UDC 551.5.539.215.2 (262.83)

FRACTIONAL AND SALT COMPOSITION OF SOILS OF THE DRAINED PART OF THE BOTTOM OF THE BIG ARAL SEA

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Аннотация. Мақолада Орол денгизининг қуриган қисмида тупроқлари таркибига оид маълумотлар келтирилган. Тупроқларнинг механик таркиби, гумус билан таъминланиши, pH даражаси, тузлар таркиби ва миқдорига оид янги маълумотлар баён этилган. Тупроқларнинг шўрланиши даражаси ва заҳарли тузлар таркиби таҳлил қилинган.
Калит сўзлар: Орол денгизи қуриган туби, механик таркиб, гумус, pH, шўр-ланиш даражаси, тузлар таркиби, заҳарли тузлар.

Аннотация. В статье представлены материалы, касающиеся состава почв в засушливой части Аральского моря. Приведены новые сведения о механическом составе почв, обеспеченности гумусом, уровне pH, составе и количестве солей. Анализирован степень засоления почв и содержание токсичных солей в почвах.
Ключевые слова: сухое дно Аральского моря, механический состав, гумус, pH, степень засоление, содержание солей, токсичные соли.

Annotation. The article presents materials related to the composition of soils in the arid part of the Aral Sea. New data on the mechanical composition of soils, availability of humus, pH level, composition and amount of salts are given. The degree of soil salinity and the content of toxic salts in soils have been analyzed.
Key words: dry bottom of the Aral Sea, mechanical composition, humus, pH, degree of salinity, salt content, toxic salts.

One of the serious problems in the last few years is soil salinization, which leads to land degradation. According to scientific research, the share of saline soils in the world accounts for about 1 billion hectares of the earth's surface, the largest part of which falls on arid and semi-arid regions [1,2,3]. In the world, more than 1.5 billion people face serious problems related to food production, because soil salinization significantly limits the production of agricultural crops and, as a result, there is a negative impact on food security. [4,5]. Determination of soil salinity in arid regions is one of the effective indicators for assessing soil salinity [6,7]. And conducting proper and effective monitoring of local dynamics of soil salinization is especially important for assessing sustainable land management in arid regions.

Since 1960 of the twentieth century, there has been a rapid decrease in the water level in the Aral Sea, due to the withdrawal of water from the main feeding rivers of the Amu Darya and Syr Darya. As a result of a reduction in the area and volume of water,

ISSN 2181-0826 2/2023 y.

an increase in its salinity, there has been a deterioration in soil and climatic conditions on the drained bottom and the Aral Sea, desiccation and desertification of the delta and floodplain of rivers, changes in the groundwater level, sand drift of previously fertile lands - which has led to the formation of a new land called "Aralkum".

Lowering the level of the Aral Sea leads to a sharp increase in the salt content in the water, and its drying leads to the formation of high salinity of the exposed seabed, due to the fact that the salt of sea water remains in the soil. The dried-up bottom of the Southern Aral Sea has become a source of salt and dust storms, which can be transported over long distances, up to the Siberian Plain and the Iranian Plateau [8-10]. The drying up of the Aral Sea caused great damage to the environment (air pollution, degradation of land and vegetation species diversity) [11,12], as a result of which serious health problems of the inhabitants of this region appeared (an increase in the number of respiratory and reproductive diseases, as well as oncological diseases) [13-15].Determination of the distribution of salinity of the soils of the exposed seabed is the basis for solving a number of environmental problems. Conducting studies to assess the global distribution of soil salinity [3, 4, 16, 17] and the coastline affected by salinity [18] helps to better understand changes in soil salinity and its distribution in large-scale spatio-temporal variations. To date, no such studies have been conducted on the drained bottom of the Aral Sea. Studies were conducted on the collection and analysis of soil samples from the drained seabed in the north-east of the Southern Aral Sea [19], on the distribution of salinity indices in this area [20]; however, the timeline, regional distribution, and accuracy are limited. There is no comprehensive assessment of the spatial patterns of soil salinization and the processes of change on the dry seabed of the Aralkum. It is well known that there is a strong salinization of the soil in the area of the Aral Sea retreat [19,20], but few studies have been conducted on the distribution and changes in soil salinization.

Thus, in order to develop strategies for ecological restoration in the areas of retreat of the Aral Sea, it is necessary to conduct a continuous analysis of temporal and spatial models of the distribution of soil salinity. This is the main and key issue in stopping salinization and increasing soil productivity.

