NORWEGIAN JOURNAL OF DEVELOPMENT OF THE INTERNATIONAL SCIENCE

№43/2020

Norwegian Journal of development of the International Science

ISSN 3453-9875

VOL.3

It was established in November 2016 with support from the Norwegian Academy of Science.

DESCRIPTION

The Scientific journal "Norwegian Journal of development of the International Science" is issued 12 times a year and is a scientific publication on topical problems of science.

1000 copies

Norwegian Journal of development of the International Science

Iduns gate 4A, 0178, Oslo, Norway

email: publish@njd-iscience.com

site: http://www.njd-iscience.com

CONTENT

AGRICULTURAL SCIENCES

BIOLOGICAL SCIENCES

EARTH SCIENCES

JURISPRUDENCE

PEDAGOGICAL SCIENCES

PHILOSOPHICAL SCIENCES

PSYCHOLOGICAL SCIENCES

EARTH SCIENCES

DETERMINATION OF THE INFLUENCE OF NATURAL AND ANTHROPOGENIC FACTORS ON THE ECOLOGICAL STATE OF THE OSKIL RIVER IN THE KHARKIV REGION

Rybalova O.,
PhD, Associate Professor,
National University of Civil Defence of Ukraine
Ilyinskiy O.,
PhD, lecturer
National University of Civil Defence of Ukraine
Bondarenko A.
lecturer
National University of Civil Defence of Ukraine

Abstract

Based on mathematical modelling, in this paper was defined the influence of climatic conditions of Kharkiv region for the last 45 years on the hydrological and hydrochemical regime of formation of the ecological state of the Oskil River. The method of mathematical modelling for the first time determined the influence of natural and anthropogenic factors on the ecological condition of the Oskil River, which represents the scientific novelty of the work. Determining of the significant factors for the ecological state of surface waters of the Oskil River basin in Kharkiv region will allow developing a scientifically sound set of measures for their rehabilitation and rational use of water resources, which represents the practical value of this work.

Keywords: ecological condition, waterflows, climate, anthropogenic pressure, hydrological indicators, Oskil, Kharkiv region

Analysis of the ecological state of rivers, especially in industrialized regions, shows their unsatisfactory quality, which requires the implementation of environmental measures based on determining the causes of degradation of aquatic ecosystems. Kharkiv region is the largest industrial centre of Ukraine with highly developed industry, diversified agriculture and numerous settlements and needs quality water resources, but it is one of the low-quality regions of Ukraine.

The Oskil river basin has transboundary importance and is subject to high anthropogenic pressure, because it flows through the territory of an industrialized region, so the practical use of research results is carried out for the Oskil River in the Kharkiv region.

The ecological condition of water bodies is influenced by many factors: anthropogenic load, climatic factors, landscape-ecological and physical-geographical features of river basins.

Global warming has affected most countries in the world, including Ukraine, leading to emergencies. Analysis of emergencies during which fish have died in the reservoirs of Kharkiv region showed that the main cause of these phenomena is the deterioration of the ecological status of water bodies, changes in hydrological regime and global warming [1]. The study of the impact of climate change within the Kharkiv region on the ecological status of the Oskil River is an extremely important task in the development of measures to prevent environmental emergencies on water bodies.

The ecological condition of the Oskil River has significantly deteriorated in recent years, so the study of the causes of pollution of watercourses in the basin is a very important task, the solution of which is aimed at developing scientifically sound measures to improve the quality of water bodies.

The territory of Kharkiv region includes 867 rivers and temporary watercourses flow:

- large rivers - 1 (Seversky Donets);
- medium rivers - 6 (Oskil, Lopan, Oskil, Merla, Orel, Samara);
- the rest are small rivers.

The total length of all rivers of the region is 6405 km, of which 172 have a length of more than 10 km and their total length is 4655 km. All rivers and temporary watercourses belong to the basins of the Don and Dnieper, covering respectively 3/4 and 1/4 of the region.

