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SUBSTANTIATION OF MELIORATIVE MODES AT CLOSE-MELTING OF WEAKLY MINERALIZED SOIL WATERS

[1]Ozatboy Bazarovich Imamnazarov, [2]Tokhirjon Olimovich Kasimov, [2]Sherzod Ergashalievich Khaidarov, [3]Muhammadali Rustamjonovich Abdullaev, [3]Sardor Salokhidinovich Sultonov

[1]Associate Professor, Candidate of Technical Sciences, Namangan Civil Engineering Institute, Uzbekistan
[2]Senior Lecturer, Namangan Civil Engineering Institute, Uzbekistan
[3]Lecturer, Namangan Civil Engineering Institute, Uzbekistan
ozodbekimomnazarov@gmail.com

Abstract.

Issues of optimization of the reclamation regime have been considered by many scientists. The article presents the scientific and technical issues of optimizing the reclamation regime developed by different scientists and presents the results of experimental studies conducted by the authors of the article. Based on the experimental studies, a formula for calculating the optimal drainage rate depending on the load on the vertical drainage for the conditions of the right-bank flood plain terraces of the Syr-Darya River is derived.

Keywords: *optimization of the reclamation regime, equation for changing cotton yield, groundwater depth, optimal drainage rate, drainage load.*

INTRODUCTION

Environmental problems associated with the use of water resources and the need to intensify agricultural production require the development of the latest land reclamation methods and methods to combat salinization, regulation of the water-salt regime of irrigated lands providing the most rational and efficient use of irrigation water and irrigated lands. In this regard, the regulation of groundwater regime with the help of irrigation and drainage systems with the aim of creating an optimal reclamation regime is of great importance. The need to solve this problem for conditions of land reclamation-unfavorable lands with a close occurrence of weakly mineralized groundwater is due to their wide distribution, both in the research zone and beyond. The area of such lands in the Ferghana Valley is 230 thousand hectares, including about 40 thousand hectares in the Namangan region of the Republic of Uzbekistan.

We chose irrigated lands located on the right-bank floodplain terrace of the Syr-Darya River as our research zone. By administrative separation, these irrigated lands belong to the territory of Namangan region.

Practice has shown that in order to apply the critical depth of the icritical regime, it is necessary to establish new forms of relationships and take into account the influence of a large number of factors, including climatic conditions of the year, soil and soil categories, the degree and nature of their salinization, the composition of crops grown, irrigation regime, etc.

So, instead of physical constants, a quantity is determined that is suitable only for that section and those specific conditions where it is observed.

Considering the above considerations, N.M. Reshetkina introduced the concept of "reclamation regime", which, under irrigation, chemicalization, high agricultural technology and other measures, will not only maintain natural soil fertility, but also ensure its steady increase and maximum crop yields at the lowest cost of water and labor [1].

MATERIALS AND METHODS

Subsequently, N.M. Reshetkina and Kh.I. Yakubov identified four reclamation regimes: hydromorphic - with a groundwater depth of I ... 2 m, semi-hydromorphic - 2 ... 3 m, subauthoric - 3

... 8m, automorphic - 8. ..I0m. They pointed out that the landscape-zonal, hydrogeological-soil-meliorative principle should be the basis for choosing the optimal meliorative regime [2].

A.A. Rachinsky, supporting and developing the concept of ameliorative regime, later on possible modes, began to divide into three: gray-earth, gray-meadow and meadow. At the same time, he believes that the third regime cannot be attributed to optimal [3]. Depending on the natural and irrigation-economic conditions, D.M.Kats divides the reclamation regimes into the following types: automorphic - with a depth of groundwater more than 5 m, semi-automorphic when the groundwater level is at a depth of 3-5 m and hydromorphic - when groundwater water at a depth of less than 2-3 m or less than 1.5-3 m, depending on the capillary properties of soils and parent rocks. Under the optimal reclamation regime, he understands such a regime of groundwater and the associated water-salt regime of soils, which, forming under conditions of high natural drainage of the land or under the influence of the interaction of natural factors, irrigation and drainage, provide a stable favorable reclamation state of the land [4]. I.P. Aydarov and E.K. Karimov believe that the reclamation regime should ensure minimal moisture exchange with groundwater, which is created at depths of groundwater in the range of 0.8 ... 1.5 capillary heights th rise. They recommend as a criterion of optimization to take the reduced costs calculated by the formula:

$$З_i = (C_i^0 + \mathrm{E}_n \mathrm{K}_i^0) + (C_i^\partial + \mathrm{E}_n \mathrm{K}_i^\partial)$$

where C_i^0 - current costs (annual costs) for the maintenance and operation of the irrigation network, the production of irrigation, taking into account the cost of irrigation water according to the i-th version of the reclamation regime; C_i^∂ - current costs (annual costs) for the maintenance and operation of the collector-drainage network; K_i^0, K_i^∂ - one-time costs (capital investments) for the i-th option of the construction of an irrigation and collector-drainage network; E_n - normative coefficient of capital investment efficiency (E_n =0,12) [5].

Based on the research results, I.P Aidarov made the following conclusion: when substantiating the optimal reclamation regime of irrigated lands and the volume of water intake into the system during the design of irrigation systems on saline or saline-prone lands, it is necessary to take the one that provides the required regime with the lowest cost as the estimated groundwater depth [5].

The methodology for establishing the parameters of reclamation regimes based on the analysis of water and salt balances and a number of theoretical principles Averyanova proposed L.M. Rex [6]. A.I.Golovanov believes that for most areas prone to salinization, the optimal mode is semi-automorphic. He recommends taking the average annual depth of groundwater intake at 0.9 ... 1.0 of the height of the capillary rise [7].

V.A. Dukhovny, M.B. Baklushinand others noted that the correct choice of the type of reclamation regime is essential: it reduces pollution of return water, it allows not only to minimize water consumption for reclamation purposes, but also to improve the quality of river water. By the optimal reclamation regime, they understand such a combination of irrigation and drainage, in which the salinization and constant increase in the natural fertility of the irrigated lands is ensured at the minimum cost of irrigation water per unit of crop. And they give the main characteristics of reclamation regimes, which are characterized not by the depth of the groundwater, but by quantitative indicators of nutrition from groundwater during reclamation measures. If evaporation from groundwater is 3 ... 7 m3 / ha, the reclamation regime is hydromorphic, 1.5 ... 3 thousand m3 / ha semi-hydromorphic, 0 ... 1.5 thousand m3 / ha semi-automorphic modes [8].

V.A. Dukhovnyproposes to make a selection of the reclamation regime at the minimum cost of investment:

$$C_d + MK_b \rightarrow \min$$

WhereC_d-cost of drainage depending on the intensity of drainage;M - reclamation share; K_b - investment cost per I m^3 of pool water [9].

A.U. Usmanov describes the reclamation regime as “a multifactorial process determined by the development of water, salt, food, air and thermal regimes of soils in natural conditions under the influence of factors of the engineering and land reclamation complex". Based on an analysis of the existing classifications of reclamation regimes and the results of research by many scientists, he suggested that each reclamation regime highlight its reclamation regimes. For example, four modes were proposed for Central Asia: automorphic with a groundwater depth of more than 4 m, semi-automorphic - 3 ... 4 m, semi-hydromorphic 2 ... 3 m, hydromorphic - I ... 2 m. Under the optimal reclamation regime A.U. Usmanov understands the multifactorial process, which allows to ensure a consistently high productivity of irrigated agriculture without disturbing the environmental conditions at the minimum cost of material resources per unit of output. He considers the criterion of optimality of the reclamation regime to be the minimum total reduced costs for the construction and operation of irrigation and collector-drainage systems and additionally saved water per complex hectare [10].

A. Khakimov was engaged in the development of reclamation regimes of irrigated lands of the saz zone of the Ferghana Valley. He notes that the development of reclamation regimes of irrigated lands is closely related to the solution of issues of integrated regulation of the main environmental factors and should include:

- making a forecast of the water regime of soils and justification of ways to regulate groundwater, type and parameters of drainage;
- making a forecast of the salt regime of irrigated lands, taking into account changes in the level of groundwater and the use of underground water for irrigation, analysis of possible changes in the properties and fertility of soils and justification of measures to prevent them;
- substantiation of the most rational reclamation regime of the irrigated lands of the gas zone based on engineering and technical and economic calculations.

