

The ways of using collector drainage waters for irrigation

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Abstract. For the conditions of Uzbekistan, it is necessary to maintain the reclamation condition of irrigated lands constantly and increase soil fertility. It is necessary to study the land reclamation condition in our region. An important factor is that collector-drainage waters are used for irrigation to pay off the shortage of water resources. The object of the study is the collector-drainage waters formed in the Republic of Uzbekistan. The article presents research on the method of statistical data processing, materials analysis, field research, and computer plotting curves and diagrams. As a result of the irrational use of collector-drainage waters, secondary clogging is observed in some areas. Data analysis was carried out from 2005 to 2020. The analysis of long-term studies shows that by 2020 there was a decrease in highly saline lands, which makes 83 thousand hectares. Whereas in 2005, saline lands made up 160 thousand hectares. Also, data analysis shows that areas with different mineralization are almost unchanged and need to develop scientifically based measures. The purpose and objectives of scientific research are to study irrigation with collector-drainage waters, their impact on the reclamation state of irrigation lands, and assess their suitability for irrigation. To increase the reliability of assessments of the quality of collector-drainage waters under various natural and economic conditions, it is recommended to use the relationship between water mineralization and the ratio of chlorine to sulfate. The dependence was built on the results of long-term data on the hydrochemical regime of collector-drainage waters. Estimates of our research have shown that at least 50% of the collector-drainage runoff is suitable for use in places of formation in Uzbekistan. Collector-drainage waters have mainly a sulfate type of salinity, and such waters with mineralization of 2-3 g/l, such waters with mineralization of 2-3 g/l can be used for repeated irrigation. To cover the shortage of irrigation water, drainage waters with increased mineralization by diluting them with fresh water will also be used for reuse.

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1 Introduction

Water is the most important resource for all life on the planet. Of all the water resources on Earth, only 2.5 percent is fresh. Two-thirds of fresh water is trapped in ice caps and glaciers. Of the remaining one percent, a fifth is located in remote, hard-to-reach areas, and a large amount of seasonal precipitation during floods cannot be easily used [1]. Over time, water is becoming less and less; access to clean and safe drinking water is becoming limited in different countries. Currently, only about 0.08 percent of all fresh water in the world is exploited by humanity in an ever-growing demand for sanitation, drinking water, production, leisure, and agriculture. Due to the small percentage of the remaining water, optimizing the fresh water from natural resources has been a constant problem in several places worldwide. Significant efforts in water resources management aim to optimize water use and minimize water use's impact on the environment. Water monitoring as an integral part of the ecosystem is based on integrated water resources management, where the quantity and quality of the ecosystem help determine the nature of natural resources. [2, 3] The object of the study is the underground and collector-drainage waters of the Republic of Uzbekistan. The actuality of the survey is to study collector-drainage waters as an additional source of irrigation and their impact on the reclamation condition of irrigated lands. [4]

R.K. Ikramov, H.I.Yakubov, A.U. Usmanov, T.U. Bekmuratov, M.A. Yakubov, Sh.Sh.Mukhamedzhanov, B. Matyakubov, Khojiyev A, Muradov R, and others were engaged in the application of collector-drainage waters for irrigation [5, 6, 7, 8]. But, even though many scientists have dealt with this issue, this issue has not been fully discovered. In particular, there were no studies covering the entire republic. This issue must be solved against the background of drainage by establishing ideal parameters of the reclamation regime, ensuring the creation and maintenance of a favorable salt regime of soils and groundwater for normal growth and development of plants, obtaining high and stable yields with minimal expenditure of irrigation water and labor per unit of crop production.

2 Methods

Methods of field research, system data analysis, and common methods of soil research and chemical analysis of groundwater are used in the article. Methods of computer programs for calculations and plotting were adopted.

3 Results and Discussion

Effective use of water resources requires consideration of the hydrological regime and the current state of water availability in arid regions. It should be emphasized that groundwater is often used for irrigation in many countries with dry and semi-dry climates. One-third of the earth's hemisphere is irrigated by groundwater. For example, the United States of America irrigates 46% with groundwater, Libya fully uses groundwater for irrigation, and 59% of the land is irrigated in Iran. In Russia, only 0.43 km³/year is used for irrigation and irrigation of agricultural land, which is 4% of the total volume of groundwater [9].

