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GEOLOGICAL ENGINEERING

THE PROCESS OF SOIL SALINIZATION IN THE IRRIGATED TERRITORIES

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Abstract: *The paper studies salinization of soils in the areas of the Syrdarya region as a result of influence human economic activities. The peculiarities of salinization problems, which was an integral part of land degradation, are considered. In general, the authors in the article "salinization of soils" are considered as a decrease or loss of biological and economic productivity of irrigated lands or areas under the influence of natural and anthropogenic factors. The object of the study was the irrigated territories of the Hungry Steppe belonging to the Syrdarya region, were there is a significant rise in groundwater of 1.5-3m and more, compared with natural conditions since 1960, 5.0-10m. The purpose of the research is aimed at studying the geotechnical properties and state of irrigated soils and grounds, taking into account natural conditions and influence of anthropogenic factors. The degradation of soils of the Hungry Steppe is currently caused by: depletion of the surface soil layer due to wind and water erosion; changes in the chemical composition of the soil and biological environment caused by salinization oxidation and rarely pollution; accelerated loss of nutrients obtained from mineral and organic substances of the soil and the loss of the organic matter itself; compaction and loosening of the soil in connection with the development of infrastructure and housing. The geotechnical properties of the irrigated areas of the Syrdarya region - mainly salinized to varying degrees by weak, medium, and sometimes strong salinization. The ameliorative well-being of irrigated lands in the irrigated part of the study area is unstable, i.e. on these lands, groundwater remains moderately (3–10 g/l) and strongly (> 10 g/l) mineralized.*

Keywords: *degradation, saline soils, groundwater, desertification, reclamation conditions, hydrogeological and engineering-geological conditions, Hungry steppe.*

INTRODUCTION. As is known, in the course of the soil-forming process, heterogeneous soils are formed from a monotonous rock. Basically, they are divided into some horizons. The horizons differ from each other in their gross chemical composition, the content of humus (soil and vegetation layer), simple salts, colloids, exchange cations, etc. Basically, among the morphological features, the most important is the structure, color, texture and addition of the so-called upper horizon. The main coloring substances in the soil are: humus (black, black-brown, cherry, etc.); iron hydroxides (red and ochre); simple easily soluble salts (white). In addition, the essential morphological features of the soil are its thickness, which can fluctuate several tens of centimeters. Hydromorphic gypsum-bearing soils (gray-meadow, meadow, meadow-swamp) semi-hydromorphic (light gray-earth and meadow-gray-earth soils) with the corresponding water-salt regime are common in the studied territory [5]. Within 40-50 years, the content of humus and nutrients has decreased in the soil conditions of the territory.

Various types of desertification and degradation of soils have been identified: intensive salinization, water and wind erosion, pollution by heavy elements from pestecides. There was over-compaction of soils, partial salinization, deterioration of physical and chemical parameters and biological activity. This caused a decline in land fertility. The peculiarity of these soils is characterized by light gray, white, sometimes brown color, very low humus content (up to 2% in the upper 0.1-0.2 m horizon).

Worldwide, desertification and drought occupy a special place among the modern global problems, hindering the sustainable development of the economy. In this regard, the study and assessment of engineering and geological conditions of irrigated and newly irrigated areas of the Hungry Steppe is an urgent problem. This is due to the conduct of the regional research aimed to assess the hydrogeological and reclamation conditions of the territory and the study of the predicted groundwater resources of the Neogene-Quaternary deposits in connection with the change in water conditions of the Hungry Steppe area on the territory of the Syrdarya region. In general, the soil conditions of the Hungry Steppe are an exhaustive resource, and its consumers are citizens of the republic, although not everyone realizes this. Almost 98% of the products that we consume come to us from these lands [2-4].

The process of desertification means the degradation of soils in drylands as a results of various natural factors, including human activities. In our case, degradation of soils of the Hungry Steppe is caused by: depletion of the surface layer of the soil due to wind and water erosion, and changes in the chemical composition of the soil and biological environment caused by salinization or pollution.

The object of research is the irrigated and newly irrigated territories of the Syrdarya region, where there is a significant rise in groundwater of 1.5-3 m and more, compared with natural conditions since 1960-70, 5.0-10 m. In recent decades, flooding due to the rise of groundwater in large areas of the Syrdarya region, occur because of violations of the rules of artificial irrigation, which creates additional difficulties, both in the cultivation of cotton, and in the construction of engineering structures, underground communications and drainage systems (vertical, horizontal drainage, etc.)