The largest left tributary of the Seversky Donets River is the Oskil River. Its length is 472 km, the area of the basin - 14,800 km^2 (according to other sources - 14,680 km^2). The Oskil River flows into the Seversky Donets at 580 km from the mouth. A feature of Oskil before over-regulation was the significant variability of runoff. After a short flood for most of the year, the river's water content was usually low. Now the drain is somewhat levelled. Among the largest left tributaries are also the rivers Aidar (length - 264 km, catchment area - 7,420 km^2) and Derkul (163 km and 5,180 km^2)

The Oskil River basin is of cross-border importance, as it flows within two countries - Russia and Ukraine. The total length of the river is 472 km, of which 290 km flows through the territory of Kharkiv region. The total catchment area is 14,800 km2, of which 3,830 km2 are located in the Kharkiv region.

Small rivers are particularly sensitive to anthropogenic pressure, so determining the causes of deterioration of their ecological state is a very important task.

Specialists of UKRNDIEP have developed a "Methodology for environmental assessment of surface water in the relevant categories" [2]. In order to adapt the environmental assessment of surface waters to the

requirements of the EU Water Framework Directive [3] in 2012 in UKRDNIEP developed a project "Methods for assessing the environmental status of surface waters by relevant categories" [4].

This technique has been improved as follows [4]:

- a new structure for constructing environmental assessment is proposed, which increases the role of biological indicators;
- expanded list of biological indicators (hydrobiological indicators of the aquatic environment and bottom sediments);
- individual regional hydrochemical features are taken into account by improving the classifications of the most indicative geographically determined hydrochemical indicators (from the point of view of ecological assessment and provided with the necessary amount of retrospective information), namely total mineralization, chlorides, sulfates and total iron.

The set of indicators of ecological classification of surface water quality includes biological, physicochemical and chemical indicators.

The system of ecological classification of surface water quality of land and estuaries of Ukraine includes two subcontracted classifications, namely: classification by biological indicators and classification by physicochemical and chemical indicators [4,5].

To adjust the ecological assessment of water quality in accordance with the water content for a certain period of observations, you can use the value of the water content of K_B [4]:

$$K_B=Q_C/Q_Б, \quad (1)$$

where

Q_C - average water consumption for the period for which the assessment is performed;

$Q_Б$ – average long-term water consumption for the same period (season).

According to the method [4] according to the analytical quality control of surface waters of Kharkiv region according to the average annual indicators for the period from 1977 to 2014, the ecological index was calculated taking into account the water content coefficient (Fig. 1).

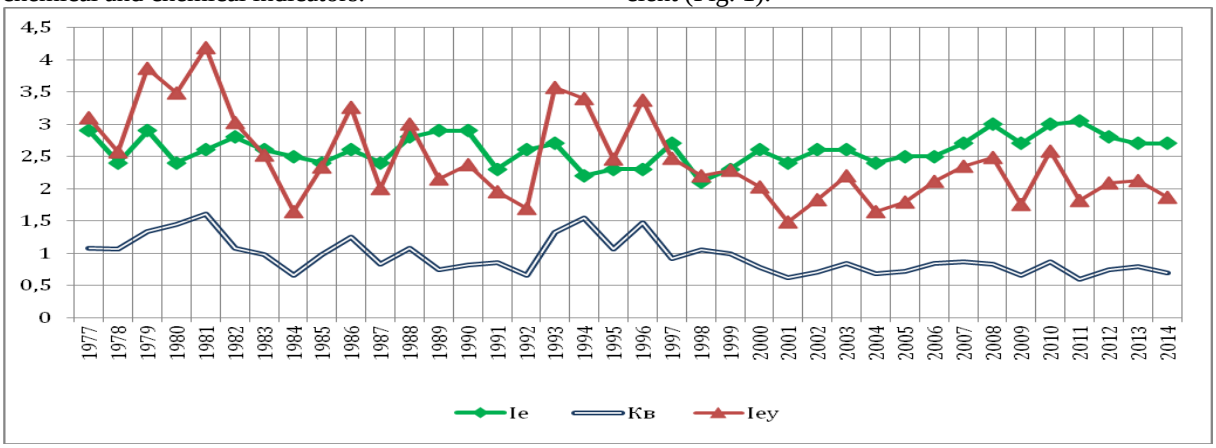

Figure 1. Dynamics of change of the ecological index in Oskil from 1977 to 2014

Ecological assessment of the surface water quality of land and estuaries of Ukraine is performed separately for each indicator. The ecological index is determined by the average and worst values of each of the indicators.