The development of agriculture and water management is of great importance for the economies of Central Asian countries. The basis of land use in agricultural production is the constant maintenance and improvement of soil fertility. In the conditions of the arid zone, the intensification of agricultural production is ensured by the introduction of a proper farming system (crop rotation system, tillage techniques, the use of optimal doses of mineral and organic fertilizers, etc.), timely reclamation, and operational techniques (field

planning, the use of advanced technologies and irrigation methods, the organization of optimal operating modes of irrigation and drainage systems, carrying out desalination measures, maintenance groundwater levels, etc.) [10-12].

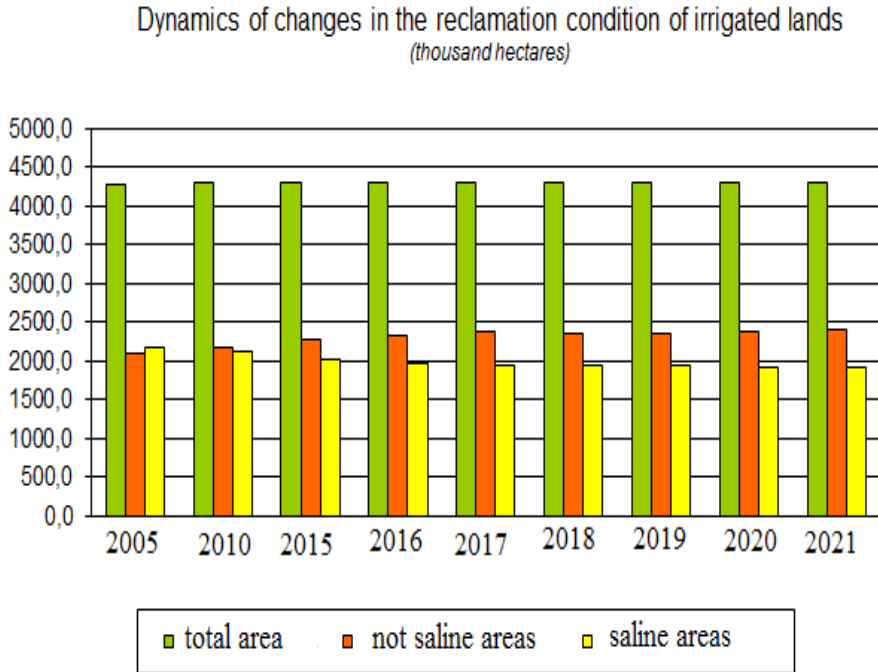


Fig. 1. Dynamics of changes in the reclamation condition of irrigated lands for 2005-2021

The republic's territory has specific soil and climatic conditions; due to insufficient natural drainage and a high level of groundwater mineralization, a number of territories are "primarily saline". At the same time, due to the irrational use of water resources and the negative impact of other anthropogenic factors, "secondary salinization" of lands is observed in some territories; 45.7 percent of the irrigated land area has a different degree of salinization [13-15].

As seen from Figure 2, by 2020, the area of heavily saline lands shortened to 77.33 thousand hectares compared to 2005.

Analysis of long-term data shows that (Fig. 2.) there is a tendency to shorten the area of heavily saline lands, so if in 2005 it was 160 thousand hectares, by 2020, the figure changed to 83 thousand hectares. In turn, saline lands are divided into slightly saline, medium saline, and highly saline lands. On the other hand, (Fig. 2.) areas with different degrees of salinity have not changed much in recent years and require the development of scientifically based measures to improve them.