Materials and methods

The soil was prepared for analysis as follows:

- to determine the cation-anionic composition according to GOST 26423-85 – soil samples were dried to an air-dry state, then crushed with a porcelain pestle and sifted through a sieve with round holes with a diameter of 1 mm;
- to determine the organic matter (GOST 26213-91), plant roots were removed in each sample before crushing with tweezers, then the soil was crushed with a porcelain pestle and sifted through a braided sieve with holes 0.25 mm in diameter.
- to determine the mechanical composition, soil samples were crushed in a porcelain mortar with a pestle with a rubber tip and sifted through a sieve with holes with a diameter of 1 mm (O'ZDST 817-97).

The analyses were carried out according to generally accepted methods.

pH, EC, TDS, HCO3, Cl, SO4, Ca, Mg, Na were determined according to GOST 26423-85 – GOST 26428-85 Method for determining the cationic – anionic composition of an aqueous extract. Humus in the samples was determined according to GOST 26213-91 – The method for determining organic matter, the mechanical composition was determined by the Kajinski method [26].

Both the FAO international classification and domestic classifications were used for the assessment [21-24].

Earlier, we reported on studies along the route and descriptions of points of the landscape, vegetation, and soil cover of the Southern Aralkum [25]. 56 soil sections were laid on typical selected sites and soil excavations were made up to 1.5 m deep. A morphological description of the profile according to the required format was carried out, genetic horizons were identified, soil samples were selected from the middle of which, a description

of soils according to genetic horizons and photographs of soil profiles were given.

In this paper we present the results of physico-chemical parameters, selected soil samples for humus content, qualitative and quantitative composition of water-soluble salts, as well as fractional composition. Laboratory analyses were performed by the laboratory of the Analytical Center for Quality, Composition and Repository of Soils under the Committee on Land Resources, Geodesy, Cartography and State Cadastre.

In the scientific expedition of 2019, the soil cover of the Muinok part of the Southern Aral Sea was studied. The Muynak part of the drained seabed is mainly flat with a general slope in the western and northern directions. In the middle of the massif there is a sand spit with dunes, currently connected to the Lazarevo Island. Table 1 and the map (Fig.1) show the coordinates and characteristics of the sampling site from 10 sections on the dried bottom of the Aral Sea.

Table 1

Coordinates and sampling locations on the dried-up bottom of the Aral Sea

Section №	Coordinates, altitude above sea level	Characteristics of the sampling site
K-4	44° 3'42.67"C 58°32'27.59"B	Salt marsh seaside, fragile-crusty, semi-automorphic, periodically washed takyrovidny surface. Plant community - *Halostachydeta belangerianae - Eremosparteta aphyllii*
K-7	44° 5'14.84"C 58°24'29.08"B	Sand with a lot of shell rock. It is covered with clay. Plant community - *Haloxyleta aphylly*
K-9	44°11'43.38"C 58°31'9.59"B	Salt marsh, fragile-crusty, semi-hydromorphic, furrows. There are no plants.
K-11	44° 9'15.75"C, 58°39'34.30"B	The salt marsh is crusty, semi-hydromorphic, furrows. There are no plants.
K-13	43°55'24.75"C 58°40'54.54"B	The salt marsh is crusty-plump, sealed automorphic, closer to the desert-sandy soil. Plant community -*Halostachydeta belangerianae - Haloxyleta aphylly*
K-14	43°50'56.35"C 59° 5'16.08"B	The salt marsh is automorphic, washed, compacted from a depth closer to the desert-sandy soil. Plant community – *Tamariceta hispidae*
K-16	43°58'49.40"C 59°17'40.07"B	Salt marsh, crusty, moderately hydromorphic, strongly saline from the surface, furrows. There are no plants.
K-18	44° 8'33.76"C 59°32'11.28"B	Salt marsh, crusty, moderately hydromorphic, strongly saline from the surface, furrows. There are no plants.
K-20	44° 8'1.06"C 58°52'20.03"B	Salt marsh, flimsy-crusty, semi-automorphic, plastered, sometimes sanded, slightly saline, furrows. Plant community – *Halostachydeta belangerianae - Eremosparteta aphyllii*
K-22	44° 9'13.25"C 58°51'17.71"B	The salt marsh is hydromorphic, crusty, furrows. There are no plants.

