EFFECTIVE USE OF IRRIGATED LANDS AND SUSTAINABLE MANAGEMENT OF WATER RESOURCES OF THE REPUBLIC OF KARAKALPAKSTAN

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Abstract. *The work examines the patterns of salt formation in soils on irrigated lands of the Republic of Karakalpakstan. Based on this analysis, it is concluded that the main measure aimed at preventing and reducing salt accumulation on irrigated lands in the region should be carried out to reduce the groundwater level below critical, depending on the magnitude of salinity and achieving desalination of groundwater.*
Keywords: *salt accumulation; underground water; irrigated lands; collector water; mineralization.*

INTRODUCTION

Uzbekistan and other Central Asian countries including Kazakhstan, Kyrgyzstan, Turkmenistan, Tajikistan and Afghanistan are struggling to come to terms with an ecological disaster affecting the Aral Sea. The crisis has been brought about by the mismanagement of water resources from the Aral's main tributaries, the Amudarya and the Sirdarya Rivers. The primary source of quality drinking water in Uzbekistan and Central Asia is ground water, which accounts for between 85 and 90% of the general water budget. Agricultural irrigation systems have caused high pollutions levels in the region's (unevenly distributed) surface waters. Historically water flow the Aral Sea was 56 km3 per year, which decreased to 47 km3 between 1966 and 1970. Water flow plummeted to 2 km3 between 1981 and 1983, and now stands at less than 1, 8 km3. A key question is how to balance social and economic development with natural resource protection. Central Asian Republics utilize the same watersheds and share many water management issues in common. It is clear that the region exists multination and regional water management and environmental protection project are insufficient by themselves to meet the scale of the problem. Further multinational agreements and joint-state/joint-agency programs will undoubtedly be required.

The Central Asian region has been designated in recent years as an ecological and social disaster zone because of Aral Sea situation. Although water resources are not a new issue, this problem can be traced back to the beginning of civilization for a number of reasons. The beginning of irrigated agriculture in the region dates back to the 6th-7th centuries B.C. This time period coincides with a flourishing of the most ancient civilization where irrigation was a major decisive factor of historical and socio-economic development.

Today the Aral Sea and surrounding territories are world-known for ecological disasters attributed mainly to anthropogenesis factors. In recent years, Uzbekistan's control under multiple regimes and governments has made it difficult for central Asia to unite. The growth in water consumption is connected to cultivation of new irrigated territories, where mainly cotton and rice are grown. That issue combined with the increase in the population and employment in agriculture, the flow of water to the sea from the two major river systems -the Amu Darya and Syr Darya -completely stopped.

The improper use of the water taken from the Aral Sea has led to many consequences that the interstate commission is trying to resolve. Unfortunately since the departure of the USSR, central Asian economies have not been strong enough to rehabilitate the productivity of the territory. Large and ominous hardships fall onto the responsibility of the government. Socially these include protecting the population from adverse impacts of desertification, creating new workplaces and job markets and trying to improve the economic and social conditions by introducing new water efficient technology. Ecologically, each country must implement new plans for the restoration of flora and fauna diversity and the prevention of any further degradation of the Aral Sea [1].

Increasing of water consumption by the population and industrial enterprises, the number and cost of water intake facilities increase accordingly. In order to stable provide water to consumers, additional wells are often used, the cost of which is quite high. There are significant reserves for improving the efficiency of the inicial investments in existing water supply systems. In this regard, the issue of ensuring stable operation of water wells is very relevant, which will reduce the costs for the design and construction of new facilities and increase the fund-raising of invested funds. At the same time, stable operation of wells is often disrupted due to failure of water lifting equipment, peeling, clogging of filter and aquifer during drilling of well filters and filter zones with salt deposits, chemical or electro-chemical corrosion elements, deterioration of water quality, local or widespread reduction of water level in aquifer.

