Substantiation of actual and forecast reclamation situation in assessing effectiveness of artificial drainage in irrigated areas in management of water resources

Bakhodirjon Amanov*

"Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National research University, Tashkent, Uzbekistan

Abstract. In the context of this work, when evaluating the effectiveness of artificial drains on irrigated lands in modern conditions, irrigation networks, reclamation regime, irrigation, salt washing, drainage, agricultural technology (not considered here), and land use in a specific composition and high flow rates, as well as one-dimensional differential equations that provide the necessary water-salt regimes by substantiating the actual and predicted reclamation state using the WASTER computer program. The amount of drainage is taken from the methodology of the water-salt balance of the Research Institute of Irrigation and Water Problems (RIIWP) and is set in the WASTER computer program. For example, artificial drainage was used on irrigated lands in the Pakhtakor district of the Jizzakh region. Irrigation regimes and rates are considered in 2 variants, considering drainage in the WASTER computer program for these areas. These models take into account the absorption of moisture and salts from the soil into the root layer of the plant, taking into account the work of artificial drainage in boundary conditions. The calculated criteria for each option are compared and analyzed. In addition, the volumetric moisture content and salinity are observed and analyzed in the layers. In addition, we considered the experiments and methods carried out by other scientists.

1 Introduction

In recent years, consistent reforms have been carried out in the country, aimed at increasing the efficiency of the use of land and water resources, improving water management systems, and modernizing and developing water management facilities.

*Corresponding author: bakhadirjonamanov@gmail.com

At the same time, the shortage of water resources is increasing from year to year due to global climate change, population growth, and economic sectors; their need for water is increasing yearly.

The average annual volume of water used was 51-53 billion cubic meters, including from rivers and streams at 97.2%, collector networks at 1.9%, and underground at 0.9%, which is 20% less than the established water intake limit.

To ensure sustainable water supply for the population and all sectors of the economy in 2020-2030, improve the reclamation of irrigated lands, widely introduce market principles and mechanisms and digital technologies in the water sector of Uzbekistan, ensure the reliable operation of the water sector facilities and increase land and water resources. An important step was the approval of the Concept for the Development of the Water Resources of the Republic of Uzbekistan for 2020-2030 by the Decree of the President of the Republic of Uzbekistan No. PF-6024 dated July 10, 2009, 2020 [1, 4, 5].

Predicting moisture and salinity migration in water-saturated and unsaturated zones of irrigated areas, groundwater levels, and irrigation regimes is also important.

2 Methods

To solve the problem of the Pakhtakor district of the Jizzakh region, we use the methods of Rex L.M. Yakirevich A.M. That is, the developed methods use a system of one-dimensional differential equations [3]. In these models, the plant absorbs moisture and salts from the soil in the root layer, considering the work of artificial drainage in boundary conditions. In addition, we considered the experiments [6-12] and methods carried out by other scientists [13-15].

The one-dimensional form of the equation looks like this:

$$\frac{\partial w}{\partial t} = \frac{\partial}{\partial x}\left[K(W)\frac{\partial н}{\partial x}\right] - e(w,x) \tag{1}$$

$$V = -K(W)\frac{\partial н}{\partial x} \tag{2}$$

$$\frac{\partial (wc)}{\partial t} = \frac{\partial}{\partial x}\left(D^*\frac{\partial c}{\partial x}\right) - \frac{\partial (vc)}{\partial x} \tag{3}$$

Here *H* is the generalized probability of soil moisture, m; H = P(W) - X, P(W) is capillary capacity (pressure), m; x is vertical axis (x = 0 on the soil surface, positive downward direction), m; W is volumetric moisture content, m3/m3; K(W) is coefficient of water permeability; e(w,x) is the function of moisture absorption by plants through the roots; V is the rate of moisture loss, m/day; C - mineralization of salts of the steam mixture, g/l; D* is coefficient of convective diffusion of salts; t is time, days.

Equation 2 can be used to calculate salt tolerance in the light and medium mechanical composition of the soil in the form of chloride, chloride-sulfate, and sulfate-chloride salinization.

Initial and boundary conditions: The initial conditions provide the initial distribution of moisture potentials and ion concentrations calculated in the area under consideration:

$$H(x,o)=(H_o(x) \text{ or } W(x,o) = W_o(x) \quad (4)$$

$$C(x,o)=C_o(x) \quad (5)$$

Calculating the boundary conditions gives the values of moisture fluxes at the upper and lower boundaries of the site.

For the upper equation of moisture transfer, the value of the boundary conditions for surface irrigation is taken:

$$X = 0, H(0,t)=H1(t) \quad (6)$$

Here: H1(t) is water layer on the soil surface, filling and irrigation along the lines, m. When irrigating along the ridges, H1 = -0.2 m should be taken.
Type 3 Dankwertz-Brenner condition for the salt transfer equation at the upper boundary.

$$X = 0,\ D^* \frac{dc}{dx} = V(C - C_p), \quad (7)$$

Here: $C_П$ is Mineralization concentration (g/l) in irrigation water during irrigation, $C_П = 0$ between irrigations.

