ISSN NO: 2771-8840
Date of Publication: 26-06-2023

Saltination of Soils in the Lower Reaches of the Amu Darya- The Main Problem of Irrigated Agriculture

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Annotation. Soil salinization in the lower reaches of the Amu Darya remains the main problem of irrigated agriculture in Karakalpakstan. Measures to combat them, such as leaching irrigation, do not give a significant effect. The established shortage of irrigation water in recent years threatens the loss of Karakalpakstan's status of the Irrigated Agriculture Zone.

Key words: soil salinization, water mineralization, groundwater, leaching regime, water-salt regime, level of groundwater occurrence, territory drainage, salt accumulation.

The Republic of Karakalpakstan is located on the alluvial plains of the lower reaches of the Amu Darya, its irrigated lands are very suitable for growing crops. According to climatic conditions, there are necessary conditions for good development and obtaining high yields of cotton, wheat, rice, alfalfa, legumes and other crops to meet the needs of the population in food products.

The irrigated area of Karakalpakstan is 504.8 thousand hectares, almost the entire area is constantly monitored by the Karakalpak hydrogeological and reclamation expedition.

The climate of the studied region is arid, sharply continental and is characterized according to the data of meteorological stations in the years. Nukus and Chimbay. The average long-term air temperatures in winter are - 7 ºC - 10 ºC, the duration of the frosty period is 100-115 days. Summer is dry and hot, average monthly air temperatures reach + 26 ºC + 31 ºC (Fig. 1).

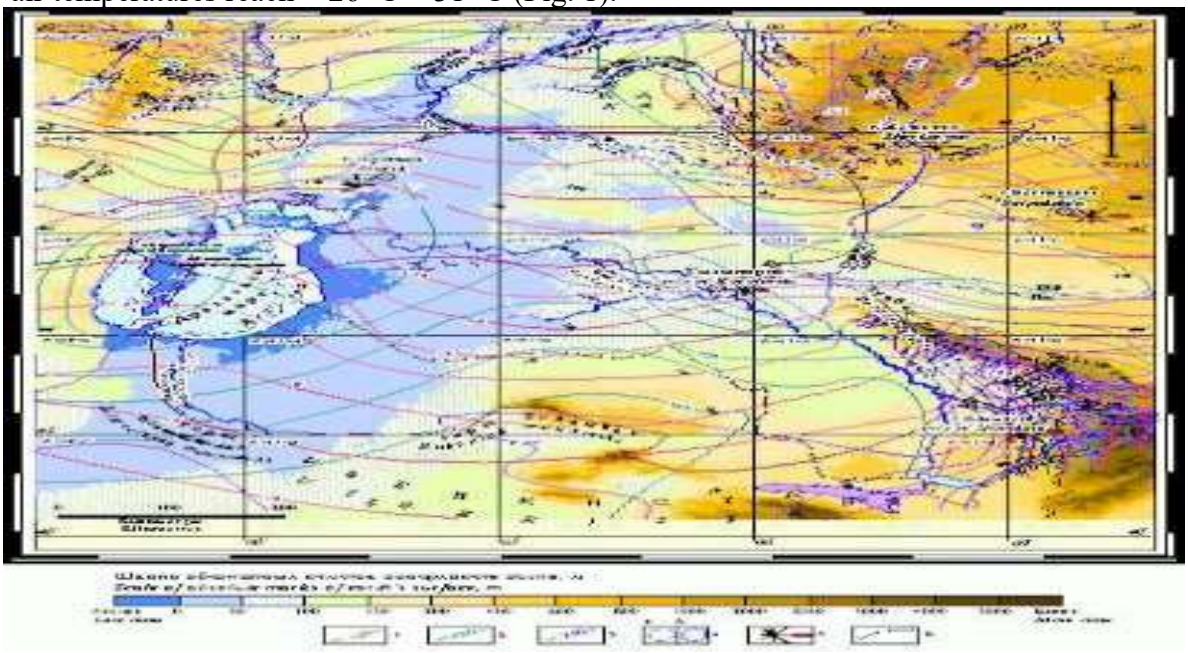

Fig1. Map of climatic indicators of the Aral Sea region

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The decrease in temperature in winter and a significant increase in summer is reflected by the intrusion of cold arctic air from the northeast and warm, tropical air from the southwest. Atmospheric precipitation for this territory is of no small importance as a source of groundwater recharge. Their average annual number in the long-term section is 90-120 mm according to the Chimbay weather station.

They are spent mainly on evaporation and infiltration. The average relative air humidity for a year in a long-term context is 55-60% High temperatures and a lack of humidity cause high evaporation (from 1649 to 1814 mm per year).

The direction of the wind is northeast (speed up to 13-15 m/s), the average duration of which is 320 days (Fig. 2).