Operating practice shows that if a well has lost more than 25% of its original production rate for one or another reason, regeneration is expedient. One of the main reasons for reduction of well flow rate is clogging (colmatation) of the filter and the filter zone by salt deposits. Since colmatation is a multi-factor and complex physical-chemical and hydrogeological processes, the concretization of the main factors will allow to correctly determine the method of recovery of well productivity. Methods for the well flow recovery should facilitate removal of clogging deposits from the filter outer surface and from the filter zone. During mechanical treatment of filters (cleaning with metal spars, scraper devices, swabbing, etc.) clogging deposits are broken only from filters and working columns. Treatment of wells by using reagent methods allows removal of salt deposits from the filter surface and at the filter zone. However, these methods do not always guarantee the desired effect, since the permeability of the reactant solutions are negligible in the colmatation of the filters and in the near filter zone with dense precipitates.

Using of impulsive methods can be effective only at the initial point in time of operation. At the same time, sediments are destroyed and dispersed, and complete removal of them during washing is impossible. Residual amount of salt deposits intensifies the process of repeated colmatation process. In addition, the application of this method is limited by the strength characteristics of the well elements (filters). Application of combined methods provides higher effect of well production recovery. In this case, the combination of impulsive and vibration techniques with reactant compensates for the disadvantages. As a result, removal of clogging deposits from the filter surface and near filter zones is improved. However, the use of the above-mentioned methods of recovery of the working elements of water intake structures fails to achieve the desired result due to complications arising in the recovery of well productivity, as each method is applicable in certain hydro geological conditions.

In this regard, research on new efficient methods of cleaning filters and near well filter space from sediments, improvement of existing methods and technical equipment for decolmatation and ensuring stable operation of water wells are urgently needed.

One of the promising method of cleaning filters and near filter zone from salt deposits, corrosion products and biological fouling is the method by using complex reagents and solid carbon dioxide. In the practice of recovery of water wells high effect of filter cleaning and subfilter zones is achieved at cyclic pressing of reagent solutions beyond the well contour. Compressed air or solid carbon dioxide is used to press solutions of reagents into the formation.

In this regard, we consider it useful to investigate the possibility of using complex reagents of selective action (RSA) to restore the yield of water wells. As an agent for pressing the solution of RSA behind the contours of the well filter in order to ensure cleaning of external walls of the filter and near filter space from clogging formations and corrosion products, it is proposed to use solid carbon dioxide. Complex studies of clogging deposits were carried out as a result chemical and mineralogical compositions were installed. Clogging well deposits consisted mainly of salts and oxides of two and three valence metals (Ca, Mg, Zn, Fi, Si, Al, Mn, etc.). Reagents for their removal are selected on the basis of obtained results on deposit compositions. As reagents there are proposed RSA NTP and OEDP in the same proportion. The choice of these RSA as complexing reagents is justified by taking into account their selective effect on metals contained in the colmatant composition.

Laboratory experiments carried out on the main factors affecting the effect of dissolution of the clogging deposition such as concentration, temperature of the solution and duration of treatment time, allowed to establish their optimal values. The adequacy of the main factors and the significance of the main hypothesis were tested by the method of planning the experiment. Corrosion activity of the proposed solution with respect to metal elements of the well is investigated. The technology of treatment of water wells with application of reagents of selective action and solid carbon dioxide in production conditions is offered.

Along the down-stream parts of Amu Darya River, including in the parts in the Republic Karakalpakstan accumulation of salt in the soil has been active for a long-term. Salt accumulation in the irrigated lands of the region originates from:

-from the irrigation water (salt in the Amudarya water);

- from the dried bottoms of the Aral sea, transported by wind;

- from salty underground waters transported up in soil profile to the surfaces.