The mechanical composition of the soil is defined as the percentage of mechanical elements in them. It depends primarily on the rock from which the soil is formed, as well as on a number of processes that influenced its formation.

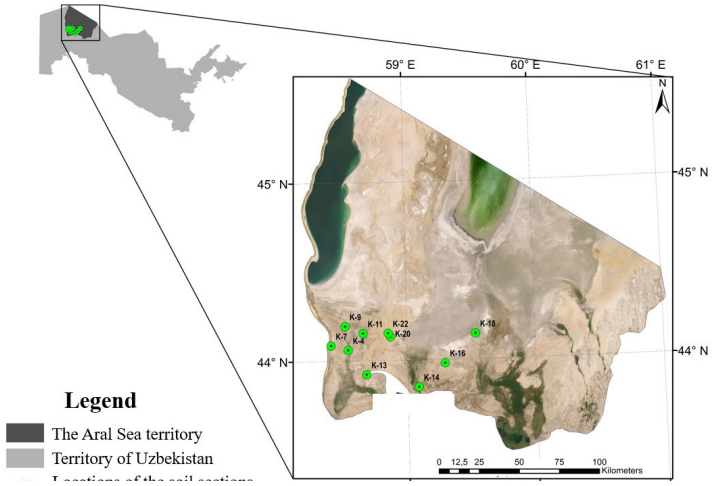


Fig.1 Location of soil sections

To study fractions, Professor N. A. Kachinsky developed a classification implying the division of soil into several types: sandy; sandy loam; loamy; clay [26].

The granulometric composition of the earth is directly related to its properties, as it significantly affects the agronomic characteristics.

The conducted studies on the granulometric composition of the selected samples of earth from the dried bottom of the Aral Sea are shown in Table 2.

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Table 2.

The results of the sieve analysis of soil samples taken at the excavation sites

Section №	Genetic horizon, cm	Weight of fractions (mm), in %					
		>0,25	0,25-0,10	0,10-0,05	0,05-0,01	Physical clay, <0.01	
К-4	0-2,5	11,6	50,5	17,3	13,5	7,2	Connected sand
	2,5-5	3,1	45,3	38,1	5,6	8,0	Connected sand
	5-13.	2,8	49,8	38,7	5,6	3,2	Connected sand
	12-31.	4,2	49,6	39,0	4,8	2,4	Connected sand
	31-53	13,3	50,1	30,3	3,2	3,2	Connected sand
	53-80	7,2	45,3	40,4	4,8	2,4	Connected sand
	80-96	0,5	0,2	76,3	15,9	7,2	Connected sand
К-7	0-1.	3,3	28,8	61,6	2,4	4,0	Connected sand
	1-12.	0,5	49,2	47,2	0,0	3,2	Connected sand
	12-17.	0,6	8,7	9,7	27,8	53,3	Heavy loamy
	dig	0,5	56,8	37,2	1,6	4,0	Connected sand
К-9	0-1,5	2,0	14,4	59,8	14,3	9,5	Connected sand
	1,5-20.	16,1	12,8	64,7	4,0	2,4	Connected sand
	20-30	4,0	22,7	42,3	27,8	3,2	Connected sand
	30-40	1,7	2,0	33,6	39,8	23,1	Light Loamy
	40-54	3,2	3,1	38,2	21,5	34,2	Medium loamy
К-11	0-2.	1,5	16,9	75,3	5,6	0,8	Connected sand
	2-6.	0,8	14,9	76,4	5,6	2,4	Connected sand
	6-13.	1,0	28,5	65,8	4,0	0,8	Connected sand
	13-20	4,7	34,6	56,8	2,4	1,6	Connected sand
	20-47	1,1	9,9	82,7	4,8	1,6	Connected sand
	under the tree	1,4	25,6	66,7	3,2	3,2	Connected sand
К-13	0,0-1,5.	24,8	25,7	27,3	10,3	11,9	Sandy loam
	1,5-5.	26,5	27,2	28,1	4,0	14,3	Sandy loam
	5-20.	56,5	22,3	3,8	8,7	8,7	Connected sand
	20-40	17,1	30,3	28,8	11,1	12,7	Sandy loam
	40-60	26,9	29,7	21,2	7,2	15,1	Sandy loam
	60-70	19,9	43,6	19,1	4,0	13,5	Sandy loam
	70-90	8,6	31,7	32,0	14,3	13,5	Sandy loam
	90-	35,0	19,6	22,4	8,7	14,3	Sandy loam
К-14	0-1,5	24,6	44,9	21,1	5,6	4,0	Connected sand
	1,5-10.	34,2	36,8	21,9	4,8	2,4	Connected sand
	10-13.	27,0	36,0	31,5	3,2	2,4	Connected sand
	13-35	29,5	57,0	5,7	4,8	3,2	Connected sand
	35-65	18,2	51,2	25,1	4,8	0,8	Connected sand
	under the tree	18,6	45,8	29,3	4,0	2,4	Connected sand

