The salinization problems and soil hydromorphism as components of land desertification, irrigated zone of Tajikistan and the liquidation ways of them

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Abstract. In this article, speak about the reveal the main causes and ways to eliminate the problems of salinization and hydromorphism of soils in the Republic of Tajikistan, since salinization is one of the main stressors, that limit the growth and productivity of agricultural plants. The existing studies show, that there are two ways of integration: passive and active. Passive, through the selection of salt-resistant and moisture-loving tree crops and their transpiration capacity. Active also offers a special reclamation survey of the sides of drains and reservoirs and the use of reclamation measures aimed at achieving good survival and survival of young seedlings. Bio-drainage consisting of local tree species under a certain arrangement can transpire a volume of water commensurate with and even superior to pumping them out by vertical drainage wells. This indicates, that it is possible to remove local ground water pressure and change the existing structure of the ground flow in the agricultural landscape.

1 Introduction

Among the unfavorable factors for planting and growing crops, the most common is the impact of climate change is widespread. According to the database of food and agriculture organization of the United Nations (FAO), more than 20% of the world's acreage and half of the irrigated land is affected by salt stress [12]. The plants, in natural conditions during ontogenesis, are under the influence of various stressors, that cause a negative impact on growth and development, which lead to a significant decrease in crop productivity.

Salinity is one of the main stressors, which is limiting growth and productivity of plant. It is mainly due to the increased sodium content in the soil. The high concentration of salts in the soil hinders the flow of water, disrupts the structure of the soil, reducing its porosity and impairing water absorption and having a toxic effect on plants, leading to a decrease in their productivity [1, 2, 3]. Salinization leads to the creation of a low (sharply negative) water potential in the soil, which greatly hinders the flow of water to the plant [5, 6].

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The Republic of Tajikistan, with a population of 9.1 million, is experiencing a lack of land, especially irrigated arable land. Only 0.09 ha of arable land per citizen of the Republic, and only 0.06 ha of irrigated land. In the coming socio-economic period, to the Republic of Tajikistan is facing acute problems of food security and household fuel. Therefore, the issues of combating desertification-soil degradation, protection of soil cover from further destruction and their restoration have become important tasks for a short-and long-term goal. This is especially touches for the valley irrigated zone, where the processes of soil degradation-desertification in the form of salinization and waterlogging-continue. The actuality of these tasks lies in the fact, that this territory has a high potential for bio – productivity like -6-10 t/ha. The good bio-productivity of plants is the main tool for the fighting against various types of soil degradation [4, 7, 8, 9].

Besides, the relatively wide spread of soil degradation is connecting with the character of mountain-valley with the geomorphological basis of irrigated land. In the zone of formation of water and associated chemical runoff rivers. There is an increase rapid in negative hydro-reclamation processes over short distances in Amudarya and Syrdarya. Aquiferous complex and their hydrogeological and hydro chemical processes the specific to each valley, they are diverse [10, 11]. The valleys and mountain slopes facing them are closely connected not only by the unity of geomorphogenesis, but also by the common formation of the climate of uplift and ground runoff, soils, vegetation, and wildlife. The development of modern irrigation, mainly in the foothills, high river terraces and elevated valleys, as a result of the development of large land masses, has radically transformed the relationships in the hydrogeological and meliorative systems of "Mountains-plains" [13, 14, 15].

2 Results and discussion

Exploration of the upper parts of these systems has turned the natural and economic systems of the irrigated territories into large complex and dynamic ones. The influence of the upper part of the systems on the lower lands subordinate to the relief has sharply increased. This quickly affected of their soil cover conditions. Over the past 40-50 years, reclamation systems (the Khojent - Konibodom massif) have had to be redesigned and rebuilt 3-4 times for individual irrigated massifs.