Salt from irrigation water. The amount of salt resulting from irrigation has changed considerably with time. Until the 1960-s mineralization of the Amudarya water was between 0,350 and 0,590 gram/liter, and for centuries it has been the basic source of salt accumulated on irrigated lands. During the last 3-4 decades the river's salinity level has sharply increased and for a period reached up to 2,5 gram/liter. A reason for this has been dumping of collector waters (spill-water from irrigation canals) along the river. Because of reduction of the amount of water of Amudarya River during the last years, the amount of salt transported on to the irrigated fields was also considerably reduced. Average annual amount of salt reaching the soils this way is 16 tons/hectare. Salt from the dried bottoms of the Aral sea transported by wind. Here the existing data differ strongly. The Central Asian research institute of irrigation has during the last three years carried out research on the quantitative and qualitative characteristics of the salt, transported from dried bottom of the Aral Sea by northern wind to irrigated lands of the Republic of Karakalpakstan. According to these investigations the number varies between 0,7 and 2,2tons/hectare, with an average of 1,2 tons/hectare [2].

Salt from salty underground waters transported up in soil profile to the surface. This process is the most important one resulting in salt accumulation in irrigated lands of the Republic of Karakalpakstan. As a rule, when the ground water table is close to the land surface the evaporation from a surface is high and salt collects on the surface of ground. The amount of salt accumulation at the soil surface depends on the mineralization level of the underground waters.

At the certain amount of evaporation from the ground water and level of mineralization $M_г$ of the ground water it is possible to determine the level of salt accumulation in the upper soil [3] by the following formula:

$$S = E_0 (1 - \frac{h_0}{h_k})^n M_г$$

Table 1 below describes the value of salt accumulation (S) for different values of h_0 and $M_г$.

Table – 1.Salt accumulation on soil lands in accordance with different meanings of $M_г$ and h_0.

h_0	Salt accumulation on soil surface (tons/hectare) for different $M_г$				
	2gram/liter	3 gram/liter	5 gram/liter	7 gram/liter	10 gr/liter
0,5	16,4	24,9	41,4	58,0	82,9
1,0	14,9	20,9	34,9	48,9	69,9
1,5	8,9	13,4	22,3	31,2	44,6
2,0	6,2	9,4	15,6	21,8	31,2
2,5	2,7	4,0	6,8	9,5	13,5
3,0	0,5	0,7	1,2	1,6	2,4

Table-1, thus, shows that the amount of salt accumulation on soil surface mainly depends on the level of ground water mineralization ($M_г$). For example, at $M_г$ equal to 3gram/liter there is almost no salt accumulation on soil surface , but at $M_г$ equal 10gram/liter the accumulation reaches 82,9 tons/hectare.

According to these calculations for the conditions of Karakalpakstan where the mineralization of ground water are within 3 to 6 gram/liter, and level of underground water on irrigated lands within 1,8 – 2,5 m, the salt accumulation on soil surface are between 4 – 24 tons per hectare [5].

Thus summarizing, the amount of salt accumulation on irrigated lands by the different, described processes shows the following numbers:

Salt transported by irrigation water (river Amu Darya) - 15-16 tons per hectare;

Salt from dried bottom of the Aral sea (salt transported by wind) - 1-1,2 tons per hectare;

Salt from ground water in irrigated lands (depending on $M_г$) - 4-24 tons per hectare.

So, total amount of salt accumulation on the surface of soil are within 20 to 50 tons per hectare.

CONCLUSION

On the basis of above carried analyze we may conclude that by the basic measure directed on prevention (or decrease) of salt accumulation on irrigating lands of Karakalpakstan should be carried out on lowering of a level of underground waters below critical (depending on $M_г$) and desalinization of these underground waters. Of course salt transported by Amudarya River plays also crucial role on salt accumulation, almost 50% (15-16 tons per hectare), but we cannot decrease it by this factor unless we stop the dumping of collector waters along the river, especially on upper parts of the river. These projects, which allow dumping of collector waters to river without cleaning it, were realized more than 50 years ago (during the Soviet time). Contemporary projects do not allow collector waters spill to Amudarya River without preliminary cleaning it.

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