Section №	Genetic horizon, cm	Weight of fractions (mm), in %					
		>0,25	0,25-0,10	0,10-0,05	0,05-0,01	Physical clay, <0.01	
K-16	0-1	8,4	47,9	24,7	11,1	8,0	Connected sand
	10-25.	11,1	61,1	16,8	9,5	1,6	Connected sand
	25-40	80,8	17,6	0,1	0,8	0,8	Connected sand
	42-50	28,3	29,0	27,6	11,1	4,0	Connected sand
	50-60	16,5	20,7	21,5	21,5	19,9	Sandy loam
	60-80	66,0	27,5	2,6	2,4	1,6	Connected sand
K-18	0-1.	4,2	22,8	42,9	18,3	11,9	Sandy loam
	1-10.	2,5	26,0	49,3	18,3	4,0	Connected sand
	10-21.	2,9	37,2	47,2	9,5	3,2	Connected sand
	21-31	2,0	13,2	43,5	35,8	5,6	Connected sand
	31-62	0,5	0,5	8,4	48,5	42,1	Medium loam
	62-80	0,4	0,6	3,6	20,7	74,7	Light Clay
K-20	0-2.	5,2	11,0	29,0	35,8	19,1	Sandy loam
	2-3.	4,3	11,4	26,3	39,8	18,3	Sandy loam
	3-10.	3,0	8,7	26,4	43,7	18,3	Sandy loam
	20-23.	1,7	3,0	16,7	45,3	33,4	Medium loam
	23-41	1,4	8,1	27,8	43,7	19,1	Sandy loam
	41-61	2,6	11,4	21,7	38,2	26,2	Light Loamy
	61-87	2,1	5,8	11,8	30,2	50,1	Heavy loam
	87-105	2,7	4,1	7,4	19,9	66,0	Light Clay
K-22	0-1.	4,3	11,1	51,3	21,5	11,9	Sandy loam
	1-10.	4,9	12,9	54,4	17,5	10,3	Sandy loam
	10-20.	3,0	13,6	61,2	16,7	5,6	Connected sand
	20-31	10,9	36,7	36,6	12,7	3,2	Connected sand
	33-64	1,2	15,7	60,9	12,7	9,5	Connected sand
	64-90	0,8	4,6	40,6	39,0	15,1	Sandy loam
	90-130	2,8	3,2	51,1	29,4	13,5	Sandy loam

As can be seen from Table 2, the mechanical composition of the soil consists of layers from loose sand to light clay (section 18, depth 62-80 cm; section 20, depth 87-105 cm). The surface has a particularly fine and loose composition of the soil K-20a and the surface K-14 is more stable.

It is known that sandy and sandy loam soils are the lightest, do not have a large amount of moisture, and also have good breathability, are easily susceptible to heating. Any useful, nutritious substances from such a soil immediately disappear, and organic ones turn into mineral particles. Consequently, thanks to granulometric analysis, it is known that for this type of cover it is necessary to use more organic fertilizers and much less mineral fertilizers in order not to harm its structure.

Soil pH is a measure of the acidity or basicity (alkalinity) of the soil. The pH of the soil is a key characteristic that can be used to conduct an informative analysis of both qualitative and quantitative characteristics of the soil. pH is defined as the negative logarithm (base 10) of the activity of hydronium ions (H+ or, more precisely, H3O+ aq) in solution.

We have analyzed the pH of the medium of soil samples taken on the dried bottom of the Aral Sea. The results are shown in Table 3.

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Table 3.