He made the selection of the reclamation regime of the irrigated lands of the Saz zone on the basis of technical and economic calculations, taking into account not only the receipt of additional water resources and capital expenditures for the reconstruction of the reclamation system, but also measures to preserve soil fertility. As a criterion for optimization, the specific reduced costs are taken:

$$\sum З_i = \frac{EK_i + C_i}{Y_i} \to \min$$

whereE– normative coefficient of efficiency of capital humidity (E=0,12). $K_i$andC_i – capital investments and annual costs; Y_i- the yield of the main crop, depending on the level of groundwater and the uniformity of lowering the level of groundwater [11].

Under the optimization of reclamation regimes F.M. Rakhimbaev and G.K.Gasanova understand the purposeful change in the parameters of irrigation and groundwater regimes in order to create favorable reclamation conditions that ensure desalinization of the land or the stability of water-salt processes on non-saline lands, at the lowest cost of water, material means and labor. By "optimal reclamation regime" they mean a controlled combination of irrigation and drainage that provides a stable water-salt regime (or regime of desalinization in the transition period) and contributes to increasing soil fertility while maximizing the efficiency of investments in the reconstruction of irrigation and drainage systems and the comprehensive reconstruction of old irrigated lands.

F.M.Rakhimbaev and G.K.Gasanova proposed a formula for determining the value of the optimal groundwater depth:

$$H_0 = \varphi(1 + 0{,}5\lg M_{гр})\sqrt[3]{M_{ор}}\,\frac{\ln H_m(L_m + \lambda \lg L_m)}{\rho(1 + 0{,}2\lg H_m)L_m} - 0{,}1\lg T + \frac{\nu\Delta h}{\ln m_b}$$

where $M_{гр}$ - groundwater salinity; $M_{ор}$ - mineralization of irrigation water, with the growth of which an increase in irrigation norms is required; H_m - the existing average depth of inter-farm collectors within the irrigated zone that received water from on-farm drainage systems, which determines the possibility of deepening drains without reconstruction; L_m - specific length of inter-farm collectors and discharges; T- conductivity of aquifers to relative confinement;Δh- the difference between the piezometric pressure in the underlying reservoirs and the level of groundwater in the cover fine earth; m_b - thickness of fine-grained cover sediments. λ, ν - coefficients that are close to unity in value and compensate for the mismatch of the differences in the dependency members;φ - coefficient taking into account environmental conditions (soil-climatic, engineering-geological, hydrogeological); ρ - coefficient taking into account the complexity of the reconstruction of inter-farm main collectors [12].

The need for intensification of agriculture, nature conservation and the large size of reclaimed territories led to the need to rethink the modern goal of land reclamation and the approach to justifying their composition.

According to I.P. Aydarov, A.I. Golovanov and Yu.N. Nikolsky, the aim of land reclamation and agriculture in reclaimed areas should not only be to increase agricultural production, but also to preserve and improve soil fertility, subject to the rational use of water resources and protection nature.

To achieve this goal, in their opinion, it is necessary to evaluate the work of irrigation and drainage systems not only by soil moisture and how “comfortable” it is for plants, but also by a set of indicators that can be expressed as requirements for regulated factors of soil formation and plant development. They called this set of indicators the reclamation regime.

In the arid zone, the reclamation regime can be favorable when, as a result of proper irrigation and drainage of the land and the implementation of all measures included in the farming system, an increase in productivity and soil fertility is observed.

Based on the foregoing, the concept of the optimal reclamation regime can be formulated as follows: the optimal reclamation regime is the optimal combination of factors for the formation of the reclamation regime in specific natural conditions against irrigation and drainage systems that provide a minimum ratio of reduced costs per unit cost of additional products received from I ha. When calculating the ratio of reduced costs per unit cost of additional products, capital and operating costs, agricultural costs, crop productivity and environmental protection costs should be taken into account [13].

The classification of hydro geologists according to the conditions for the use of drainage, based only on hydrogeological principles (lithological section and the quality of pumped water), cannot be the basis for choosing the type of drainage in the conditions of the object of study. An integrated approach to assessing the conditions for the use of drainage from reclamation positions is required.