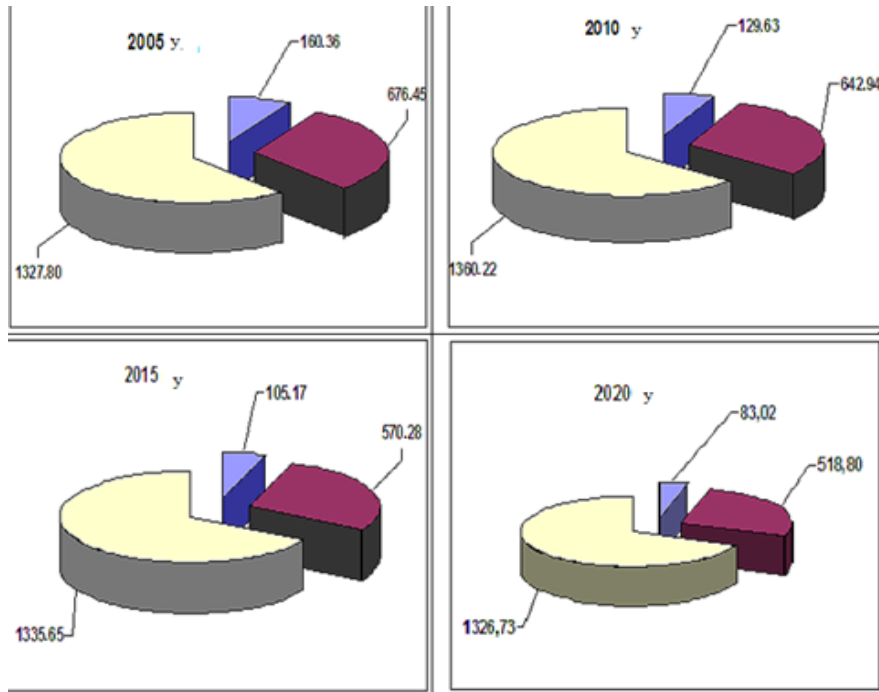


Fig. 2. Distribution of irrigated lands by degree of salinity in a multi-year section.

One of these measures is assessing the quality of collector drainage waters (CDW). It is known that with a shortage of irrigation water, these waters are an additional source for irrigation. It should be noted that the collector drainage waters assessment shows their suitability for irrigation and land washing in the appropriate hydrogeological soil-reclamation conditions of all districts. This is due to the absence of the danger of salinization when using collector drainage waters having high calcium (50-60% of the number of salts) in the soils of Central Asia [16].

Similar quality assessments of irrigation and drainage water quality were carried out by researchers. The results of the assessment of the quality of collector-drainage waters showed that waters with mineralization of 2-3 g/l could be used for growing cotton and other salt-resistant fodder crops on light desert-sandy soils. Collector-drainage water with increased mineralization (3-5 g/l) can only be used when washing salt marshes and highly saline soils [17, 18].

According to the conducted estimates, the suitability of drainage waters of various irrigation arrays located in different soil and climatic zones and having a different chemical composition of waters varies significantly even within the same group of waters in quality. The first group is from 0.4 to 1 g / l, the second – from 0.4 to 2.5 g / l, the third – from 2.5 to 5 g / l, and the fourth – from 3.5 to 6 g / l.

When assessing the suitability for the risk of salinization and water quality, it is necessary to consider the conditions of their use – irrigation regime and technique, soil-reclamation conditions, and the degree of drainage of territories.

To assess the possibility of using CDW for irrigation, information about the mineralization and chemical composition of water in certain planning zones is needed [19, 20].

In recent years, a complete chemical analysis of collector and drainage waters has not been carried out in the Central Asian republics. Still, a reduced analysis is carried out with only a certain amount of water mineralization. (The abridged analysis includes dense residue, chlorine, and sulfate). According to the chemical composition, most of the CDW has changed to the sulfate type due to the intensive washing of chlorides. Therefore, to increase the reliability of the quality estimates of KDV for various natural and economic conditions, it is possible to use the dependencies between the mineralization of water and the ratio of chlorine to sulfate. Such dependencies are based on the results of the collection and generalization of long-term data on the hydrochemical regime of collector-drainage waters in certain irrigated zones, which make it easy to determine the suitability of CDW for irrigation according to the unified classification of CARII (Central Asian Research Institute of Irrigation) (Fig. 3).