Results of pH analysis of soil samples collected at the excavation sites

Section №	Genetic horizon, cm	pH	Evaluation	EC 1:5, dS/m	ECe, dS/m	TDS, %
K-4	0-2,5	8,7	Highly alkaline	5,83	23,32	3,812
	2,5-5	8,8	Highly alkaline	3,32	13,28	1,486
	5-13.	8,9	Highly alkaline	1,17	4,68	0,652
	13-31	8,9	Highly alkaline	1,43	5,72	0,462
	31-53	8,95	Highly alkaline	1,61	6,44	0,500
	53-80	8,9	Highly alkaline	2,03	8,12	0,676
	80-96	8,9	Highly alkaline	3,20	12,80	1,094
	96-150	8,8	Highly alkaline	3,14	12,56	1,076
K-7 roots	0-1	8,7	Highly alkaline	0,41	1,64	0,142
	1,12.	8,9	Highly alkaline	0,30	1,20	0,128
	12-17.	8,9	Highly alkaline	3,08	12,32	1,076
	17-55	9,04	Very strongly alkaline	1,84	7,36	0,572
K-9	0-1,5	8,50	Highly alkaline	1,21	4,84	0,552
	1,5-20	8,7	Highly alkaline	1,07	4,28	0,392
	20-30	8,8	Highly alkaline	2,08	8,32	0,786
	30-40	8,7	Highly alkaline	4,37	17,48	1,692
	40-54	8,8	Highly alkaline	4,45	17,80	1,714
	54-120	8,9	Highly alkaline	4,15	16,60	1,496
K-11	0-2	8,8	Highly alkaline	0,71	2,84	0,248
	2-6.	8,8	Highly alkaline	0,47	1,88	0,168
	6-13.	8,95	Highly alkaline	0,28	1,12	0,118
	13-20	8,8	Highly alkaline	0,63	2,52	0,248
	20-47	8,98	Highly alkaline	0,95	3,80	0,296
	47-70	8,6	Highly alkaline	4,92	19,68	1,808
	under the tree	9,1	Very strongly alkaline	0,31	1,24	0,128
K-13	0-1,5	9,2	Very strongly alkaline	0,28	1,12	0,112
	1,5-5	8,8	Highly alkaline	0,42	1,68	0,162
	5-20.	8,6	Highly alkaline	0,85	3,40	0,444
	20-40	8,3	Medium - alkaline	1,94	7,76	0,980
	40-60	8,4	Medium - alkaline	1,65	6,60	0,722
	60-70	8,3	Medium - alkaline	1,96	7,84	0,984
	70-90	8,4	Medium - alkaline	3,00	12,00	1,392
	90-	8,7	Highly alkaline	2,86	11,44	1,358

Section №	Genetic horizon, cm	pH	Evaluation	EC 1:5, dS/m	ECe, dS/m	TDS, %
K-14	0-1,5	9,1	Very strongly alkaline	0,18	0,72	0,086
	1,5-10	8,95	Highly alkaline	0,20	0,80	0,088
	10-13.	9,1	Very strongly alkaline	0,14	0,56	0,078
	13-35	9,0	Highly alkaline	0,20	0,80	0,082
	35-65	8,3	Medium - alkaline	1,83	7,32	0,890
	65-120	8,3	Medium - alkaline	2,41	9,64	1,216
K-16	0-10	8,8	Highly alkaline	15,95	63,80	7,874
	10-25.	8,9	Highly alkaline	2,22	8,88	0,824
	25-40	9,1	Very strongly alkaline	0,56	2,24	0,176
	42-50	8,95	Highly alkaline	2,18	8,72	0,676
	50-60	8,6	Highly alkaline	3,19	12,76	1,190
	60-80	8,9	Highly alkaline	1,30	5,20	0,398
	80-100	8,9	Highly alkaline	2,00	8,00	0,688
K-18	0-1.	8,7	Highly alkaline	19,45	77,80	11,922
	1-10.	8,9	Highly alkaline	4,82	19,28	2,142
	10-21.	8,98	Highly alkaline	2,70	10,80	0,980
	21-31	8,8	Highly alkaline	5,30	21,20	2,012
	31-62	8,8	Highly alkaline	7,27	29,08	2,818
	62-100	8,8	Highly alkaline	7,08	28,32	2,836
K-20	0-2	8,53	Highly alkaline	2,80	11,20	1,456
	2-3.	8,50	Highly alkaline	4,40	17,60	2,264
	3-10.	8,40	Medium - alkaline	6,80	27,20	3,652
	10-23.	8,45	Medium - alkaline	7,70	30,80	3,746
	23-41	8,53	Highly alkaline	4,60	18,40	1,914
	41-61	8,7	Highly alkaline	4,87	19,48	1,896
	61-87	8,6	Highly alkaline	7,37	29,48	3,540
	87-105	8,6	Highly alkaline	8,77	35,08	4,116
K-22	0-1	8,9	Highly alkaline	9,56	38,24	4,244
	1-10.	8,9	Highly alkaline	4,70	18,80	1,832
	10-20.	8,95	Highly alkaline	1,69	6,76	0,776
	20-31	8,9	Highly alkaline	1,67	6,68	0,768
	33-64	8,7	Highly alkaline	2,26	9,04	0,968
	64-90	8,48	Highly alkaline	6,38	25,52	2,656
	90-130	8,7	Highly alkaline	3,12	12,48	1,246

