

# Study of technology to reduce formation of collector-soil water in saline soil conditions

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**Abstract.** This article presents the results of scientific research aimed at the rational use of water resources in the Khorezm region under the conditions of water shortage, prevention of secondary salinization of irrigated areas, reduction of water wastage from irrigation networks, and improvement of efficient water use technologies in reducing the water formed in collector-sink networks.

## 1 Introduction

According to the decisions of the President of the Republic of Uzbekistan dated February 24, 2021, No. Presidential decree-5005 "STRATEGY for the management of water resources and development of the irrigation sector in the Republic of Uzbekistan for 2021-2023", to further improve the reclamation of irrigated lands, to introduce intensive methods to the field of agricultural production, first of all, modern water-saving irrigation technologies that save water and resources are aimed at reducing water formed in collector-ditch networks.

Effective and rational use of water resources in the cultivation of agricultural crops is of great importance in the conditions of increasing water scarcity in the Republic, including the Khorezm region.

One of the main indicators in the development of the technology for reducing the formation of collector-wastewater is to catch the technical condition of irrigation systems at the required level to ensure their operation through design parameters (taking measures to increase the coefficient of useful work), to supply water to the channel based on the demand of the crop, to the irrigation procedure developed for the crop compliance, use of water-saving irrigation technologies (drip, sprinkler, pulsar, etc.) in irrigated fields, the introduction of crop rotation in the irrigated area is of great importance.

To ensure the amelioration of the lands used in irrigation farming in the Khorezm region to be at the required level, it is mainly necessary to raise the level of storm water, form collector-water reservoirs, improve the technical condition of irrigation networks, and apply water-saving irrigation technologies in the irrigation of agricultural crops in field conditions, as well as to implement agrotechnical measures on time [1-3].

In the conditions of the Khorezm region, one of the most important tasks is the rational

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use of water resources, as well as the prevention of secondary salinization of irrigated, that is, cultivated areas, the issues of reducing water waste from irrigation networks, and the implementation of measures aimed at improving the technologies of efficient use of water in the reduction of water formed in collector-sink networks [4-7].

From this point of view, analysis of indicators of irrigation networks (utility coefficient, technical condition, service area, water supply, water carrying capacity, etc.) based on modern methods, development of measures for modernization of hydromelioration systems and taking into account meteorological indicators it is necessary to improve the methods of calculating the irrigation rates for the crops, predicting the water taken into the canal and the water distribution.

Therefore, measures aimed at determining the useful work coefficient of irrigation networks in the rational use of the limited amount of water taken from the border of Khorezm region and developing measures to increase it, introducing drip irrigation technology to reduce the formation of collector-sour water, and the use of biological preparations in salt washing are being observed in our Republic and are increasing. It is relevant in the conditions of increasing water scarcity.

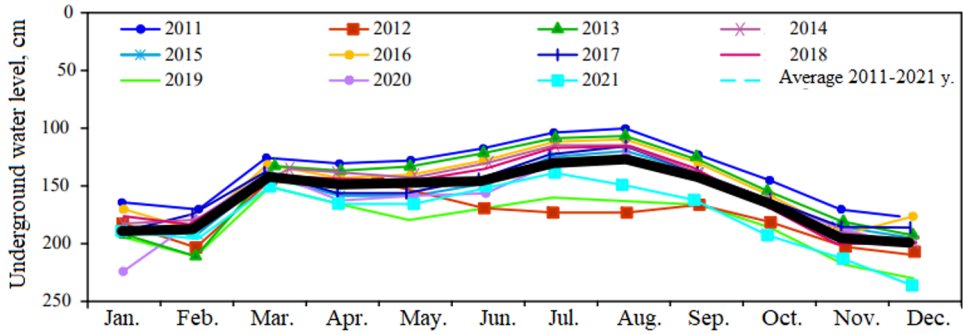
## 2 Methods

Statistical and graphical work coefficient processing of data, empirical relationships, laws of salt leaching processes in the soil, and determination of quantitative indicators of the effect of agromelioration methods on soil properties, forecasting method and "General and Irrigated Lands" developed at the Research Institute of Irrigation and Water Problems in conducting scientific research work "composing private water-salt balances" method was used. Also, for soil analysis, observation, measurement, and analysis of cotton, methodological manuals "Methods of studying agrophysical, agrochemical and microbiological properties of soil in cotton fields" and "Methods of conducting field experiments" adopted at the Scientific Research Institute of Cotton Selection, Seeding and Agrotechnology of Cultivation were used [8-12].