MATERIAL AND METHODS. The Syrdarya region is characterized by approximately uniform natural and climatic, geomorphological and geological-reclamation conditions for the desert zone of the Hungry Steppe [10, 11, 14-16]. The purpose of the research is aimed at studying the geotechnical properties and state of irrigated soils and grounds, taking into account natural conditions and anthropogenic factors. To achieve this goal, the following tasks were set: to identify the causes of the formation of both areal and deep distribution of saline soils and grounds; to establish regional features of salt accumulation; to assess the land reclamation state of the territory of the Syrdarya region.

Specific features are expressed in a sharp change in the water-physical properties of soils when interacting with water. In this regard, we have studied the engineering and geological properties both in the natural saline and in the destroyed state. Taking into account a large complex of definitions and naturally heterogeneous composition and properties of soils, the selection of monoliths from pits was carried out with a size of at least 30x30x30 cm [9]. The monoliths were selected from all the selected lithological-genetic and textural differences of soils in depth and area. The total number of monoliths and samples made it possible to obtain reliable values for the calculated indicators for each rock difference. In general, the methods of engineering and geological study of saline soils are well developed; many of them are standardized and are given in regulatory documents, manuals and methodological recommendations [1-3, 8-11, 14, 15].

Some Russian departments (for example, State Committee on Land Resources and the Ministry of Ecology) recommend using their methods for assessing physical soil degradation [3], the essence of which is approximately the same - the assessment of soil deterioration in relation to a certain initial state. In fact, the only sources of information for judging the presence of physical degradation and subject to hypergene changes are the results of comparative observations in non-irrigated and irrigated areas of long-term field geotechnical studies accompanied by experimental studies. Based on these sources of information, it seems important to us to systematize the processes in soils related to hypergenesis and physical degradation, to establish its causes, a clearer diagnosis, possible distribution areas, and to search for ways to prevent it.

RESULTS AND DISCUSSION. A widespread rise in the level of groundwater is observed in the study area. Considering that the way of groundwater recharge in the Syrdarya region as a whole is atmospheric precipitation and infiltration from irrigation canals. There is no discharge of groundwater in the central and eastern parts of the study area. In conditions of irrigation management, with a sharp change in the water regime of the studied territory, it is not uncommon for the level of saline groundwater to rise to such a height in which capillary uplift and evaporation occur, as a result of which easily soluble salts are enriched with crystals and powder. These include sodium (NaCl), potassium (KCl), calcium ($CaC1_2$) and magnesium ($MgCl_2$) chloride salts, sodium bicarbonate ($NaHCO_3$), sodium (Na_2SO_4) and magnesium ($MgSO_4$) sulfate. The medium-soluble salts include gypsum – $CaSO_4 \cdot 2H_2O$ and anhydrite – $CaSO_4$. [8, 9, 16].

The paper uses the results of mining and experimental filtration studies of irrigated and newly irrigated territories of the Syrdarya region. Based on these comparative studies, conclusions will be drawn about the change in physical properties, which we interpret as degradation and supergene changes in soils. As indicators of these processes, we used the results of studying the macro- and micro-morphological and textural structure of soils and individual soil aggregates, structural and textural composition, water resistance of aggregates, porosity, and the ratio of vertical and horizontal pores - anisotropy.

According to the methodological manuals for conducting hydrogeological and geotechnical studies [1, 4, 5, 6, 7, 18], it is recommended to describe the lithological composition of rocks in the outcrop and their stratigraphic position in little detail. The procedure for describing the soils was carried out in the following sequence: a) petrographic name; b) mineralogical composition of the rock; c) the color of the rock; d) impurities and cement of the rock; e) density; f) structure and texture; g) layering and various features associated with the conditions of formation of the rock; h) inclusion; i) fractured rock; j) fauna and flora; k) estimated age.