According to the results of the pH analysis of the studied soil samples, they are mainly strongly alkaline, there are medium and very strongly alkaline.

Humus (Latin Humus "earth, soil") is the main organic matter of the soil,

ISSN 2181-0826 2/2023 y.

containing nutrients necessary for higher plants. Humus makes up 85-90% of the organic matter of the soil and is an important criterion in assessing its fertility. In the weight composition of the upper soil layer, the humus content varies from fractions of a percent in brown soils (brown desert-steppe) to 10-15% in black soils.

Studies have been carried out to determine humus in soil samples taken from the dried bottom of the Aral Sea. The results are shown in Table 4.

Table 4.

The amount of humus in soil samples taken at the excavation sites

Section №	Genetic horizon, cm	Humus, %	Degree of supply	Humus carbon, % (Sg, %)	P_2O_5, mg/kg	K_2O, mg/kg
K-4	0-2,5	0,190	Very poor	0,11	10,0	158,9
	2,5-5	0,190	Very poor	0,11	10,0	228,8
	5,-12	0,253	Very poor	0,15	8,5	178,2
	12-31.	0,232	Very poor	0,13	8,0	93,5
	31-54	0,190	Very poor	0,11	7,5	72,2
K-9	0-1,5	0,506	Very poor	0,07	49,0	130
	1,5-20	0,127	Poor	0,29	12,0	120,4
	20-30	0,148	Very poor	0,07	10,5	149,3
	30-40	0,127	Very poor	0,09	9,5	106
K-11	0-2	0,148	Very poor	0,06	16,0	72,2
	2,-6	0,190	Very poor	0,09	14,0	72,2
	6,-13	0,127	Very poor	0,11	13,0	72,2
	13-20.	0,127	Very poor	0,07	12,0	65,1
	20-47	0,106	Very poor	0,07	11,0	65,1
K-13	0-1,5	0,211	Very poor	0,09	12,0	72,2
	1,5-5	0,232	Very poor	0,07	11,0	72,2
	5,-20	0,127	Very poor	0,12	10,0	79,2
	20-40	0,106	Very poor	0,13	9,5	79,2
K-14	0-1,5	0,127	Very poor	0,07	11,0	89,1
	1,5-10	0,127	Very poor	0,06	10,0	72,2
	10,-13	0,190	Very poor	0,07	10,0	72,2
	13-35	0,148	Very poor	0,07	9,5	65,1
K-16	without writing.	0,338	Very poor	0,09	10,0	963,2
	10,-25	0,127	Very poor	0,07	9,0	106,0
	25-40	0,148	Very poor	0,20	9,0	72,2

Section №	Genetic horizon, cm	Humus, %	Degree of supply	Humus carbon, % (Sg, %)	P_2O_5, mg/kg	K_2O, mg/kg
K-18	0-1	0,739	Very poor	0,22	19,0	2480,0
	1,-10	0,485	Very poor	0,18	17,0	264,9
	10,-21	0,464	Poor	0,43	12,0	120,4
	21-31	0,401	Poor	0,28	11,0	113,2
	31-62	0,338	Poor	0,27	10,5	106,0
K-20	0-2	0,781	Very poor	0,12	23,0	252,8
	2,-3	0,781	Very poor	0,12	19,0	438,2
	3,-10	0,760	Poor	0,45	17,0	373,2
	10-23.	0,633	Poor	0,45	15,0	216,7
	23-41	0,485	Poor	0,44	13,5	113,2
K-22	0-1	0,506	Poor	0,32	10,0	741,6
	1,-10	0,485	Poor	0,29	9,0	423,8
	10,-20	0,253	Poor	0,32	9,0	216,7
	33-64	0,232	Poor	0,29	8,5	113,2

According to the content of humus, the soils mainly belong to very poor security and poor security. Considering that humus is formed in the soil as a result of the anaerobic transformation of plant and animal organic residues, humification will occur in the soil of the dried bottom of the Aral Sea after landscaping and the formation of green pastures.