In the research area in the 40s, open-type collector-drainage networks were built to drain the land. Which are currently working. Our studies on the effectiveness of existing CDS have shown that they work inefficiently. This is revealed in a decrease in crop yields and worsening conditions for the mechanization of agricultural work (the proximity of UGB to the surface of the earth). In each year, 25 ... 30% of the yield due to decline, 10 ... 15% due to the deterioration of the mechanization of agricultural work are lost.

One of the main reasons for the unsatisfactory operation of existing water supply systems is sub-pressure water. Even after mechanized cleaning of drains and collectors, the water level drops slightly.

Calculations of water balance elements showed that the average vegetation drainage module at the OUKMI is 0.86 l / s / ha [14].

At OUKMI, the main article of the water balance determining the regime of groundwater is the underground inflow: horizontal and vertical.

The water content of the underlying sediments is 6900 ... 7800 m2 / day. The thickness of the cover deposits varies from 0.5 to 3.0 m (according to the mechanical composition of the sandy loam and loam).

Based on the analysis of hydrogeological, soil-reclamation and economic conditions of the research object, it can be concluded that the regulation of the groundwater regime and the creation of an optimal reclamation regime can be carried out using vertical drainage.

The design scheme for vertical drainage is a two-layer thickness of a single-layer system. The aquifer filtration coefficient is 26 m / day. The depth and flow rate of a vertical well are 25 m and 50 l / s, respectively.

On the correlation curve of the cotton yield that we derived on the basis of field studies, three characteristic points can be distinguished: the first, where the yield reaches maximum values; the second, where the yield begins to stabilize; the third is a point symmetrical to the point at which stabilization begins. And the optimality of the reclamation regime is determined relative to these points, i.e. depths of occurrence GB.

The values of irrigation norms, groundwater recharge, and evapotranspiration were determined based on the forecast of the water regime of soils.

Under the conditions of the object of research, the main method is to water the surface - irrigation along the furrows. Elements of irrigation technique when substantiating optimal reclamation regimes were assigned depending on the slope of the earth's surface and the water permeability of the soil according to the recommendations of N. F. Laktaev [15]. At the research object, the average slope of the earth's surface is 0.0005. And accordingly, he was assigned with a row spacing of 0.6 m the length of the furrows on light loamy soils of 250 m, and on medium loamy 350 m. Losses for infiltration during furrow irrigation depend on the soil mechanical composition.

RESULT AND DISCUSSION

The average cotton yield against a background of vertical drainage is determined by the following formulas derived by us based on field studies:

for light loamy soils

$$У_{ср}^{л} = \begin{cases} \dfrac{У_{л}^{\max} \int_{x_1}^{x_2} \left[\alpha \dfrac{h_{гв}^{Д}(x)}{H_k} - \beta \right] \left[\gamma - \dfrac{h_{гв}^{д}(x)}{H_k} \right] dx}{x_2 - x_1}, & \dfrac{h_{гв}(x)}{H_k} \prec 0,56 \\ \varphi У_{л}^{\max}, \dfrac{h_{гв}^{д}(x)}{H_k} \geq 0,56 \end{cases}$$

For medium loamy soils

$$У_{ср}^{с} = \begin{cases} \dfrac{У_{с}^{\max} \int_{x_1}^{x_2} \left[\beta + \alpha \dfrac{h_{гв}^{д}(x)}{H_к} \right] \left[\gamma - \dfrac{h_{гв}^{д}(x)}{H_к} \right] dx}{x_2 - x_1}, & \dfrac{h_{гв}^{д}(x)}{H_к} \prec 0 < 68 \\ \varphi У_{с}^{\max}, \dfrac{h_{гв}^{д}(x)}{H_к} \geq 0,68 \end{cases}$$

where $h^{д}_{гв}$- the depth of the dynamic groundwater level on the background of vertical drainage, which is determined by the following relationship:

$$h_{гв}^{д}(x) = (H_{ск} - h_0) - 43{,}2 \cdot 10^{-4} \frac{q_д R^2}{K a \alpha_0} (\ln \frac{x}{r_{ск}} - \frac{x^2}{2R^2})$$

where $H_{ск}$ - vertical well depth;h_o - the height of the water column in a vertical well when pumping water; $q_д$ - drainage module; R- radius of influence of a vertical well; K - coefficient of filtration of underlying sediments; α - immersion depth of a vertical well in an aquifer; α_o- coefficient taking into account the imperfection of a vertical well:

$$\alpha_0 = 1 + 5(r_{ck})^{1/2} \cos(\pi \alpha / m)$$

$r_{ск}$ - vertical well radius; m- aquifer thickness; x_1, x_2 - the distance from the vertical well to the boundaries of the plot against the background of vertical drainage, where the average estimated cotton yield is determined.