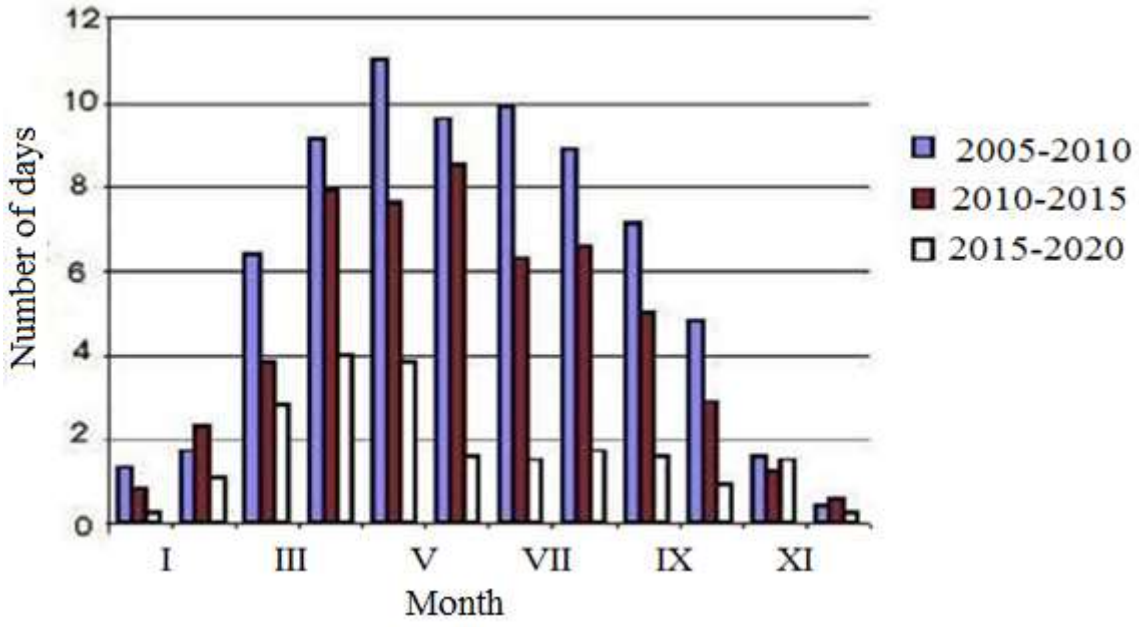

Fig.2. Graph of the average long-term removal of the mass of sand in the Aral Sea region.

It is well known that the increase in land productivity depends mainly on such a factor as the ameliorative state of land, which is expressed by the depth of groundwater, their degree of mineralization, the degree of soil salinity and crop yields.

Salinization of soils of varying degrees in the Amudarya river basin creates certain problems for farmers, in addition, the rise of mineralized groundwater to the surface of the earth leads to secondary salinization of soils and deterioration of the reclamation state of lands.

According to the data of the Karakalpak hydrogeological and reclamation expedition, out of the total area of irrigated lands, 27% are in the category of “good”, 65% in the category of “satisfactory” and 10% in the category of “unsatisfactory”. This means that only on 27% of the land the soil is not saline, and on the rest of the land it is salinized from a weak to very strongly saline degree. The deterioration of the reclamation state of lands as a result of the development of processes of secondary salinization of soils leads to the degradation of irrigated lands and a decrease in agricultural productivity.

According to scientists like M.M. Rogov, A.A. Rachinsky, F.M. Rakhimbaev, Kh.I. Yakubov, V.A. Dukhovny, A.A. Ramazanov, R.K. Ikramov and others. The main source of salt accumulation in the drainless Aral-Caspian depression is the water of the Amudarya River. In their works, they point to the influence of river runoff on the processes of salt accumulation in the lower reaches of the Amu Darya and give the following relationship:

$$\boldsymbol{Ru = 0,0108\,R2b - 0,471\,Rb + 18,87}$$

where: Ru – ion sink, million m^3;

Rb- is water runoff, km^3.

With deep groundwater levels, soil desalinization occurs as a result of leaching irrigation, which leaches salts from the earth's surface to deep horizons.

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With a close occurrence of groundwater and insufficient drainage of the territory, the arid climate causes high evaporation from the day surface. The predominance of ascending currents over descending currents in the soil layer entails the movement of water-soluble salts into the active layer, thereby causing soil salinization. Therefore, in the conditions of Karakalpakstan, despite the supply of a large volume of water per unit area, in particular for flushing, there is no steady improvement in the ameliorative state of the land and the radical desalinization of the soil.

Seasonal desalination of soils is carried out by supplying large volumes of water for washing the land. Under existing conditions, at a rate of leaching irrigation from 2.7-4.7 thousand. m^3/ha and total evaporation of 7.7–8.0 thousand m^3/ha, the annual balance of salts is achieved at the ratio (W/I+Tr)–O = 2.0–2.4, which exceeds the optimal value of 2 0-2.4 times (Fig. 3).