Regardless of the chemical composition of the compounds that saline the soil, the salts themselves can concentrate in a certain soil horizon. According to the depth of the salt horizon, saline (0-30 cm), saline (30-80 cm), deep saline (80-150 cm) and deep saline (>150 cm) soils are distinguished from the daytime surface.

Depending on the composition of salts in the soil, several main types of salinization are distinguished: a) chloride salinization of soils is due to the excessive content of sodium chloride and magnesium chloride (NaCl, $MgCl_2$) in the soil; b) sulfate salinization is due to the accumulation of sodium sulfate and magnesium sulfate ($MgSO_4$, $CaSO_4$, Na_2SO_4); c) soda (carbonate) salinization due to the presence in the soil of increased amounts of sodium bicarbonate or other sodium salts ($NaHCO_3$), Na_2CO_3).

According to the harmfulness to plants, salts are divided into the most harmful (Na_2CO_3, $NaHCO_3$, NaCl), harmful ($CaCl_2$, $MgCl_2$, Na_2SO_4) and less harmful ($MgSO_4$, $CaCO_4$).

The main reason for the death of plants on saline soils is the high osmotic pressure of the soil solution, which exceeds the pressure of their cell juice, as a result of which the flow of water into individual tissues decreases, transpiration increases, assimilation, respiration and the formation of sugars deteriorates, which leads to drying and death of plants. So, what is the salt composition of the soil of the dried bottom of the Aral Sea. For this purpose, studies have been conducted to determine the salt composition of samples of selected soils. The results are shown in table 5.

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Table 5.