As noted above, the color of the soils and ground can often indicate the genesis of the rock and its properties. So, in our studies, bright red shades caused by the presence of anhydrous iron oxide (Fe_2O_3) or hydroxides ($2Fe_2O_3 \cdot H_2O$), gypsum ($CaSO_4 \cdot 2H_2O$) indicate continental formation conditions, a rather dry and hot climate. It should be borne in mind that the rocks in a fresh fracture often have a color or shade different from the color of the rock at the surface. This last circumstance is caused by the processes of weathering: oxidation, reduction and decomposition of the main rock-forming minerals. Many features of the rock were determined by eye and hand; for example: the sand content and clay content of the rock were determined by hand by rubbing or rolling the rock; iron content was recognized due to the rusty color of the rock; micaceous content was determined by the glitter of mica plates; the presence of water-soluble salts in terms of the content of crystals in soils - potassium and sodium hydrates, contributing to the formation of the so-called “puffy” units of bright white color in the section, which is a loose, dusty medium.

The density of soils was described as follows: sands and sandy loams are subdivided into loose, compacted (packed), clays, clay loams in terms of viscosity, plasticity. When describing the structure and texture of the rock, the shape, location and size of the minerals that make up the rock are noted. If there are grains of various sizes in the rock, secondary formations are described as uneven-grained. The grain sizes are determined using a pie chart, and with a known skill, they can be determined by eye.

To determine the filtration coefficient of non-water-saturated soils, i.e. soils lying in the aeration zone, the authors use the method of filling water into the sump. The essence of the method consists in creating a vertical filtration flow, seeping through dry soil down from the bottom of the sump, measuring the cross-sectional area of the flow and the flow rate. Water is absorbed by dry soil and moves in it not only under the action of downward gravity, but also under the action of capillary forces that can act in all directions. As the soaking depth increases, the rate of change in the moistening figure slows down, and the water flow rate for infiltration from the sump stabilizes. Thus, according to this method, the value of the filtration coefficient was established only approximately, but with an accuracy that is quite acceptable for practical purposes.

Experimental filtration work on the study of the filtration coefficient of various genetic types (in our case, $aQ_{IV}sd$ and $apQ_{III}gl$ of the Quaternary age) of saline sandy loam and sandy loam soils showed that the filtration coefficient is determined by a natural combination of features of their composition, state and nature of structural bonds.

The comprehensive studies carried out on the territory revealed that groundwater has a multifaceted effect on the formation of secondary salinization zones in the soil section. In the studied reference areas, groundwater occurs at a depth of 0.5-0.75 to 2.0-2.5 m. Depending on the general mineralization, the ground waters of the territory have average (from 5 to 15 g/l) and high (from 15 g/l and more) mineralization, according to the chemical composition, the groundwater is mainly chloride-sulphate-sodium-magnesium, and rarely sulphate-potassium-sodium (fig.1, table1).

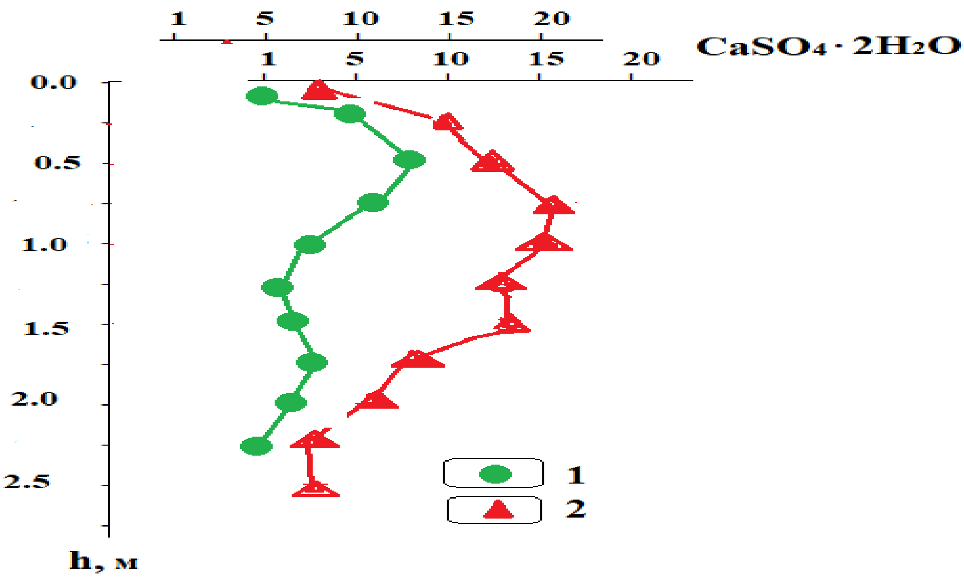

Fig. 1. Comparative diagram of gypsum changes in depth for different periods:
1 - Results of stock materials of 1960 - 70; 2 - results of personal research

The composition of salts in soils is largely related to the composition of groundwater. The mechanism of this process is very complex. Usually the composition of salts in soil and saline groundwater is not the same. The composition is explained by the fact that, saturating the soil, the composition of groundwater undergoes significant changes due to various chemical, physical-chemical and biological reactions. An example is some transformation, which undergo, getting into the soil, sodium sulfate, which is widespread in the composition of groundwater.

