



MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

V. N. Karazin Kharkiv National University

# **ECOLOGY IS A PRIORITY**

**Proceedings of the English-Language  
Scientific Conference**

**Kharkiv – 2020**



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V. N. KARAZIN KHARKIV NATIONAL UNIVERSITY

# **Ecology is a priority**

Proceedings of the English-Language Scientific Conference

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*Under the General Editorship of  
N. V. Maksymenko, DSc (Geography), Prof.,  
English Language Supervisor N. I. Cherkashyna*

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The publications contain the proceedings which address the modern ecological state of environment and ecological problems in different regions of Ukraine and other countries and also ways of their solution.

Видання містить матеріали, які стосуються сучасного екологічного стану довкілля та екологічних проблем у різних регіонах України та інших країн, а також шляхи їх вирішення.

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N. I. Cherkashyna English Language Supervisor



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<b>Kartseva V. V.</b> ATMOSPHERIC AIR CONDITION IN KHARKIV.....	27
<b>Kobets.T. A., Honcharova A. E.</b> LARGE-SCALE MAPPING OF MEADOW PLANT COMMUNITIES OF SLOBOZHANSKY NATIONAL NATURE PARK USING MOBILE GIS.....	30
<b>Komarov A. K.</b> IMPACT OF DERGACHI LANDFILL ON UNDERGROUND WATER QUALITY.....	33
<b>Krotko A. S., Lydina V. I.</b> ASSESSMENT OF ATMOSPHERIC AIR POLLUTION IN THE CITY OF KHARKIV BY CARBON OXIDE.....	36
<b>Larionova A. M.</b> ACCOUNTING THE EUROPEAN BEAVER IN NNP «SLOBOZHANSKYI»: EXPERIENCE IN PARTICIPATING IN THE EVENT.....	38
<b>Lobachik A.</b> ECOLOGICAL PROBLEMS OF KHERSON REGION AND THEIR EFFECTS ON ECO-TOURISM DEVELOPMENT.....	41
<b>Lobzenko A. P.</b> BIODIVERSITY LOSS.....	44
<b>Maksimov O. M., Shevchyk K. V.</b> PECULIARITIES OF THE HUMAN BUCCAL EPITHELIUM CELLS REACTION ON THE CHEMICAL COMPOUNDS EFFECT.....	47
<b>Mishchenko V. Y.</b> DEVELOPMENT AND EFFICIENCY OF PHYTOREMEDIATION METHODS FOR AGRICULTURAL PURPOSES OF POLLUTED PESTICIDES.....	50
<b>Mishina V. O.</b> MODELING OF OPERATIONAL CONTROL OF THE OXYGEN REGIME OF THE AQUATIC ECOSYSTEM IN THE CONDITIONS OF THE DNIEPER BASIN.....	54
<b>Myshkin K. K.</b> ENVIRONMENTAL QUALITY OF TOBACCO PAPER.....	58

**Mishina V. O.**, *student*

National University of Civil Defence of Ukraine

**Ponomarenko R. V.**, *PhD, Senior Researcher*

## **MODELING OF OPERATIONAL CONTROL OF THE OXYGEN REGIME OF THE AQUATIC ECOSYSTEM IN THE CONDITIONS OF THE DNIEPER BASIN**

**Abstract.** The article investigates the adequacy of the mathematical model of oxygen regime prediction in the Dnieper basin, based on the classic Streiter-Phelps model. Retrospective analysis of the Dnieper oxygen parameters with further verification of the Streiter-Phelps model adequacy for the Dnieper basin conditions was used. The mathematical model of the dynamics of the integral indices of the ecological state of the reservoir (the Streiter-Phelps model) has been improved by supplementing the corrective coefficients, which allows predicting with sufficient accuracy the change of the Dnieper ecological state.

**Keywords:** Dnieper basin, ecological state, anthropogenic load, quality assessment, quality forecast.

Continuous human activity constantly leads to a deterioration of water quality and environmental flow of river runoff. The issue of protecting river basins, and in particular their rational use, is the most pressing issue of today, directly related to the health of the nation as a whole.

The issue of real-time water quality is of paramount importance. Systematic analysis of the current environmental state of the Dnieper basin and the organization of management and protection of its water resources allows to identify a number of the most urgent problems that need to be addressed.

It is difficult to overestimate the importance of the Dnieper basin waters in providing Ukraine's water resources, since almost 80 % of the economic water supply in Ukraine, which accounts for two thirds of the country's population of about 30 million people, belongs to the Dnieper waters. On its shores are located more than fifty major cities and industrial centers, in particular the capital of Ukraine – Kiev, which determines its national significance for the country [1].

In [1,2] the main characteristics of the Dnieper basin that determine its ecological state were considered. A retrospective analysis of the water quality of the Dnipro River was carried out according to the monitoring demand of Ukraine's water resources over the last 10 years (difference of total anion content,  $\text{PO}_4^{3-}$  phosphate ions,  $\text{NH}_4^+$  ammonium ions, biochemical oxygen demand ( $\text{BOD}_5$ ) ratio to dissolved oxygen (DO) concentration), and possible causes of surface water quality change were identified.

