater receiver - up to 20% of Russia's total wastewater flows into it every year, and almost 30% of all harmful substances from the total mass of emissions in the country get into the atmosphere of densely populated Volga cities. The consequence of all these chronic loads was the steady pollution of water and benthial deposits (Khasaev, Lazareva, Kudinova, Kuznetsova, & Rozenberg, 2019).

The indicated transformations as a whole in their impact represent a large-scale ecological catastrophe that fundamentally changed local nature. Wastewater regulation as a result of the construction of hydraulic structures (dams, water intakes), pollution, and excessive fishing led to a significant decrease in its volume and quality. The most valuable species of sturgeon, herring and salmon were lost, the conditions of migration of those species that managed to survive changed (Kudinova, Lazareva, Rozenberg, & Rozenberg, 2019). Their spawning run against the current is stopped by dams, which leads to the cessation of natural reproduction, and their down-current spawning run ends with the death of fish in hydroelectric turbines and in reservoirs.

2. Problem Statement

Sustainable development of the socio-ecological-economic system (SEES) of the Volga basin implies the solution of several interrelated problems (Mineev, 2007).

- Bio-indication assessment of water quality. In addition to traditional physicochemical and hygienic methods for assessing water quality, it is proposed to develop bio-indication methods (according to the anatomic anomalies of fish fauna, pathologies of fish blood cells, the level of “water flowering”, etc.). The frequency of anatomic anomalies in fish larvae increases with an increase in pollutants in the water body. A kind of bio-indicator (not only the water quality, but also the quality of life in general) is the health of the population.

- Problems of regulated impacts on aquatic ecosystems. Environmental regulation is a key problem in environmental safety. More than two decades ago, there was the need to determine permissible environmental loads and adequate restrictions (rationing) of existing anthropogenic impacts, taking into

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account the totality of possible harmful effects of many factors and the natural specificity of objects in Russia. The Federal Law "On Environmental Protection" (2002), among others, prescribes the justification and use of two types of standards in:

- Environmental quality standards - "are established to assess the state of the environment in order to preserve natural ecological systems, the genetic fund of plants, animals and other organisms";

- Standards of permissible environmental impact (including standards of permissible anthropogenic load) - "are established for business entities and other activities in order to assess and regulate the impact of all stationary, mobile and other sources of environmental impact located within specific territories and / or water areas."

Environmental regulation takes into account the so-called maximum permissible load on the ecosystem (Antonov, 2008).

- Development of a system of methods and indicators for the integrated assessment of freshwater ecosystems by the value of the population status index (PSI), which in a single number makes it possible to evaluate the total effect of negative factors on fish.

- Development of a system of methods and indicators for assessing invasion. Today, the main reason for the penetration of invaders is human activity. Canals in Russia and Europe began to be built as far back as the 19th century, connecting previously isolated rivers and reservoirs. Their inhabitants do not know how to fly or jump, but have learned to travel along the channels – they do it themselves or cleave to the bottoms of numerous ships. But most often, for the stability of ships, they take in ballast water at loading points at some ports and pour it out after discharge at others. So, Black Sea gobies and ordinary ruffles were in American Great Lakes. Great damage to Russian, European and American hydraulic structures was caused by the dispersal of the mollusk Dreissena bugensis instead of river zebra mussel (Dreissena polymorpha).

- Conservation of biodiversity of aquatic organisms and protection of rare and endangered species. For almost 50 years of the existence of the Saratov reservoir, the state of Russia's national pride - sterlet - has undergone major changes. The sharp decline in sterlet stocks is due to several factors:

- The Saratov reservoir violated the natural course of abiotic factors necessary for the normal existence of sterlet;

- Fishing and poaching have declined the population in the reservoir;

- The unsatisfactory state of the aquatic environment has a negative impact on survival and population size.

On the one hand, human activity to change nature has led to a sharp decrease in the number of sterlet. On the other hand, people are obliged to start saving this species of fish. Without human intervention, the sterlet population will not improve in the near future. Conservation of the sterlet population of the Middle Volga should go two ways. The first is a complete ban on sterlet fishing and the protection of places of natural reproduction. The second is the urgent expansion of artificial reproduction (Tikhiy, 1933).

- Development and improvement of expert information systems. The Institute of Ecology of the Volga Basin of the Russian Academy of Sciences developed EIS REGION for the analysis of spatially distributed environmental and economic data. It is able to solve the tasks of a comprehensive analysis of

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the region's ecosystems, assessing the nature of the anthropogenic load, using model "scenarios" to forecast the development of the environmental situation in the region and to give recommendations on how to achieve environmental safety in the region, sustainable environmental and economic development and areas of socio-environmental rehabilitation of territories. This EIS allows comparing indicators of sustainable development for basins of different rivers and different territories.

- Finally, the solution of the above problems can be "replicated" to other anthropogenically loaded basins of large rivers.

3. Research Questions

In the course of this study, it is supposed to answer a number of questions:

-What environmental and economic problems seem most relevant for large river basins?

- How significant is the discrepancy between the values of the HDI and the EF of the Volga basin and European countries?

- How to improve the international study of the problems of sustainability of socio-ecological-economic systems at different levels?

4. Purpose of the Study

The main purpose of the study is to analyze the main environmental and economic problems that appear to be the most relevant from the point of view of large river basins. The authors compared the main demographic indicators of the studied zones, and also calculated additional indicators to achieve the purpose.