Table 1

Summary table of the chemical composition of groundwater in the Syrdarya region (Compiled by the authors)

Administrative testing area	Dense residue, g/l	Chlorine, Cl^-, g/l	Sulfate, SO_4^-, g/l	Type of salinity
Syrdarya district	6,99	0,908	3,190	chloride-sulfate potassium-magnesium, chloride-sulfate-sodium-magnesium, lfate-magnesium-potassium
Saykhunabod district	6,57	0,431	3,715	sulfate-sodium, chloride-sulfate-sodium
Mirzaobod district	14,18	1,328	7,258	chloride-sulfate-magnesium-sodium, chloride-sulfate-magnesium-sodium, chloride-sulfate-sodium
Gulistan district	8.3	0,362	4,064	sulfate-magnesium-sodium, sulfate-potassium-magnesium
Akaltyn district	7,71	0,756	4,179	chloride-sulfate-magnesium-sodium, chloride-sulfate-potassium-sodium, chloride-sulfate-sodium-magnesium
Sardoba district	10,93	1,260	5,328	chloride-sulfate-magnesium-sodium, sulfate-sodium-potassium, sulfate-potassium-sodium, chloride-sulfate-sodium, sulfate-potassium-magnesium

Rising through the capillaries, sodium sulfate can enter into a physical-chemical reaction with the absorbing substance of soils containing exchangeable calcium. In this case, the sodium cation enters the absorbed soil, displacing calcium from there, and gypsum is deposited. This leads to the formation of a gypsum horizon in the soils and ground. An increase in the critical level of groundwater with increased mineralization sharply worsens soil reclamation conditions. The frequency of capillary uplift leads to the processes of desertification and secondary salinization.

In addition, in the study area, there is no discharge of groundwater to the waste drainage systems during the operational and reclamation periods. The provision of surface natural runoff to drainage systems is still not efficient enough. Against the background of an increase in the level of groundwater in the Hungry Steppe, a widespread deterioration of the reclamation state of soils occurs due to secondary salinization. This comes from the impact of large canals and irrigation systems contributing to the rise in the level of groundwater. Salinization leads to the formation of gypsum horizons approximately at depths from 0.75-1.0 to 1.5 m (table 2). An interesting fact is that private farms (Khavas, Mirzaabad and Boyovut districts) extract a gypsum horizon and equip mini-greenhouses at a depth of 1.0-1.5 m (fig. 2).