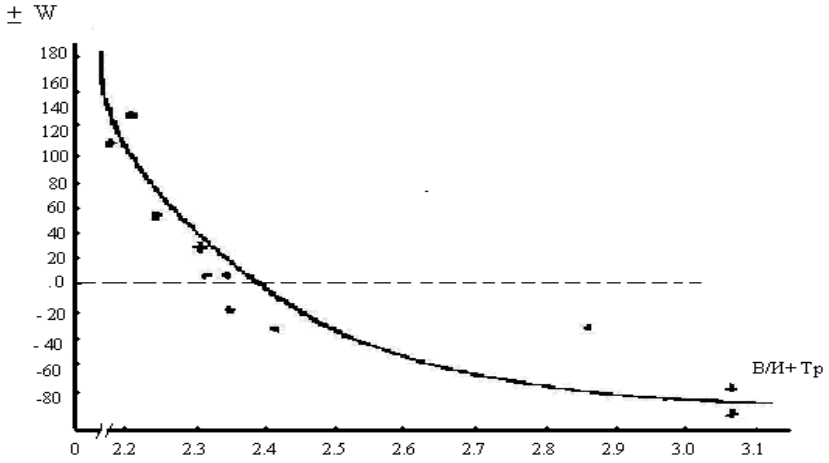

Fig.3. Change in salt reserves W depending on B/I+Tr

The results of studies on pilot production sites show that in many cases, with a close occurrence of groundwater levels, a process of vertical movement of salts is observed, i.e. after land leaching, salts sink into the lower layers of soils, and at the end of the growing season they are restored, which indicates insufficient drainage of irrigated lands. Pilot studies on various soil structures show that in some cases, with groundwater mineralization in the range of 10–16 g/l and groundwater level of 1.2–1.4 m, the seasonal salt accumulation (SAS) reaches 1.5-2.0 (Fig. 4).

Usually, at the end of the growing season, an increase in the salt content in the soil is observed; under these conditions, due to the close occurrence of groundwater levels, the supply of a large volume of irrigation water is impossible and, accordingly, the irrigation rate ranges from 2,1 to 3,3 thousand m^3 / ha (the rest of the moisture, almost 50% of the plant is obtained from groundwater), while the leaching rate increases and reaches 5,7-5,9 thousand m^3/ha.

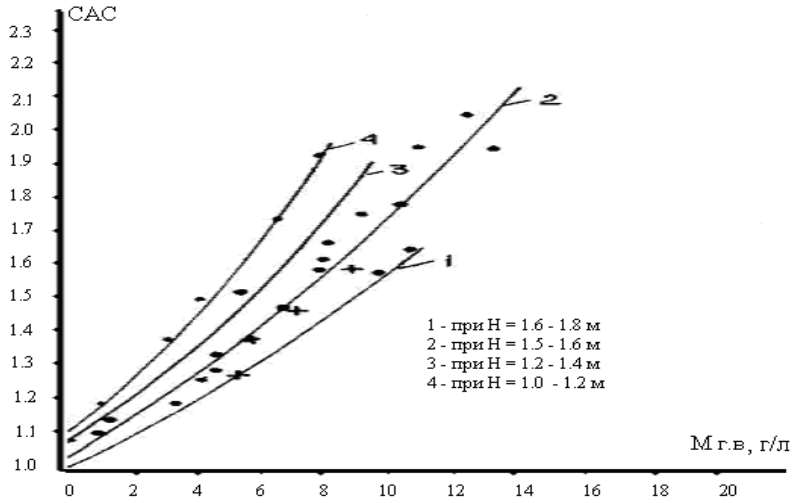

Fig.4. Curve of CAC dependence on GWL and M h.v.

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Other causes of salt accumulation in soils are:

- close location to the ground surface of groundwater with salinity over 3-4 g/l;
- insufficient effect of leaching irrigation as a result of violations of irrigation technology and necessary conditions, recommendations;
- climatic conditions conducive to intensive evaporation from surface and ground waters;
- reuse of return water without the necessary assessment of the suitability of water for irrigation of crops.

To reduce soil salinity, it is necessary to carry out high-quality soil leaching in a well-drained area, adherence to irrigation regimes and leaching rates, as well as to prevent disruption of the operation of collectors and drains. The use of agrotechnical measures at the residual level, such as deep loosening, the application of mineral fertilizers and chemical ameliorants, helps to increase the effectiveness of measures.

Loosening of soils with heavy mechanical composition to a depth of 60-70 cm and the introduction of up to 25 t / ha of lignin and organic fertilizers increases the filtration properties of soils and significantly accelerates the process of soil desalinization.

Despite the measures taken, it is not possible to achieve complete soil desalinization; the problem always exists to one degree or another. To achieve a stable salt regime, it is necessary to follow the rules for the use of irrigation water, prevent over-limit irrigation, comply with the calculated norms of leaching, plant crops on non-saline, slightly saline and moderately saline soils.

A good effect in reducing soil salinity in the conditions of Karakalpakstan is the use of biological drainage. Experiments conducted by the international organization IWMI on saline soils of the Hungry Steppe show that after 4 years of growing licorice on highly saline soils, cotton yields increased 6 times, and wheat - 2.8 times. Since licorice grows in natural conditions in Karakalpakstan, special cultivation technologies and costs are not required, and high efficiency can be achieved.

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ISSN NO: 2771-8840
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