## Results and Discussion

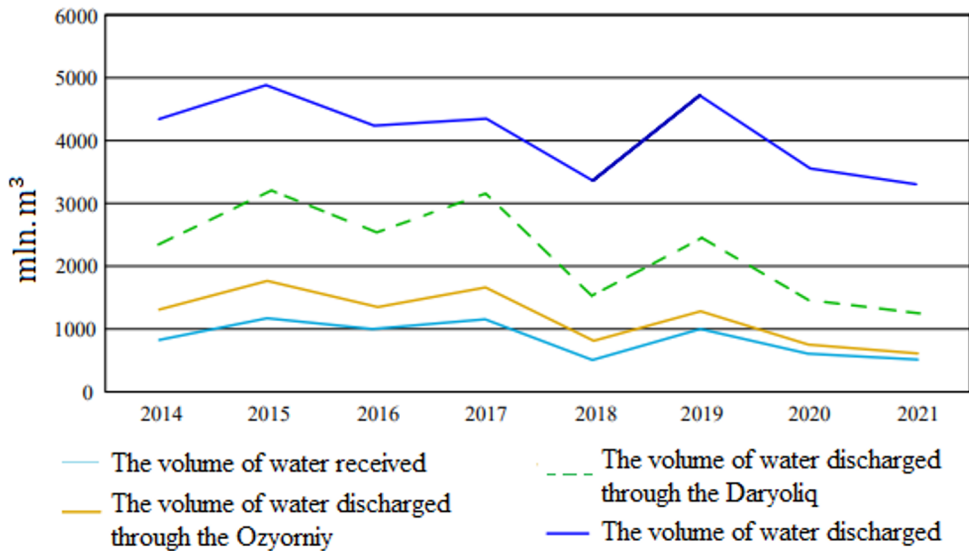
Geomorphologically, the alluvial rocks of the Khorezm region consist of clay, loamy sand, sand, and loam deposits. In terms of surface structure, it is a flat plain, with a slope of 0.00015 - 0.0005 on the one hand to the north and the other to the northwest. Also, due to the Khorezm region's location in the lower part of the Amudarya, anthropogenic (agro irrigation) layers with a 2-3 m thickness have been formed in the irrigated agricultural lands since ancient times. The formation and development of the region's soil are directly related to the alluvial deposits brought by the Amudarya. According to the mechanical composition of the regional soils consisting of alluvial rocks, they are mainly heavy sandy and muddy soil (17.3%), medium sandy soil (40.3%), light sandy soil (29.1%), and sandy and sandy soil (13.3 %).

Hydrogeologically, the region's territory is characterized by the fact that it is associated with a very small slope, making underground groundwater flow very difficult. Seepage water is very close to the earth's surface, and its average annual depth varies from 1.0 to 2.5 m in irrigated areas. During the vegetation period, the average depth of underground water is 1.4-1.5 m (Fig. 1). Because of this, groundwater with low salinity and located close to the ground level has an active influence on the water and salt regimes of the soil.



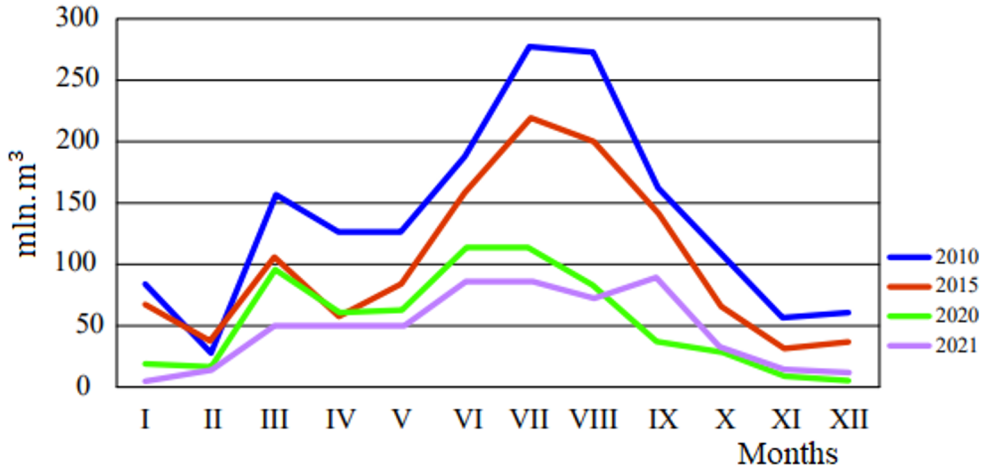
**Fig. 1.** Average monthly changes in level of flood waters in Khorezm region. (Source: Developed by the authors).