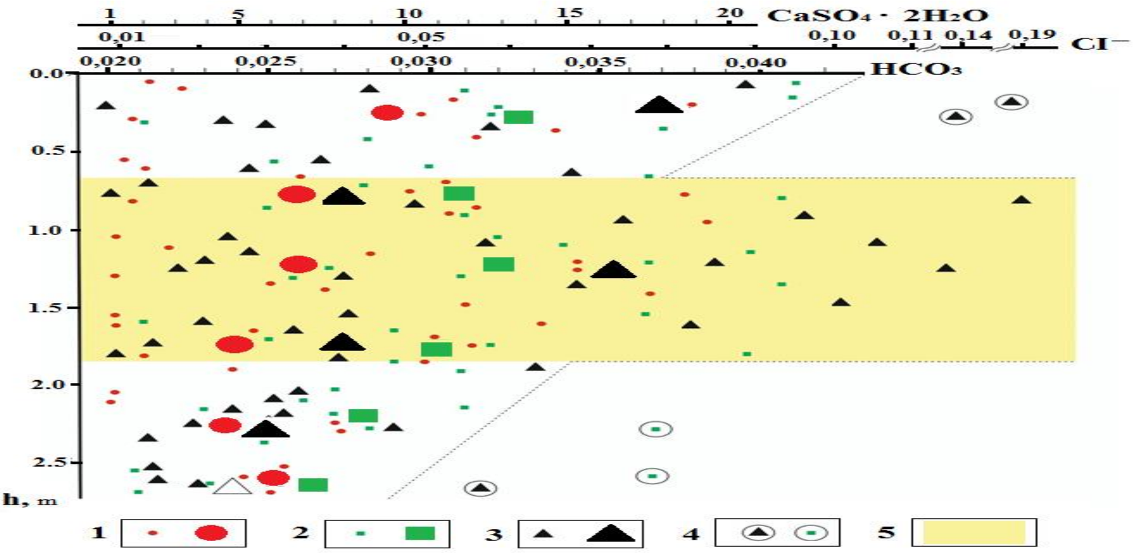

Fig. 2. Change with the depth of the parameters: Gypsum $CaSO_4 \cdot 2H_2O$; Cl^-; and HCO_3.
1-Indicators of $CaSO_4 \cdot 2H_2O$ with average values for depth; 2-indicators of Cl^- with average values for depth; 3-indicators of HCO_3^- with average values for depth; 4-possibly erroneous indicators;
5-a dense zone of secondary formed salts. (Compiled by the authors).

The presented data show that the quantitative values of the dense residue are in very wide ranges: from slightly saline 0.35-0.485% to highly saline 2.02-2.65%. The composition of water-soluble salts in saline soils is very diverse, but in this case, these salts are combinations of only three cations - sodium (Na^+), magnesium (Mg^{++}) and calcium (Ca^{++}) and three anions - chlorine (Cl^-), sulfate (SO_4^{--}), and bicarbonate (HCO_3^-). It is obvious that the formation of the following salts is possible from them: NaCl, Na_2SO_4, $NaHCO_3$, $MgCl_2$, $MgSO_4$, $Mg(HCO_3)_2$, $CaCl_2$, $CaSO_4$, and $Ca(HCO_3)_2$ (table 2).

Note: CH-S - chloride-sulfate; S – sulfate; Source: (Compiled by the authors).

Thorough study of saline soils in the Syrdarya region revealed their different sensitivity to water. In the study area, a dense saline zone is established at a depth of 0.75-1.0 to 1.5 m, depending on the texture, structure, content and composition of re-formed salts (amorphous silica -SiO_2, gypsum - $CaSO_4 \cdot 2H_2O$, etc.). The formation of the zone is possibly associated with the capillary rise of saline groundwater, and due to the influence of the arid climate, a dense zone of re-formed salts appears. This zone negatively affects the reclamation state of the soils of the irrigated area.

In our case, according to the graph of the change in water consumption from time, sandy loams, being sufficiently strong in a saline state, in the process of leaching are additionally hydrated, softened and sharply weakened to varying degrees, passing from the initial one, their ameliorative state improves and in the areas of settlements and central farmsteads of the region, the relationship of soil with water leads to leaching of salts; in sandy loams, coagulation and crystallization structural bonds are weakened and broken, which leads to a sharp decrease in strength and a change in the deformation behavior of soils. The above materials are mainly used by agronomists, builders of drainage systems, meliorators and other specialists to choose the best technical and economic solutions in accordance with natural conditions.

Table 2.

Summary table of water-physical properties of soils of the Syrdarya region in percentage.