According to the results of the assessment of the ecological index according to the new method, the ecological condition of the Oskil River corresponds to the worst indicators of class 3, category 5 (mediocre condition), but the index of chemical tropho-saprobiological indicators (ITSred) corresponds to category 7 (class V - very poor condition). Therefore, determining the causes of pollution of the Oskil River basin is a very important task.

Despite the declining trend of water use, the quality of water resources remains unsatisfactory, because the rivers receive pollutants not only from point sources but also in large quantities with surface runoff from urban areas and farmland.

The control system covers only point sources of pollution, i.e. wastewater from utilities and industry, reporting in the form of 2-tp vodhosp. Standards for maximum allowable discharges (GDS) are set for them. And for such sources of pollution as surface runoff from urban areas and agricultural lands, there is no system of monitoring and restriction on the flow of pollutants into water bodies.

Analysis of drainage into water bodies of the Oskil river basin in Kharkiv region showed that in 2014 the return waters were discharged:

– "insufficiently treated" – 0.071 million m^3, which is 4.0% of the total wastewater discharge;

– "normatively treated" – 1,876 thousand m^3, which is 96.0% of the total wastewater discharge.

It should be noted that wastewater discharge has decreased more than 6 times from 1986 (12.2 million m^3) to 2014 (1.947 million m^3).

The identified trends in reducing wastewater discharge from point sources of pollution indicate the need to study the impact of climatic factors on the ecological status of the river Oskil.

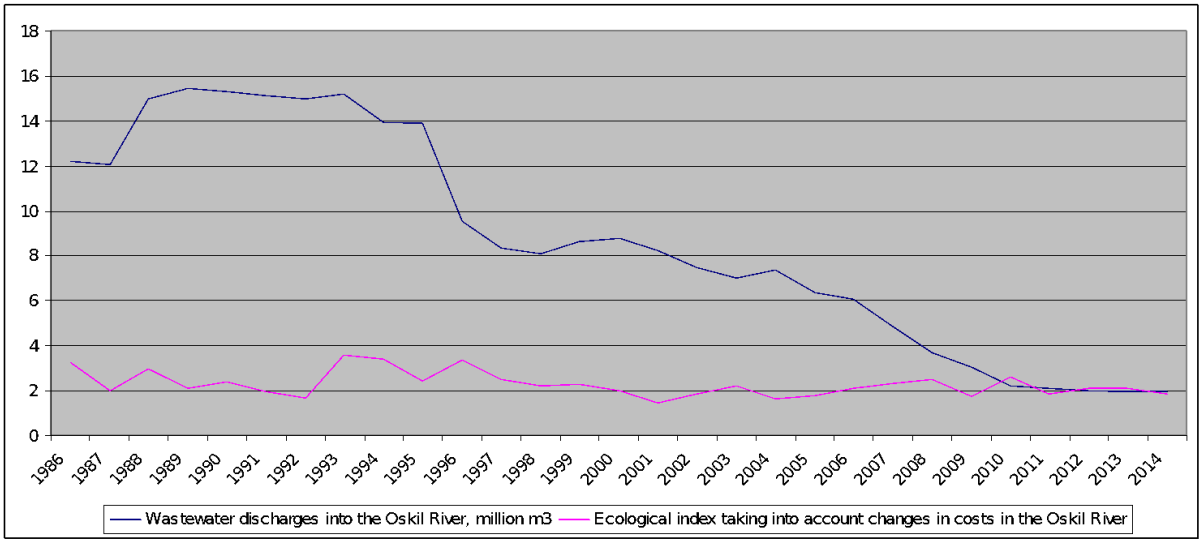

Figure 2. The impact of wastewater discharges on the ecological status of the Oskil River in the Kharkiv region by the value of the ecological index taking into account the water content coefficient (K_B)

Analysis of the impact of wastewater discharges on the ecological status of the Oskil River in the Kharkiv region has shown the need to take into account also climate change and other natural factors in the development of environmental measures.