According to the study of the water balance of the irrigated area of the Khorezm region, the amount of water received and released in 2014-2021, including the inter-republican "Daryoliq" and "Ozyorniy" collectors, is shown in Figure 2. From the analytical data, it can be said that the amount of water received was from 3346.922 million m<sup>3</sup> (2021) to 4363.51 million m<sup>3</sup> (2014), the amount of water released from the border of the region was 1275.610 million m<sup>3</sup> (2021). y.) to 3199.73 mln m<sup>3</sup> (2015), and the amount of released water was 38-41% compared to the total received water. 33.2-42.7% of the water released in the region as a whole corresponded to the inter-republican "Daryoliq" collector and 49.1-56.2% to the inter-republican "Ozyorniy" collector (Fig. 2).



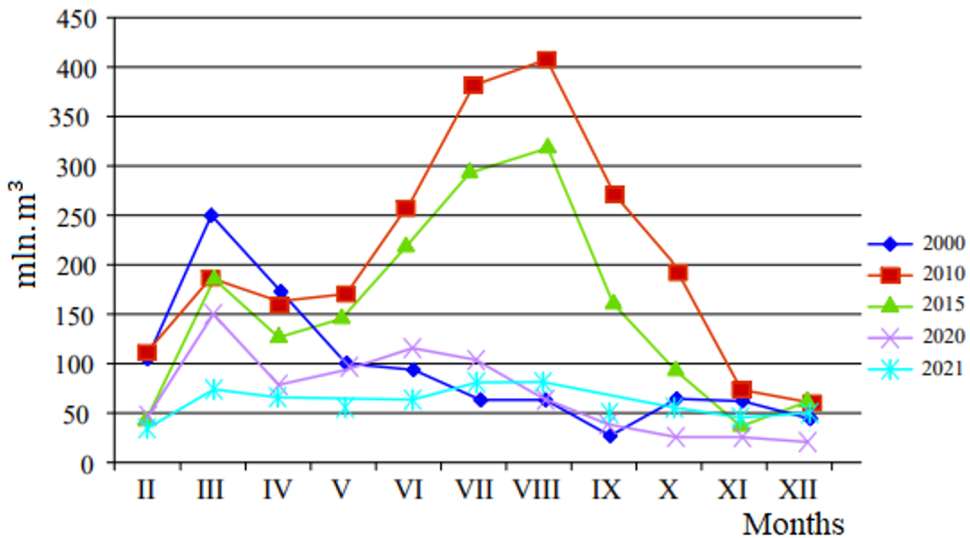
**Fig. 2.** Water balance of Khorezm region for 2014-2021.

The analysis of the data of the inter-republican "Daryoliq" collector for 2010-2012 shows that the least amount of water is released in February, on average, around 23.77 million m<sup>3</sup>, and the most in July - 168.57 million m<sup>3</sup>. It was determined that the average long-term water discharge was around 988.40 million m<sup>3</sup> per year (Fig. 3).



**Fig. 3.** Changes in water flow of Inter-Republic "Daryoliq" collector in Khorezm region in 2010-2021.

The analysis of long-term data of the inter-republican "Ozyorniy" collector shows that the least amount of water is released mainly in November, and on average, it is around 48.39 million cubic meters, and the maximum is 186.54 million cubic meters in July. It was found that the average long-term water discharge was around 1331.91 million m<sup>3</sup> per year. Fig.4).



**Fig. 4.** Changes in water flow of Inter-Republic "Ozyorniy" collector in Khorezm region in 2000-2021.

Field experiments were carried out in three sections (upper, middle, and lower part of the collector) in the territory of the Inter-Republic Ozyorny collector. The selected area is a grassland of the desert region, an alluvial oasis soil that has been irrigated since ancient times. These soils are located on lands that have been irrigated and cultivated since ancient times. As a result of many years of irrigation, fertilizing, sedimentation of the river, and ditch runoff, an agro-irrigation layer was formed in this type of soil. As a result of the

irrigation of these soils, the level of seepage water in the area fluctuated due to the constant water leakage from canals and irrigation channels. At the beginning of the experiments (at the beginning of the growing season), i.e., in 2022, soil sections were dug, and genetic layers determined soil morphology [13-15].

According to the information given above, along with improving the water-physical properties of the meadow-alluvial soil, which is of varying degrees of salinity, measures were taken to enrich it with nutrients. In addition, to improve the water-physical properties of the soil, irrigation was carried out using modern irrigation methods.