5. Research Methods

As part of the study, the human development index and ecological footprint were calculated. The indicators of the area and population of European countries and the Volga basin were compared. The main results were analyzed.

6. Findings

The authors noted the similarity of the outline of one of the most popular tourist routes in Europe and the outlines of the Volga basin. It was decided to conduct a comparative analysis of these territories. Western and Central Europe is a territory of a very high concentration of population, cities, industrial and agricultural production, transport, tourism and recreation; all this has ever-increasing pressure on the environment. The Volga basin is very important and also extremely anthropogenic for Russia (Rozenberg, 2009). The possibility of comparing these territories follows from the fact that the area of the selected part of Europe is only 1.5 times larger than the area of the Volga basin (see Table 01).

For comparison, the authors used the human development index (HDI). The content of the HDI constituent parameters reflects the basic opportunities that people should have for active participation in

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society: the possibility to have a healthy and long life, and the possibility to have knowledge (education) and access to resources necessary for a decent standard of living.

Table 01. Characteristics of European countries and the Volga basin (for 2018)

Region	Area (km^2)	Population (mln people)	GDP (trillion $)
European countries (Fig. 1a)	1 959 300	319,3	14,88
Volga basin	1 360 000	56,2	1,22*

Source: authors.

The indicator is calculated on the basis of normalized statistical data (the conversion of any indicator to an index whose value is between 0 and 1): regional GDP per capita (X1 is the index of income in US dollars at purchasing power parity [PPP]), the index of life expectancy (X2), education level index (X3): HDI = (X1 + X2 + X3) / 3

Each of constituent parameters of the HDI is the result of interrelated indicators of socio-economic development and has its own qualitative characteristic. The GDP per capita shows the economic performance of people, the life expectancy index is the state of the physical, psychological and social health of the population, the education index is the professional and cultural potential of the population, and the quality of the labor force. The value of the HDI is a criterion for dividing regions into groups with different levels of human development. Regardless of the level of economic development, regions with a high level of human development are those in which the HDI > 0.8; to regions with an average level of human development - 0.5 <HDI <0.8; regions with a low level of human development - HDI <0.5.

Another indicator is the ecological footprint [EF]. Humanity's EF reflects anthropogenic pressure on the biosphere; this is the area of a biologically productive territory / water area necessary for the production of human resources and services (food, wood, seafood, land for construction, etc.) and the assimilation of waste (estimated primarily by the absorption of carbon dioxide). The EF is measured in global hectares per person (ha / person; ha - hectare with an average ability to produce resources and assimilate waste) and is the sum of the scores for the following parameters:

- Plough land area for growing cereals consumed by humans;
- Pasture area for livestock production;
- Forest area for the production of wood and paper, for the absorption of CO2 emissions from energy consumption per capita;
- Sea area for fish and seafood;
- Area occupied by housing and infrastructure;
- Emissions, discharges, waste generation.

In 2007, the global ecological foot print amounted to almost 18 billion hectares or 2.7 ha / person, while the total area of productive areas and water areas of the planet (its bio-capacity) was about 12 billion hectares or 1.8 ha / person (in other words, the EF of mankind has already exceeded the planet's natural capacity by 1.5 times).

Using the REGION EIS, the human development index (HDI) and ecological footprint (EF) for the main territories of the Volga basin were calculated.

According to the HDI (except for Moscow, the republics of Tatarstan and Bashkortostan and the Vladimir region), all the territories of the Volga basin "lag behind" European countries. Apparently, this can be explained by the fact that the HDI is directly dependent on GDP (gross domestic product [X1]; first proposed in 1934 by our compatriot, Simon Kuznets - Nobel Prize winner in economics in 1971), whose "contribution" to this index is overestimated in comparison with the "natural" and "social" components of sustainable development. And if the average GDP per capita at PPP (purchasing power parity) grew by 25% over 10 years (from 2006 to 2016) in the world and equals to $ 16 thousand. Then for the Volga basin, on average, it grew faster (1, 5 times) and approximately equals to $ 25 thousand. At the same time, the indices of life expectancy (X2; indirect characteristic of environmental quality; we should note that the forest cover of the compared territories is approximately the same: 39.2% for European countries and 35% for the Volga basin) and educational level (X3; social component) do not grow so fast and are very heterogeneous in space.

In terms of the EF (in terms of its impact on ecosystems), the territories "mixed up" more evenly, although for the Volga basin regions the "ecological footprint" is larger (the maximum [from the analyzed European countries] was noted for Belgium, and it is almost two times less than for the Moscow region - the maximum EF for the Volga basin). But both the countries of Europe and the Volga basin demonstrate strong pressure (impact) on the natural environment: the average EF for the entire Earth is estimated today to be just over 3 ha / person.

7. Conclusion

The study allows identifying the most relevant environmental and economic problems in a large river basin (using the Volga basin as an example), and also indicating some solutions to these problems. It is very important to establish a partnership at the international level of states, regions, and scientists to study the most complex problems of sustainability of socio-ecological-economic systems at various levels, to conduct joint large-scale expeditions, scientific conferences, and to exchange personnel. The result of such a partnership (EIS REGION can become the basis) will be a scientific and educational complex that establishes a spatial policy for sustainable development (taking into account the basin approach) at the macro-region level (several states) and meets the goals formulated in national projects "Ecology" and "Conservation and Prevention of Pollution of the Volga River."

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