According to statistics, about 90% of all deaths of fish in fish farms of Ukraine are caused by disorders of the oxygen regime, 5% are the result of toxicosis, and 5% are caused by diseases. The most sensitive to oxygen are cold-water fish: salmon, whitefish, sturgeon, as well as perch, pike perch and other predatory fish. The least demanding crucian, tench, carp. The zone of physiological comfort for most species of fish is from 70% to 100% of normal saturation. If the oxygen content is lower, the fish grows worse, uses food less productively, and reduces its physiological activity. Falling oxygen below the allowable level is strong stress, which is often followed by certain diseases. At high water temperatures, algae in the reservoir decompose, absorbing large amounts of oxygen. In addition, if the water temperature changes sharply from the bottom of the reservoir, hydrogen sulfide rises. This phenomenon caused an environmental disaster in a pond near the town of Lyubotyn.

Rising air temperatures, especially in summer, lead to disturbances in the oxygen regime, so identifying trends in climate change is an extremely important task.

Analysis of meteorological observations over the past 60 years shows that the climate of the Kharkiv region is currently in a state of change, largely due to natural factors, as well as anthropogenic pressure on the environment. These changes lead to extreme meteorological and climatic phenomena, and as a consequence - to unfavorable conditions for human life and activity, violation of the ecological stability of natural ecosystems [6].

Analysis of the dynamics of air temperature showed that in general over the past 60 years there is a tendency to a slight increase in average annual temperatures.

Only one cold year has been observed in the last 30 years. The deviation of the average annual temperature from the average long-term indicator was 2.4ºC. Thus, we can predict that while maintaining the trend of rising air temperature in the north of Kharkiv region will be drier, and in the south wetter.

Observations of the average annual temperature in the Kharkiv region according to the State Committee for Hydrometeorological Service from 1969 to 2016 and the construction of a forecast model showed that climate warming is expected to be 1.9^0 from 7.8^0 to 9.7^0 in 2020. [7].

Observations of the average annual precipitation in the Kharkiv region according to the State Committee for Hydrometeorological Service from 1969 to 2016 and the construction of the forecast model showed that a slight decrease in precipitation from 523 mm in 1969 to 504.8 mm in 2022 [7].

Studies of the volume of runoff of the Oskil River for the period from 1924 to 2014 showed its significant variability, and according to the forecast model by the Holt-Winters method in 2024 is expected to be 613.8 million m^3, which is much less than the average volume for the years studied (1159.7 million m^3) [7].

The events of recent years indicate that many reservoirs in the Kharkiv region have an emergency situation due to fish deaths, which requires urgent research and clarification of the causes of this phenomenon. Therefore, the research presented in the scientific work of the impact of climate change within the Kharkiv region on the ecological status of the Oskil River is very important for the prevention of further emergencies in ecological bodies on water bodies.

Not all influencing factors are the same in their importance, their combination acts differently on individual components and on the ecosystem as a whole.

Therefore, in addition to the qualitative assessment of the state of the studied water body, which is primarily affected by anthropogenic activity, it is also extremely important to take into account climatic and other natural factors.

This will allow a more objective assessment of the ecological status of surface waters and therefore more accurately identify priority issues and trends in the future, to plan long-term environmental measures.

In many cases, the effective feature is influenced not by one but by several factors. There are complex relationships between factors, so their impact on the performance trait with a complex, not just the sum of isolated influences.

Multifactor correlation-regression analysis makes it possible to assess the degree of influence on the studied performance of each of the factors introduced into the model at a fixed position at the average level of other factors. An important condition is the lack of functional connection between the factors.

The correlation index estimates the bond density. He, like the empirical correlation, measures only the density of the connection and does not indicate its direction.

From the given table 1 it can be concluded that the quality of the Oskil River is most affected by wastewater discharges and an increase in the average annual temperature. This means that when developing measures to improve the quality of the Oskil river basin, it is necessary to pay attention to reducing wastewater discharges.