The similar pictures of the dynamics reclamation state of irrigated soils as a " mirror of the landscape" were typical for Dilvarzinsky, Zafarobod, Spitamen, and J. Rasulov massif. Irrigation of the 1st terrace of the Akgazinsky massif also caused a rise in the ground water level on the adjacent 5-6 km strip of the third terrace in the Vakhsh valley. In 2009, almost 110 thousand hectares of soils with varying degrees of salinity were recorded (table 1). Of these, 34 thousand hectares of natural salinity, i.e. these are newly irrigated lands (Asht, Tashrobod, Dangara and other massifs) that have not yet passed the necessary saline reclamation period. On an area of 76 thousand hectares, the observed salinization of soils is considered secondary. These are the lands of old-irrigated areas of the Vakhsh valley, the Khojent-Konibodom massif, etc. Their distinctive feature in this regard is, that the proportion of toxic salts in the salt composition has decreased to 10% or less. The proportion of toxic salts in naturally saline soils will be 20-30-50% of the dry residue [15-22].

A retrospective analysis of available materials over many years clearly shows, that the main factors in the formation of the reclamation state of the soil cover of the irrigated zone were both natural and organizational and technical, as well as methods of development of reclamation laid down in the concept, including, as it turns out now, unacceptable environmental and reclamation guidelines.

Table 1. Distribution of irrigated soils (ha) by salinity level, in a layer of 0-100 cm

Regions, districts	Non-saline	Lightly salted	Medium- salty salty	Highly salted
Soghd	197270	46682	10589	4776
DRS republican Republican Subordination	99906	130	28	25
Kulob	76486	2273	779	192
Bokhtar	197650	26504	14945	2620
Tajikistan	593449	75589	26341	7621

The existing concept of development of irrigated agriculture provided for the development of large tracts and proceeded from the inevitability of rising ground water levels and their subsequent regulation by drainage at a depth of 2-3 m with the mandatory implementation of a wash irrigation regime to prevent secondary salinization. This required the construction of deep horizontal (3-4 m) and vertical drainage. The rate of development of new land in 1970-1990 amounted to more than 9 thousand hectares per year, and the need for artificial drainage of land during this time increased from 219 thousand hectares to 310 or by 91.2 thousand hectares, i.e. 4.6 thousand hectares per year, which is equal to half the area of newly developed land. At the same time, the technology of drainage of irrigated territories has changed in terms of quality. Drains were built mainly of a closed type and vertical drainage was widely implemented. The rate of their construction was 3.4 and 2.3 thousand hectares per year, respectively. In this regard, some massifs have combined drainage.

Total and specific water consumption for irrigation since the second half of the 70 years increased from 9 km³ and 17 thousand m³/ha per year to 12.7 km³ and 20 thousand m³/ha, respectively. This high level of water consumption continued in 1980-1985 years, and then began to decline sharply. By 1989 and 1990 years, total water consumption for irrigation decreased to 10.75 km³/year, and specific water consumption to 15.2 thousand m³ / ha. In subsequent years, this relatively high level of water consumption is maintained. For example, in 1992, a value of 9.4 km³/year was recorded.

From 1970 to 1985, water discharge from irrigated lands gradually increased from 3.84 to 5.77 km³ / year, then stabilized with a slightly decreasing trend. The relatively low salinity of the drained runoff water-1.2 (1977) - 1.95 (1990) - indicates that the drainage network, in addition to drained ground water, also drains surface waste water from fields and irrigation network.

Calculations show, that the runoff collectors in 1970 amounted to 37.5 per cent in 1975 to 52.9% in 1980 to 40.6 per cent in 1985, and 43.6% in 1990 to 50.4% of water. As you can see, a large volume of water is diverted from irrigated oases.

The weighted average salinity of ground water shows, that the salinity of drainage water should be in the range of 2-2. 5 g / l. therefore, we can assume that at least 40% of drainage runoff is not used in the fields of irrigation water. Due to the low technical level of the irrigation network and the lack of discipline in the actions of water users, some fresh water is infiltrated from the channels of irrigation channels. The efficiency of irrigation systems during the period under review increased slightly - from 0.56 in 1970 to 0.65 in 1989, so the water use coefficient (Ccoefficient Ecological Use) is very low and is 0.4-0.5.

Increased drainage to prevent soil salinization during the hydromorphic regime increases the flow of drainage water to rivers and leads to a deterioration in the quality of irrigation water. This, in turn, requires strengthening the flushing mode of irrigation and even more strengthening of drainage, resulting in a vicious circle.