Type 3 state - current, depending on H; In expression (6.7) $Q_2 = f(H, t)$ In the WASTR-2 program, this condition is modeled by runoff outside the field with horizontal drainage. Irrigated lands are currently equipped with artificial drainage, and their efficiency does not meet the needs of all areas. The current general and particular water-salt balances in the Pakhtakor district of the Jizzakh region have been established [2, 3]. By adjusting the amount of drainage from this developed water-salt balance to this state of the Waster computer program, we adjust the adaptation and calibration conditions.

The following condition is accepted for the salt exchange equation in the lower limit:

$$\frac{\partial c}{\partial x} = 0 \quad (8)$$

Based on the above equations, the computer program "Vaster" allows you to develop a forecast of the irrigation regime on the site.

3 Results and discussion

The mathematical models allow computer programs to predict the migration of moisture and salinity, groundwater level, and irrigation regime in water-saturated and unsaturated zones under specified boundary conditions.

In 2 experiments, the plant's root layer was 60 cm from April to May, and the root layer was 80 cm from June to September, and soil moisture and salinity were observed. However, studies of the 4-meter layer as a general fund yielded results. The analysis took into account the stages of plant development.

The WASTER computer program calculates irrigation regimes and norms in 2 options, considering drainage (see Table 1).

In Option 1, salinization and moisture transfer of soil layers developed using the computer program "Waster" Pakhtakor of Jizzakh region (Experiment 1 RICBSPA (Research Institute of Cotton Breeding, Seed Production and Agrotechnology) Pakhtakor parameters obtained from experimental field studies in Jizzakh Experimental Station (semihydromorphic groundwater level 1.5-3.0 m) and Zarbdor districts. Calibrated results from the program are given. Water and atmospheric precipitation in the total area of Pakhtakor district are 13043 m^3 / ha, net water and atmospheric precipitation in the irrigated net area are 12133 m^3/ha, drainage modulus Dg = 2831 m^3/ha (Table 2).

Table 1. In the computer program WASTER imitation prediction for cotton drainage conditions and norms with different drainage conditions

Options	Indicators	1 irrigation, m^3/ha			2- irrigation, m^3/ha,		
1 (current)	Dimensional humidity	0.279	*23.06	GL	0.249	*11.08	GL
	Salinity, %	0.441	904	1.63 m	0.495	907	1,98 m
2 (prediction)	Dimensional humidity	0.301	*13.06	GL	0.248	*20.07	GL
	Salinity, %	0.317	1004	2.81 m	0.328	1005	3.01 m

Continuation of table № 1.

Options	Indicators	3 irrigation, m^3 / ha			Sugo-scan rate, m^3/ha
1 (current)	Dimensional humidity				1811
	Salinity, %				
2 (prediction)	Dimensional humidity	0.249	*11.08	GL	3013
	Salinity, %	0.301	1004	3.18 m	

Note: * -date of irrigation, GL-groundwater level

Option 1 had a water table of 2.03 m in May, 1.51 m in May, 1.63 m in June, 1.86 m in July, 1.98 m in August, and 2.06 m in September. Volumetric humidity fluctuated within 0.275-0.342 in 60-cm active layers in April-May, with salinity within 0.275-0.565. In June-September, it can be seen that the trend towards salinity decreases with a volumetric moisture content of 0.214-0.29 and the study of salinity from the top of the active layer to the bottom every 10 cm.

According to option 2, the groundwater level in April was 2.73 m, in May - 2.79 m, in June - an average of 2.83 m, in July - an average of 3.06 m, in August - 3.18 m, in September - 3.26 m. Volumetric humidity fluctuated within 0.275-0.345 in 60-cm active layers in April-May, with salinity within 0.222-0.555. In June-September from the table. 3 also shows that the volumetric moisture varies monthly, depending on the active layer. On the other hand, salinity shows that the tendency to salinity decreases when studying the active layer from top to bottom every 10 cm.

4 Conclusion

The results of planning the irrigation procedure for cotton, calculated using the computer program WASTER (see Table 1), set the actual drainage values, so the irrigation norms are 1811 m^3/ha. Because the drainage in Pakhtakor district did not work well and the groundwater level was above the depth recommended by RIIWP, the number and irrigation norms were low. Soil salinity has also risen slightly. (See Table 2). When calculations were made to increase the length and number of drains, the groundwater level depth at the depth recommended by RIIWP, the irrigation norm was 3013 m^3 / ha. By September, the salinity of the land in this option had dropped to 0.292%. It should be noted that the advantage of the WASTER computer program is that it allows you to achieve the desired results, taking into account abrupt climate changes, the mechanical composition of the soil, salinity, water mineralization, groundwater depth, and other parameters and factors.

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