Various indicators can be used as a criterion for comparing options for the irrigation and drainage system in conjunction with a set of methods for “dry” land reclamation to ensure the soil reclamation regime. unit value of additional products obtained from 1 ha due to land reclamation. When determining the value of the optimum depth of groundwater uses isolate method recommended by a group of scientists: P.P.Aydarovym, A.N.Golovanovym and Yu.N.Nikolskim [13].

As a result of comparing various options for the construction of the irrigation and drainage system (trough irrigation network and vertical drainage), we choose the best one - the best option, which corresponds to the minimum indicator of reduced costs (3) for the installation of irrigation and drainage systems in order to create the optimal reclamation regime.

In the field of research, when designing an irrigation and drainage system, it is recommended that a gutter irrigation network of vertical drainage with water intake for irrigation be built. Gravity irrigation –by furrows. Soils - meadow series are light and medium loamy, non-saline. Fresh irrigation water. Groundwater salinity up to 2 g / l.

Comparison of the options for constructing an irrigation and drainage system with a minimum of indicator 3 showed that the optimal drainage rate depends on the load on the drainage. The larger the load on the drainage, the lower the optimal drainage rate. In turn, the value of the effective radius of influence depends on the value of the optimal drainage rate. The larger the value of the optimal rate of drainage, the greater the value of the effective radius of influence.

According to the calculations of comparing options for irrigation and drainage systems in order to determine the optimal drainage rate for given drainage loads, the regression equations were derived to calculate the optimal drainage rate depending on the value of the drainage load using the least squares method and the highest likelihood:

for light loamy soils

$$H_{н.о}^{опт} \quad 0{,}209\left(\frac{2{,}721 + g_{н.д}}{0{,}489 + g_{н.д}}\right) \; r = \pm 0{,}95$$

for medium loamy soils

$$H_{н.о}^{опт} = 0{,}257\left(\frac{2{,}308 + g_{н.д}}{0{,}463 + g_{н.д}}\right) \; r = \pm 0{,}96$$

where $g_{нд}$- load on drainage, l / s / ha; r –correlation coefficient.

Under the conditions of the object of study, with a drainage load of 0.86 l / s / ha, the optimal drainage rate for light loamy soils was 0.55 m, and for medium loamy soils 0.61 m. The following effective radii of influence correspond to these drying norms: on medium loamy 156m [16].

CONCLUSION

1. The focus of regulation of factors of the reclamation regime is ensured by irrigation and drainage systems in combination with agricultural activities. The latter affect the factors of the formation of the reclamation regime, but these impacts are not directed. Therefore, when substantiating the optimality of one or another reclamation regime, against the background of regularly conducted agro technical measures, irrigation and drainage systems act as the main means of controlling plant life factors and environmental processes.

2. When substantiating the reclamation regime, the main criterion for comparing options for the irrigation and drainage system is the ratio of the reduced costs per unit cost of additional products received from I ha due to reclamation. The above costs take into account capital and operating costs, agricultural costs, crop productivity and environmental costs.

3. The value of the optimal drainage rate against the background of vertical drainage depends on the magnitude of the load on the drainage. The greater the load on the drainage, the lower the drainage rate.The effective radius of influence of a vertical well is directly proportional to the optimal drainage rate, and the load on the drainage is inversely proportional.

4. A study of the dynamics of the salt regime of the active soil layer showed that during the growing season salts accumulate from spring to autumn. The coefficients of salt accumulation amounted to 1.6 ... 1.74. But during the non-vegetation period, desalination of the active soil layer occurs, which does not require irrigation of irrigated lands.

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