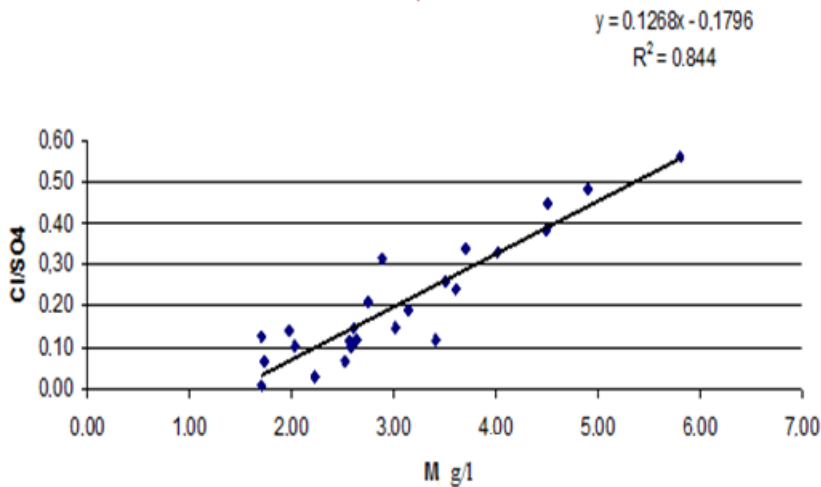


Fig. 3. The relationship between the mineralization of CDW and the ratio of chlorine to sulfate

According to this dependence, with a ratio of Cl/SO₄ equal to 0.2 to 0.4, the limits of natural mineralization of CDW range from 2.5 to 4.5 g/l.

The decision to dilute CDW with fresh water is made, considering their mineralization using the well-known balance equation of substances. The proportion of mineralized and fresh water is defined as:

$$M = \frac{(S_3 - S_{pr})}{S_{dr} - S_{pr}} \cdot 100, \% \quad (1)$$

Where S_3 is given mineralization of mixed water, g/l; S_{dr} is mineralization of drainage water, g/l; S_{pr} is too, fresh water in channels, g/l.

In the long term, considering the exhaustion of available water resources, it is obvious that everywhere we will have to involve drainage waters with increased mineralization by diluting them with fresh water for reuse.

Under these conditions, the development of irrigated agriculture is associated with the need to regulate the ion-salt regime of rock strata with active water and salt exchange. This is because as a result of irrigation and especially when using artificial drainage, the

conditions for the formation of incoming and outgoing elements of the water-salt balance change dramatically: the rate of infiltration, evaporation, an outflow of groundwater, salinization and salinization regimes, and others. These factors manifest themselves through certain processes that directly change salts and ions' quantity and quality (composition) in soils, rocks, soil-pore solutions, groundwater, and groundwater. In the long-term and seasonal changes in the ion-salt regime, an important role is played by such regime-forming processes as salt dissolution, rock leaching, crystallization, evaporative concentration, ion exchange, molecular and convective (filtration) diffusion, mixing of solutions, coagulation, ion-salt equilibrium in the solution-solid phase system, displacement of pore solutions, etc. which constantly flow in the aeration zone, groundwater and in the entire the thickness of active water and salt exchange. The depth of the active water and salt exchange is determined by the first water barrier or a conditional boundary, below which the influence of water reclamation measures does not manifest itself. Thus, during irrigation and artificial drainage of lands from the characteristics of the aquifer complex, the main factors influencing the formation of the zone of active water and salt exchange are the thickness of the aquifer, the layering of the soil, the location of the water barrier, the salinity of rocks, and others.

4 Conclusion

Analysis of long-term data shows a tendency to decrease the area of heavily saline lands.

The assessments carried out according to the methodology we chose showed that in Uzbekistan, at least 50% of the collector-drainage runoff is suitable for use in the formation places, except the drainage-discharge waters of the Karshi steppe, certain districts of the Bukhara region.

In modern conditions in each republic, the chemical composition of the formed CDW is mainly of the sulfate type of salinization, which means that everywhere it is possible to use such waters with mineralization of 2-3 g / l for repeated irrigation. Each region should decide the amount of collector-drainage water used as an additional resource.

In the long term, considering the exhaustion of available water resources, it is obvious that everywhere we will have to involve drainage waters with increased mineralization by diluting them with fresh water for reuse.

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