Based on the analysis [1,2], the aquatic ecosystem of the Dnieper River, as the main aquatic artery of Ukraine, being under constant technogenic influence, tends to permanently and steadily deteriorate its ecological state.

In the future, changing the ecological state of the surface waters of the Dnieper basin in the direction of its improvement cannot occur without the development and implementation of a reliable and effective model for predicting its ecological state.

The solution to the complex problem of the Dnieper basin environmental rehabilitation should be taken to a new level in accordance with the radical changes in the nature of nature management and development strategy of the country's economy, and only by developing a national program of restoration of its ecological state.

Today, substantive reviews on the prediction and analysis of dissolved oxygen content and biochemical oxygen demand are reported in [3].

Two-component predictive models of the ecological state of water have become quite widespread, where the processes of formation of water quality are estimated by the demand of oxygen (processes of biochemical oxidation of organic compounds) and its receipt (the process of atmospheric aeration).

Some differences are noted in the prediction of water quality: a return to classic models in which the concentration of dissolved oxygen is a function of the decay of dissolved organic matter and natural processes (atmospheric aeration). The DO-BOD relationship is described by the classic Streeter-Phelps model, whose equations of processes based on first-order kinetics assumptions were analytically solved by Phelps and Streeter for a river section, and are now quite widely used in calculations.

Meaning that, it is advisable to determine the adequacy of the mathematical model for the prediction of oxygen regime conditions in the Dnieper basin on the basis of the classic Streeter-Phelps model, taking into account the data of a retrospective analysis of its oxygen indices.

The purpose of the article is to determine the adequacy of the predictive mathematical model for predicting oxygen regime (BOD and DO) in the Dnieper basin on the basis of the classic Streeter-Phelps model.

To achieve this goal, it is necessary to solve the following problems:

- carrying out a retrospective analysis of the data of oxygen indicators of the Dnieper;
- verification of the adequacy of the Streeter-Phelps model for the conditions of the Dnieper basin.

A retrospective analysis of the water quality was carried out according to the water sampling samples of the Dnipro River within the Basin Water Resources Management Department for 12 posts [3].





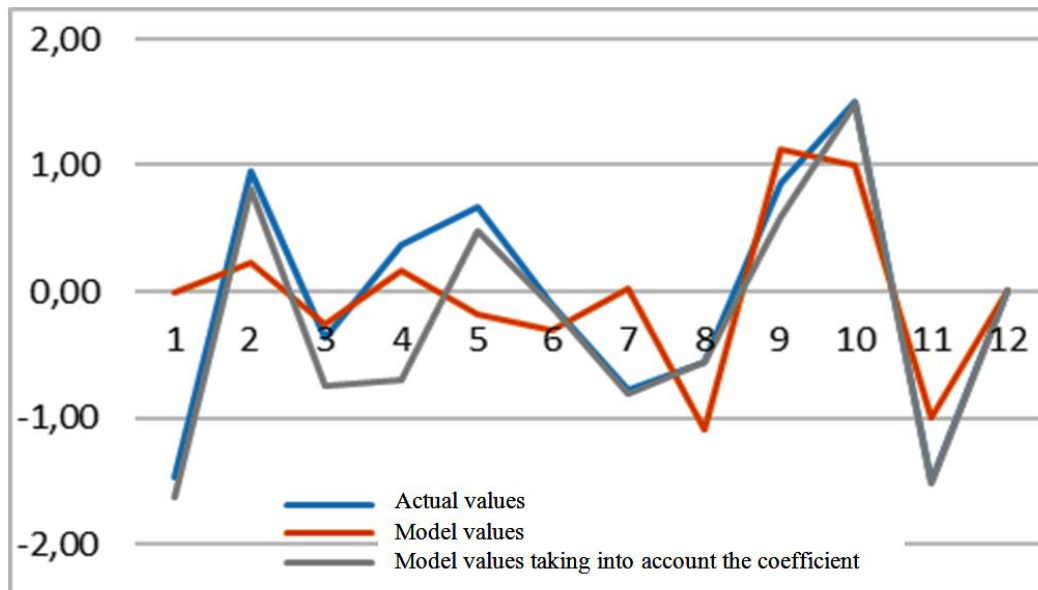


Fig. 2. Dynamics of simulated and actual (2018) dissolved oxygen values (mg/dm<sup>3</sup>).

in the BOD<sub>5</sub> and DO indicators in the Dnieper water was performed according to 12 sampling posts. Trends in the deterioration of the oxygen regime of the river have been identified – a decrease in the concentration of dissolved oxygen and an increase in BOD<sub>5</sub> by annual average. This can be explained by the increase in anthropogenic load on the reservoir pool. The mathematical model of the dynamics of the integral indices of the ecological state of the reservoir (the Streeter-Phelps model) has been improved by supplementing the corrective coefficients, which allows to predict with sufficient accuracy the change of the ecological state of the surface source, including in the conditions of the water ecosystem of the Dnieper basin. The parameters  $k_1$  (coefficient of biochemical oxidation of organic substances) and  $k_2$  (coefficient of reaeration) of the Streeter-Phelps model for the water conditions of the Dnieper basin were calculated.

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Наукове видання

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