Table 1

Influence of natural and anthropogenic factors on the quality of the Oskil River [7]

Name of the substance	Correlation coefficients		
	Wastewater discharges, million m^3	the average annual temperature	Annual precipitation, mm
Soluble oxygen, mg O_2/ l	0,76	0,42	
Petroleum products, mg / l	0,5		
Manganese, mg / l	0,69		
BIA_5, mg / l	0,62		
Zinc, mg / l	0,43	0,53	
Total chromium, mg / l			0,46

The constructed regression and correlation dependences allow to estimate the state of surface waters more objectively, therefore to define priority problems more precisely, and also to reveal time periods of various degrees of influence.

The Oskil River Basin is of cross-border importance, as it flows within two countries - Russia and Ukraine, so the assessment of the ecological status of watercourses in the basin is a very important task.

Climate change affects the hydrochemical and hydrological regimes of water bodies, which is an important cause of mass fish deaths. Mass death of fish is one of the indicators that is most important in the event of an emergency on a water body and demonstrates the disadvantages of the aquatic ecosystem and threats to commercial water use.

The events of last years indicate that many reservoirs in the Kharkiv region have an emergency situation due to fish deaths, which requires urgent research and clarification of the causes of this phenomenon. Therefore, the research presented in the scientific work of the impact of climate change within the Kharkiv region on the ecological status of the Oskil River is very relevant for the prevention of further environmental emergencies on water bodies.

The constructed regression and correlation dependences are aimed at comparing the influencing factors and establishing a more accurate ecological state of the selected river, which is very relevant especially given the global climate changes such as rising average temperatures.

Determination of significant factors influencing the quality of surface waters of the Oskil River on the basis of multifactor correlation - regression analysis showed that the greatest influence of wastewater discharges and average annual temperature. Analysis of water use in the Oskil river basin showed that between 1986 and 2014 wastewater discharge decreased more than 6 times, but many indicators of river quality do not meet the maximum allowable concentrations for fishery water use as according to monitoring data for 2015, modal indicators from 1977 to 2015, and forecasts for 2025.

REFERENCES:

1. Rybalova, O.V. Analiz prychyn vynyknennia nadzvychainykh sytuatsii masovoi zahybeli ryby v Kharkivskii oblasti [Tekst] / O.V. Rybalova, S.V. Bielan.,// Vostochno-Evropeiskyi zhurnal peredovыkh tekhnolohyi – Kharkov, 2012. – № 6/10 (60). – S. 17-21

2. Romanenko V.D,, Zhukynskyi V.M., Oksikiuk O.P. ta in. Metodyka vstanovlennia i vykorystannia ekolohichnykh normatyviv yakosti poverkhnevykh vod sushi ta estuariiv Ukrainy – K., 2001. – 48s.

3. Vodna Ramkova Dyrektyva YeS 2000/60/ES. Osnovni terminy ta yikh vyznachennia. EU Water Framework Directive 2000/60/EC. Definitions of Main Terms. – Kyiv, 2006. – 240 s

4. Metodyka ekolohichnoi otsinky yakosti poverkhnevykh vod za vidpovidnymy katehoriiamy [Elektronnii resurs]: proekt / A. V. Hrytsenko, O. H. Vasenko, H. A. Vernichenko [ta in.]. – Rezhym dostupu: http://www. niiep. kharkov. ua/sites/default/files/metodika_2012_14_0. doc

5. Intehralni ta kompleksni otsinky stanu navkolyshnoho pryrodnoho seredovyshcha: monohrafiia /O.H. Vasenko, O.V. Rybalova, S.R. Artemiev i dr. – Kh.: NUHZU, 2015. – 419 p

6. Rybalova O. V. Vyznachennia vplyvu pryrodnykh umov na ekolohichnyi stan richky Oskil [Tekst] / O. V. Rybalova, H.V. Korobkova // Materials of the XII International scientific and practical conference, "Science and civilization". – 2016. Volume 16.– P, 37 – 40

7. Vasenko O. H. Analiz znachymykh faktoriv vplyvu na yakisnyi stan vod richky Oskil (Ukraina) / O. H. Vasenko, O. V. Rybalova, O. V. Kozlovska // Vostochno-Evropeiskyi zhurnal peredovыkh tekhnolohyi. — 2016. — № 3/10 (81). — S. 48-55