To clarify the situation at the present time, when the information field has greatly narrowed and lost some quality, we will use the data-TSME (table 2). It should be noted,

that the level of ground water (0-3 m) involved in soil formation processes is 29.6% of the total irrigated area. The level of ground water that causes increased soil profile hydromorphism-0-1.5 m is spread over an area of 37,351 thousand hectares (52%), and for a number of other sources even 60-65 thousand hectares.

Comparison of these data (table. 2) shows, that areas with a ground water level of up to 1 m increased by 2.6 thousand ha, with a level of 1 to 1.5 m by 3.6 thousand ha, and from 1.5 to 2.0 by 4.6 thousand ha. As we can see, there is a rise in close-lying groundwater. At the same time, the distribution of irrigated land by groundwater mineralization has not changed much in comparison with previous years. These are usually naturally poorly drained areas where an extensive drainage network has been built. However, the consequences of civil conflict and unstable market relations do not allow the drains to be maintained in working order. On the contrary, the area with deeper groundwater has decreased. For example, areas with a level of 2-3 m decreased by 35.2 thousand hectares, and with a level of 3-5 m by 6.0 thousand hectares.

Table 2. The distribution of irrigated land according to the level of the groundwater table, ha (2009)

Regions, district	Depth of ground water level, m					
	less than 1	1,0-1,5	1,5-2,0	2,0-3,0	3,0-5,0	more than 5
Soghd	1572	9051	11325	28750	33680	169921
DRS	444	1376	2692	8595	13693	73289
Kulob	870	5460	12180	21210	13754	26256
Bokhtar	5974	12604	23123	58925	92724	48377
Tajikistan	8860	28491	54330	117480	153859	339930

It should be noted that special tests of the drains' effect on the ground water level showed their very weak effectiveness even after their major cleaning. This test was carried out on the experimental section of vertical drainage of the Vakhsh valley in conditions of high ground water pressure, lack of vertical drainage and heavy granulometric composition of 6 m thick soils. This is due to the fact, that more or less successfully developed land with relatively better soils in terms of reclamation, and remained, of course, with heavy or very heavy characteristics. All this shows, that the old technologies for the development of saline soils on those, which have not yet been developed may not be effective, so fundamentally new technologies are needed.

The need to develop new approaches to regulating ecological and reclamation processes on saline land masses is dictated by several other considerations: the concept of complete discharge of salts from a large thickness of soil and groundwater should be considered erroneous, since it focuses on intercepting the geochemical flow that formed millions of years ago from the rising Pamir - Alai and Tien-Shan mountains towards the Aral basin. Its dialectical failure is obvious due to attempts to oppose the law of nature, especially at the global level, which contributes to a strong increase in the cost of land reclamation assigned according to this concept. This geochemical flow must flow in its natural way. Extracted to the daytime surface from almost 100 m of soil and ground water, the salt mass contributes to the generation of environmental crises, as is currently observed in the Aral Sea basin and in most of its basin.

The deep and ultra-deep drainage is a guide only to the technical solution of the problem without relying on the forces of nature itself. In addition, they are resource-intensive and resource-intensive. Both are unacceptable in the new conditions of society.

Access to fundamentally new technologies for conducting irrigated farming systems in General, including in terms of optimal regulation of reclamation processes, is seen in its full biologization. Adaptive agro-forest landscape farming is planned as a reference point for this.

All-round biologization of agriculture is a modern broad understanding of the "green revolution" not only in its selection content, but also the entire complex of agro technical,

ecological and meliorative measures for the modernization of traditional agricultural technologies. In the field of ecology and land reclamation, it is a supplement to the achieved organizational and hydro technical level of measures to combat the considered malicious type of degradation-desertification by bio-drainage plantations and soil bio melioration in cultivated fields, united in a single reclamation function.

Dokuchaev V. V. in her research noted about the biotechnical subsystem of irrigation systems created in this way, consisting of elements of living and inanimate nature, embodies the soil-forming process with the biological leading factor. This is probably the best approach to solving problems of protecting and improving the quality of the environment, including the soil cover.

By increasing the biodiversity, which is so necessary for the normal functioning of ecosystems in the agricultural landscape, biotechnical drainage helps to better use and increase the natural resource base. Bio-drainage elements are created on the ecological niches that are now formed in the degraded part of the irrigated zone and increase its KEI. This occurs through a productive, environmentally friendly transpiration process, while being included in the regulation of water-salt balances and agricultural landscape regimes, and this helps to reduce the discharge of brackish drainage waters into the Amu Darya and Syr Darya river channels.