The testing area for sting area	Sampling depth, in meters	Humidity, in %	Dense residue	Salt ions, in % to the mass of the soil					Type of salinity	Gypsum $CaSO_4 \cdot 2H_2O$	CO_2 Carbonates
				HCO_3	Cl^-	SO_4^-	Ca	Mg			
Syrdarya district	0.0	-	0.86	0.041	0.091	0.4	0.127	0.009	CH-S	2.21	6.28
	0.0 - 0.5	21.8	0.485	0.025	0.038	0.225	0.071	0.014	-//-	1.63	6.63
	0.5 - 1.0	32.8	0.405	0.032	0.024	0.21	0.112	0.011	-//-	1.25	5.98
	1.0 - 1.5	23.9	0.63	0.037	0.042	0.305	0.084	0.019	-//-	13	6.05
	1.5 - 2.0	30.4	0.7	0.027	0.035	0.3	0.136	0.015	S	1.31	6.01
Saykhunabad district		-	1.04	0.031	0.045	0.615	0.032	0.013	-//-	3.42	5.57
	0.0 - 0.5	34.5	0.86	0.03	0.021	0.515	0.08	0.018	-//-	2.26	6.28
	0.5 - 1.0	30.1	0.35	0.034	0.059	0.135	0.156	0.029	CH-S	3.08	6.45
	1.0 - 1.5	21.7	0.39	0.021	0.024	0.21	0.143	0.022	S	1.35	5.93
	1.5 - 2.0	21.8	0.31	0.026	0.031	0.189	0.135	0.014	-//-	1.23	5.26
Gulistan district		-	2.65	0.041	0.199	1.475	0.032	0.010	-//-	11.73	5.93
	0.0 - 0.5	26.5	2.02	0.037	0.07	1.175	0.052	0.017	-//-	7.12	5.56
	0.5 - 1.0	34.3	1.43	0.04	0.028	0.86	0.034	0.019	-//-	9.32	6.16
	1.0 - 1.5	34.6	1.28	0.029	0.035	0.785	0.143	0.02	-//-	5.7	5.98
	1.5 - 2.0	29.0	2.14	0.031	0.027	1.3	0.102	0.016	-//-	6.2	4.98
	2.0 - 2.5	30.2	2.04	0.021	0.017	1.215	0.063	0.012	-//-	6.43	5.98
Mirzaobod district	0.0	-	0.425	0.032	0.01	0.261	0.258	0.029	-//-	18.87	5.75
	0.0 - 0.5	14.6	1.44	0.028	0.014	0.81	0.132	0.031	-//-	11.75	6.28
	0.5 - 1.0	11.2	1.13	0.037	0.023	0.679	0.152	0.034	-//-	15.06	7.16
	1.0 - 1.5	14.2	0.675	0.025	0.007	0.397	0.134	0.03	-//-	11.21	6.63
	1.5 - 2.0	11.2	1.29	0.027	0.035	0.77	0.143	0.022	-//-	5.52	6.16

Boevut district		-	1.11	0.029	0.14	0.76	0.122	0.028	-//-	10.7	6.68
	0.0 - 0.5	-	1.04	0.031	0.01	0.66	0.150	0.034	-//-	10.43	6.94
	0.5 - 1.0	15.6	1.03	0.021	0.021	0.689	0.154	0.038	-//-	15.06	7.16
	1.0 - 1.5	15.8	0.585	0.032	0.017	0.387	0.157	0.031	-//-	12.14	5.98
	1.5 - 2.0	21.1	0.965	0.028	0.021	0.52	0.08	0.026	-//-	8.12	6.31
	2.0 - 2.5	21.8	0.965	0.037	0.018	0.54	0.072	0.018	-//-	5.12	6.16
Akaltin district			0.38	0.021	0.059	0.156	0.043	0.012	CH-S	1.84	5.45
	0.0 - 0.5		2.07	0.041	0.392	0.901	0.032	0.029	-//-	1.78	5.28
	0.5 - 1.0	20.7	0.805	0.037	0.147	0.383	0.045	0.031	-//-	1.33	5.91
	1.0 - 1.5	28.6	0.7	0.04	0.116	0.345	0.048	0.034	-//-	2.1	5.98
Khovos district	0.0		1.56	0.037	0.027	0.99	0.102	0.032		14.68	5.98
	0.0 - 0.5		1.9	0.025	0.049	1.18	0.063	0.038	-//-	12.58	5.34
	0.5 - 1.0	22.6	1.83	0.027	0.042	1.155	0.258	0.028	-//-	6.1	4.4
	1.0 - 1.5	20.5	1.345	0.029	0.042	0.77	0.132	0.026	-//-	10.86	5.46
	1.5 - 2.0	21.8	1.14	0.037	0.014	0.66	0.152	0.018	-//-	8.43	6.94
	2.0 - 2.5		1.03	0.023	0.021	0.68	0.134	0.015	S	6.06	4.16
Sardoba district	0.0		1.685	0.028	0.084	086	0.122	0.038	-//-	12.46	6.26
	0.0 - 0.5		1.71	0.031	0.098	0.89	0.109	0.028	-//-	10.86	5.29
	0.5 - 1.0	28.6	1.86	0.026	0.07	0.98	0.093	0.026	-//-	7.65	6.33
	1.0 - 1.5	28.6	2.03	0.035	0.066	1.225	0.032	0.018	-//-	4.98	6.36
	1.5 - 2.0	33.9	1.714	0.025	0.047	1.327	0.101	0.015	-//-	6.21	4.81
	2.0 - 2.5	-	1.643	0.021	0.057	1.219	0.095	0.038	S	6.18	5.65