**Preparation of the field for salt washing and introduction of Biosolvent compound into the soil.** Washing of soil salt in the field is carried out in the following order (Fig. 6):

1. The saline-washed field was plowed to a depth of 35–40 cm using a Magnum drive tractor and leveled using a laser leveler.

2. 9 checks measuring 50x50 m were taken along the field with the help of a channel digging device.

3. The received checks are directed from the side of the water source to the collector, and the water entering the checks is measured using a "Chipoletti VCh-75" water meter. Because when salt washing is carried out in this order, the water that enters the floor is absorbed into the soil, joins the seepage water from the ground, and is ensured that it flows towards the ditch.



**Fig. 5.** Preparing field for salt washing

Biosolvent compound developed by the scientists of the O. Sodikov Research Institute of Bioorganic Chemistry, affiliated with the Academy of Sciences of the Republic of Uzbekistan, is applied at the rate of 5.0-6.0 liters per 1 ha in areas with weak salinity, 7.0-8.0 liters in areas with moderate salinity, and 7.0-8.0 liters per 1 ha in areas with strong salinity. It is recommended to use 11.0-12.0 liters on land. In the studies, the Biosolvent compound is mixed with water at the rate of 8.0 l/ha in the 3rd option, according to the recommendation, taking into account the average salinity in the experimental field, and it is sprinkled along the edges of the field where the salt will be washed (Fig. 6).



**Fig. 6.** Application of biosolvent compound

### 3 Conclusions

The following preliminary conclusions were made on the part of the scientific research work carried out in 2021 on the topic "Development of technology to reduce the formation of collector-source water in Khorezm region" (research on the impact of water-saving salt washing and irrigation and the use of collector-source water in irrigation on the formation of collector-source water planned to continue in 2022 in 3 selected pilot areas):

1. To mitigate their negative consequences in the years of water shortage in the region and to ensure an optimal melioration regime in the irrigated lands, the use of water-saving irrigation and salt washing technologies makes it possible to obtain a high and quality harvest from agricultural crops.

2. Drip irrigation of the main agricultural crops in the conditions of saline soils of the Khorezm region and its effect on the soil reclamation regime, crop growth, development, and productivity have not been adequately researched.

3 Modern water-saving salt washing technologies for soil salt washing in the region: biological compounds that increase the solubility of soil salts in water: use of "Biosolvent" and "Supersal", with "Tact" (blocking salt in the first step), etc. experiments on the application of salt washing technologies have not been carried out at all.

4 There is not enough research on the technology of using collector water as an additional resource in irrigated agriculture, including the biotechnology of biological reduction of mineralization.

5. The Khorezm region has 265,537 thousand hectares of irrigated land. Meadow-alluvial soils, 30.0 percent of the soils, according to their mechanical composition, are medium loam soils, 21.6 percent are light soils, and the rest are heavy and mixed soils.

6. In the Khorezm region, the area with an underground water level of up to 1.0 m is 30.2 thousand hectares (11.4%), 1-1.5 meters - 103.0 thousand hectares (38.8%), 1.5 -up to 2 meters - 88.5 thousand ha (33.3 %) and the area below 2 meters - 43.8 thousand ha (16.5 %). These observations are higher than 80% of the irrigated area.

7. 60% of the irrigated area in the region is low salinity, 29% medium salinity, and 11% strong salinity.

8. 38-71% of the total water received for irrigation in the region is sent through the collector networks. 49.1-56.2% of the discharged water corresponds to the Inter-Republican Ozyorny collector.

9. The last 20-year analysis of the water flow regime of the inter-republican "Ozerniy" collector shows that its flow is maximum (250 million m<sup>3</sup>) mainly in the period of non-vegetation, i.e., during the washing of soil salts and during the vegetation period it is on average 50-100 million m<sup>3</sup>.

10. To manage the water flow regime of the inter-republican "Ozerniy" collector:

- wide use of water-saving irrigation methods during the growing season, the introduction of scientifically based irrigation procedures that provide water to the active layer during the growing season, use of "washing" irrigation procedures using biological compounds, structure-creating polymers to reduce water consumption for salt washing;

- modern water-saving salt washing technologies in the period of no vegetation: biological compounds that increase the solubility of salts in the soil: use of "Biosolvent" and "Supersal", with "Tact" (blocking collectors in the first tact), etc. application of salt washing technologies;

- the wide implementation of the technologies of using collector water as an additional resource in irrigated agriculture, including the biotechnology of reducing their mineralization biologically, is effective to a certain extent.

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