Biotechnical drainage fits into the centuries-old agricultural way of life of the peoples of Central Asia, which empirically developed the rule “a tree (plant) ennobles the land”. Therefore, there is a reason to use this vast age-old experience in the scientific justification of a promising case in various soil and climate zones, and the population itself in their practical implementation. One of the decisive problems is the creation of a base of “household fuel”, the demand for which has increased very sharply in the coming transition period, which has shown the property of irreplaceability and its resource completeness. In the future, it is even possible to produce commercial household fuel and fake construction wood, medicinal raw materials and delicious berries, as well as secondary products in agro-forest landscapes.

Created from local materials (seedlings, cuttings, seeds) on existing drainage and irrigation networks, biotechnical drainage will be 3-4 times cheaper both in creation and in operation compared to purely hydraulic. In their functions, bio-drainage elements are mainly aimed at the underground element-regulation of the ground water level, possibly also at their speed, deduction of soil and ground humidity, and through them on the water-salt balance and modes in agricultural landscapes. This is their difference from protective forest stands, which resist the air element-active wind activity and atmospheric drought, so they are created in rectangular-square configurations.

Bio drainage, in accordance with the laid drains and collectors, will have a spruce-like localization supplemented with inter-wind tree strips so that on the terrain, or rather in its underground part, they would form geochemical basins of ground water runoff.

In table 3 we performed a numerical simulation according to the second principle transpiration and drainage capabilities of the bio on the example of a 400-hectare pilot area vertical drainage in the Vakhsh valley. The estimation showed, that a bio-drainage consisting of local tree species under a certain arrangement can transpire a volume of water commensurate with and even superior to pumping them out by vertical drainage wells. At the same time, it (bio-drainage) it was able to completely block the infiltration of water from the on-farm irrigation network. This indicates, that it is possible to remove local ground water pressure and change the existing structure of the ground flow in the agricultural landscape.

Table 3. Approximate calculation of transpiration under different bio - the saturation plots of vertical drainage

Name of trees	Transpiration, m3 / tree per year!	Total consumption of water transported by trees, thousand m3					1 row on the sprinkler -2 rows on the KDS+MD, m3 / ha	-2 rows per sprinkler, 4 rows per CD +MD м³/га
		drains-12400 p. m.			sprinklers - 8000 p. M.			
		2 ряда	3 ряда	4 ряда	1 ряд	2 ряда		
Turanga	12	99,2	148,8	198,2	32,0	64,0	0,3	0,6
Elaeagnus	33	272,8	409,2	545,6	88,0	176,2	0,9	1,8
Apricot	33	204,6	306,9	409,2	66,0	132,0	0,7	1,4
Silks'	66	409,2	613,8	818,4	132,0	264,0	1,4	2,8
Poplar	83	2058,4	3080,6	4116,8	664,0	1328,0	6,8	13,6
Willo	91	752,2	1128,4	1504,4	242,0	485,4	2,5	5,0
Eucalypust	100	620,0	990,0	1240,0	200,0	400,0	2,0	4,0

3 Conclusions

1. Integration of hydraulic drainage with biological drainage in a single system has its own specifics. These are issues related to the soil and hydro technical components of the irrigated massif and their characteristics, as well as issues related to bio-drainage and bio melioration. The existing studies show, that there are two ways of integration: passive and active. Passive, through the selection of salt-resistant and moisture-loving tree crops and their transpiration capacity. This makes it difficult to select breeds. Active also offers a special reclamation survey of the sides of drains and reservoirs and the use of reclamation measures aimed at achieving good survival and survival of young seedlings. However, in this case, the selection of crops is somewhat easier-by evaluating their transpiration capacity. Transpiration capabilities of plantings can be enhanced by creating an undergrowth of shrubs or semi-shrubs.

2. Bio-drainage consisting of local tree species under a certain arrangement can transpire a volume of water commensurate with and even superior to pumping them out by vertical drainage wells. At the same time, it (bio-drainage) it was able to completely block the infiltration of water from the on-farm irrigation network. This indicates, that it is possible to remove local ground water pressure and change the existing structure of the ground flow in the agricultural landscape.

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