Thus, according to the research results, the marked horizon of salt accumulation is marked in the drawing: water shortage-lack of water resources to meet the biological needs of agricultural crops and other vegetation species for their normal growth and development, as well as environmental requirements for stabilizing the development of salt accumulation and degradation processes; drought a long period of the year with insufficient precipitation at elevated air temperatures; climate aridization-increasing the aridity of the climate due to an increase in air temperature, evaporation and a decrease in precipitation; - felling of trees and shrubs-denudation of the territory of growth and development of forest stands, which led to a violation of snow retention, accumulation of moisture reserves, soil erosion in the form of flushing and erosion, and the development of ravine formation processes; lack of drainage lack of availability of groundwater outflow in the natural-historical development of the territory and general drainage flow during artificial drainage to prevent the rise of groundwater and, as its consequences, flooding and secondary salinization in the process of irrigation and land development.

Accumulation in the aeration zone (the layer located between the earth's surface and the ground water level) due to the transfer of salts by underground tributaries of the studied territory, which subsequently creates a weakly permeable saline horizon above the ground water level, in the aeration zone.

The amount of salt accumulation depends on the intensity of the flow (capillary rise) of groundwater. In this case, the intensity of salt accumulation depends on the salinity of rocks, underground waters and soils, the hypsometric location of the territories and the degree of mineralization of underground waters transiting into the irrigated massifs located below. In addition, salt accumulation is formed due to the transfer of the weathered product of rocks and salts under the influence of wind activity of the climate.

CONCLUSION. Based on the foregoing, the following conclusions can be drawn:
-changes in the composition and properties of soils in the irrigated territories of the Syrdarya region are formed due to the formed groundwater in a "critical" state, a large amount of surface irrigation water used for irrigation, which do not have sufficient outflow and are spent mainly on evaporation and transpiration, which creates prerequisites for the development of secondary salinization in poorly drained territories;
-dense saline zone was identified at a depth of 0.75-1.0 to 1.5 m, formed due to secondary salinization associated with the periodic capillary rise of saline groundwater and a dense zone of secondary salts accumulation is formed;
-the engineering and geological properties of the irrigated territories of the Syrdarya region are mainly attributed to the chloride-sulfate-sodium-magnesium, sometimes potassium-magnesium and magnesium-sodium type of salinization;
-reclamation well-being of irrigated lands of the studied territory is unstable due to groundwater, which remains medium (3-10 g/l) and strongly (> 10 g/l) mineralized.

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ECOLOGICAL CONSEQUENCES OF POSSIBLE EARTHQUAKES OF THE CHARVAK RESERVOIR COASTLINE

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Abstract: *The region of the Charvak reservoir, the nature of which is the subject of national pride of the Tashkent region, is practically involved in international tourism activities. The Charvak reservoir is a recreation area for workers, serves as a supplier of agricultural products and the only raw source of bismuth. Reservoirs are the main reservoir of drinking, irrigation water, and a source of electrical energy. Gravitational processes and other types of disturbances occurring on the slopes, bring not only material damage, but also human casualties. Therefore, any changes, primarily in the relief, significantly destabilize the existing landscape, and thereby lead to irreparable damage to the environment, unsuitable condition of life providing buildings, structures and areas of farmland of the population in the research area. The territory of the Charvak reservoir is characterized by a high level of seismic activity, assessment of the stability of slopes due to seismic activity and the problem of ensuring the safety of the population and the ecosystem is the most urgent task. In modern conditions, with colossal industrialization and the most popular among tourists, the area of the Charvak reservoir is actively being equipped with boarding houses and recreation areas. An increase in population density, disruption in the functioning of natural ecosystems and anthropogenic systems, in particular, environmental protection management, the impact of earthquakes on the manifestation of geological and techno genic processes of the ecological crisis is becoming increasingly significant.*

Keywords: *gravitational processes, landslides, landslides, rock avalanche, landslide body, abrasion, gully erosion, cracking, deformation, seismic activity, magnitude, ecosystem.*

INTRODUCTION. The studied territory of the Charvak reservoir is a recreation area for workers, serves as a supplier of agricultural products and the only raw source of bismuth. The reservoir itself is the main reservoir of irrigation, drinking water and a source of electric energy. The territory of the Charvak reservoir is characterized by a high level of seismic activity, and therefore the problem of ensuring the seismic safety of the population and the ecosystem of