DOI https://doi.org/10.30525/978-9934-26-340-8-13

RESOURCE OPTIMIZATION AS A BASIS FOR INCREASING THE EFFICIENCY OF IRRIGATION SYSTEMS FUNCTIONING IN MODERN CHANGING CONDITIONS AND REQUIREMENTS

РЕСУРСНА ОПТИМІЗАЦІЯ ЯК ОСНОВА ПІДВИЩЕННЯ ЕФЕКТИВНОСТІ ФУНКЦІОНУВАННЯ ЗРОШУВАЛЬНИХ СИСТЕМ У СУЧАСНИХ ЗМІННИХ УМОВАХ ТА ВИМОГАХ

Prykhodko N. V.
Candidate of Technical Sciences, Associate Professor at the Department of Water Engineering and Water Technologies
National University of Water and Environmental Engineering
Rivne, Ukraine

Приходько Н. В.
кандидат технічних наук, доцент кафедри водної інженерії та водних технологій,
Національний університет водного господарства та природокористування,
м. Рівне, Україна

Rokochynskyi A. M.
Doctor of Technical Sciences, Professor, Professor at the Department of Water Engineering and Water Technologies
National University of Water and Environmental Engineering
Rivne, Ukraine

Рокочинський А. М.
доктор технічних наук, професор, професор кафедри водної інженерії та водних технологій,
Національний університет водного господарства та природокористування
м. Рівне, Україна

Modern changing conditions and requirements related to global food, water and energy crises, which are exacerbated by threatening climate changes, demand the need to increase the efficiency of agricultural production in Ukraine, primarily on reclaimed lands, which are kinds of guarantee fund for food security in our country and beyond. Russia's war against Ukraine showed how much our agricultural production affects the food security not only of Europe, but also of the whole world. And under such conditions, the unused potential of reclaimed land can be the key to obtaining stable and high yields.

On the way to this, we already had a program to restore land reclamation in Ukraine, which was designed to be implemented in peacetime. This is the Irrigation and Drainage Strategy in Ukraine for the period up to 2030 [1], one of the priority tasks of which is to increase the potential of irrigation and drainage, which involves in particular, the need to increase the overall technical, technological, economic and ecological efficiency of the

functioning of existing irrigation systems in accordance with changing modern conditions and requirements.

Modern changes in the operating conditions of irrigation systems lead to the need for changes in methodological approaches to their creation and design, which should be based on a resource approach. Therefore, the methods of creating and functioning of irrigation systems should provide for the optimization of project decision-making based on taking into account indicators of the technical, ecological, and economic efficiency of the irrigation system, which at this stage meets modern conditions and requirements.

Therefore, new methodological approaches to the creation and functioning of irrigation systems, improvement of regime-technological aspects of irrigation, types, design and parameters of irrigation systems adapted to these changes should be based not only on the evaluation of the effectiveness of the adopted technical decisions, but also take into account the real conditions of object functioning, the level and direction of agricultural production, as well as the amount of resources spent to ensure it.

As is known, irrigation is one of the most water- and energy-consuming branches of agriculture, which directly affects the economic and ecological effect of its implementation. At the same time, during the implementation of agricultural production on irrigated lands, in addition to the main ones – water and energy, this process involves a large number of other types of resources, such as land, human and others.

In this regard, the methodology should be based on resource optimization, the basis of which is the minimization of the use of water and energy resources with the maximum effect from agricultural production, namely the rational use of resources with the maximum economic result. The complexity of such methodology lies in the need to take into account resources of different nature – water and electricity, which, in turn, are interconnected and mutually determining in their parameters.

At the same time, it is possible to achieve savings of the specified resources by developing and implementing appropriate resource-saving regime and technological measures, primarily related to the improvement of crop irrigation regimes and water supply regimes to the irrigation system and its structural elements [2; 3; 4].

In the development of our earlier studies, the substantiation of optimal solutions in the projects of construction, reconstruction and functioning of irrigation systems, as complex natural-technical ecological-economic systems, with this approach, can be performed according to a complex optimization model [5], which in a general implicit form is the following

$$\begin{cases} U_0 = \underset{\{i\}}{extr}\, U_i, i = \overline{1, n_i}; \\ R_{0j} = \min\limits_{\{i\}} \left| R_{ji} - \widehat{R}_j \right|, j = \overline{1, n_j}; i = \overline{1, n_i}, \end{cases}$$

where U_o – extreme value according to the accepted condition of the chosen criterion of economic optimality U, which corresponds to the optimal technical and technological solution according to the set of possible options

$$I = \{i\}, \; i = \overline{1, n_i}; \; R_{ji} - \text{a set} \; \{j\}, \; j = \overline{1, n_j}$$

of resource use criteria for the relevant technical and technological solution options; $\widehat{R}_j$ – relevant reasonable indicators of the level of use of this resource.

The system of equations in a general implicit form allows, on the basis of resource optimization, to theoretically justify the possibility of setting a problem, searching, and consistently determining optimal regime, technological and technical solutions for heterogeneous constituent elements and the system as a whole in their relationship both empirically and empirically-functionally level of equal definition of the dependence between them.

Thus, modern conditions and requirements for conducting agricultural production make it necessary to change approaches to project decision-making in projects of construction, reconstruction and functioning of irrigation systems based on resource optimization, the purpose of which is to optimize the consumption of water and energy resources per unit of agricultural production, which will ensure an increase in the economic and ecological efficiency of the functioning of irrigation systems in accordance with modern conditions and requirements and the efficiency of agricultural production on irrigated lands as a whole.

Bibliography:

1. Стратегія зрошення та дренажу в Україні на період до 2030 року. URL: http://surl.li/kiffo (date of request 20.08.2023).

2. Kovalenko P., Rokochynskiy A., Gerasimov, I., Volk P., Prykhodko N., Tykhenko R., Openko I. Assessment of the energy and overall efficiency of the closed irrigation network of irrigation systems on the basis of the complex of resource-saving measures. *Journal of Water and Land Development*. 2022. Special Issue. Pp. 15–23. DOI: 10.24425/jwld.2022.143717.

3. Рисові зрошувальні системи України: підвищення ефективності їх функціонування : колективна монографія / за ред. д.т.н., проф., акад.

НААН Сташука В. А., д.с.-г.н., проф., акад. НААН Вожегової Р. А., д.т.н., проф. Рокочинського А. М. Київ-Херсон-Рівне : НУВГП, 2023. 422 с. https://ep3.nuwm.edu.ua/25344/

4. Науково-практичні засади підвищення енергоефективності закритих зрошувальних систем : монографія / Є. Г. Герасімов, Н. В. Приходько, А. М. Рокочинський; за загальною редакцією академіка НААН України В. А. Сташука. [Електронне видання]. Рівне : НУВГП, 2023. 288 с. ISBN: 978-966-327-552-9 https://ep3.nuwm.edu.ua/26293/

5. Рокочинський А. М. Наукові та практичні аспекти оптимізації водорегулювання осушуваних земель на еколого-економічних засадах: монографія. Рівне : НУВГП, 2010. 351 с.