The number of soluble ions of the soil selected at the excavation sites

Section №	Genetic horizon, cm	Content of soluble ions														
		in mg-eq/100 gr. of soil								Na/Cl	Evaluation	Cl/SO_4	Evaluation	Assessment of the degree of salinization of the soil		
		HCO''_3	Cl'	SO''_4	Σanions	$Ca^{\cdot\cdot}$	$Mg^{\cdot\cdot}$	$Na^{\cdot}+K$	Σ cations					ECe, dS/m	Cl', %	Na, mg-eq/100 gr.
K-4	0-2,5	0,340	15,299	34,528	50,167	10,200	3,748	36,302	50,250	2,4	X-C	0,4	X-C	5	5	5
	2,5-5	0,320	5,527	14,685	20,532	9,500	2,269	8,805	20,574	1,6	C-X	0,4	X-C	5	5	4
	5-13.	0,360	1,974	6,656	8,990	2,600	1,184	5,222	9,006	2,6	X-C	0,30	X-C	3	3	3
	13-31	0,320	4,244	2,413	6,977	0,700	1,282	5,000	6,983	1,2	X	1,8	C-X	3	5	3
	31-53	0,300	4,836	2,579	7,716	1,300	1,677	4,745	7,722	1,0	X	1,9	C-X	3	5	3
	53-80	0,340	6,218	3,578	10,136	1,500	2,170	6,474	10,144	1,0	X	1,7	C-X	4	5	4
	80-96	0,320	10,364	5,325	16,008	2,000	2,959	11,063	16,022	1,1	X	1,9	C-X	4	5	4
	96-150	0,340	9,377	5,990	15,707	2,700	3,156	9,865	15,722	1,1	X	1,6	C-X	4	5	4
K-7 roots	0-1	0,420	0,197	1,435	2,053	1,500	0,197	0,360	2,058	1,8	C-X	0,1	C	1	1	1
	1,12.	0,440	0,296	1,186	1,922	1,100	0,296	0,530	1,925	1,8	C-X	0,2	C	1	1	1
	12-17.	0,340	9,475	5,990	15,806	2,000	2,959	10,861	15,820	1,1	C-X	1,6	C-X	4	5	4
	17-55	0,340	5,527	2,662	8,530	1,000	1,381	6,156	8,537	1,1	C-X	2,1	C-X	3	5	4
	90-120	0,240	15,792	6,323	22,355	2,500	2,269	17,607	22,375	1,1	X	2,497	C-X	4	5	5
K-9	0-1,5	0,400	1,086	6,157	7,643	5,000	0,592	2,070	7,662	1,9	X	0,2	C	3	3	2
	1,5-20	0,280	1,974	3,578	5,832	2,500	0,690	2,652	5,842	1,3	X	0,6	X-C	3	3	2
	20-30	0,260	5,231	5,990	11,482	2,800	2,367	6,329	11,496	1,2	X	0,9	X-C	4	5	4
	30-40	0,320	16,779	9,651	26,750	4,600	5,129	17,046	26,776	1,0	X	1,7	C-X	5	5	5
	40-54	0,340	15,299	10,650	26,288	5,300	4,242	16,776	26,317	1,1	X	1,4	C-X	5	5	5
	54-120	0,360	15,792	7,155	23,307	2,800	3,551	16,976	23,327	1,1	X	2,2	C-X	5	5	5
K-11	0-2	0,320	0,395	2,662	3,377	1,900	0,493	0,991	3,385	2,5	X-C	0,1	C	2	1	1
	2-6.	0,280	0,296	1,872	2,448	1,300	0,296	0,857	2,453	2,9	X-C	0,2	C	1	1	1
	6-13.	0,340	0,296	1,123	1,759	0,700	0,296	0,766	1,762	2,6	X-C	0,26	C	1	1	1
	13-20	0,320	1,086	2,184	3,590	1,500	0,493	1,603	3,596	1,48	X	0,5	X-C	2	3	2
	20-47	0,440	2,862	1,248	4,550	0,500	0,493	3,561	4,554	1,2	X	2,3	C-X	2	4	3
	47-70	0,500	19,247	8,653	28,400	2,700	4,340	21,382	28,422	1,1	X	2,2	C-X	5	5	5
	under the tree	0,520	0,296	1,123	1,940	0,600	0,493	0,849	1,942	2,9	X-C	0,26	C	1	1	1
K-13	0-1,5	0,380	0,296	0,998	1,675	0,600	0,197	0,880	1,677	3,0	X-C	0,30	X-C	1	1	1
	1,5-5	0,280	0,247	1,872	2,399	1,500	0,197	0,707	2,405	2,9	X-C	0,1	C	1	1	1
	5-20.	0,200	0,691	5,325	6,216	4,000	0,690	1,541	6,231	2,2	X-C	0,1	C	2	2	2
	20-40	0,280	0,888	12,688	13,856	11,800	0,986	1,111	13,897	1,3	X	0,1	C	3	2	2
	40-60	0,300	1,086	8,653	10,039	7,400	0,986	1,679	10,065	1,55	C-X	0,1	C	3	3	2
	60-70	0,280	0,888	12,688	13,856	10,500	2,071	1,322	13,894	1,49	X	0,1	C	3	2	2
	70-90	0,220	3,652	15,974	19,846	13,200	2,269	4,426	19,895	1,2	X	0,2	C	4	4	3
	90-120	0,240	2,961	15,974	19,175	13,300	1,677	4,248	19,225	1,4	X	0,2	C	4	4	3

Section №	Genetic horizon, cm	Content of soluble ions														
		in mg-eq/100 gr. of soil								Na/Cl	Evaluation	Cl/SO_4	Evaluation	Assessment of the degree of salinization of the soil		
		$HCO^{"}_3$	$Cl^{'}$	$SO^{"}_4$	Σanions	$Ca^{..}$	$Mg^{..}$	$Na^{'}$+K	Σ cations					ECe, dS/m	Cl', %	Na, mg-eq/100 gr.
K-14	0-1,5	0,420	0,197	0,686	1,304	0,400	0,197	0,708	1,306	3,6	X-C	0,29	C	1	1	1
	1,5-10	0,360	0,197	0,749	1,306	0,400	0,247	0,661	1,308	3,4	X-C	0,26	C	1	1	1
	10-13.	0,560	0,197	0,458	1,215	0,350	0,197	0,669	1,216	3,4	X-C	0,4	X-C	1	1	1
	13-35	0,320	0,197	0,686	1,204	0,350	0,148	0,708	1,206	3,6	X-C	0,29	C	1	1	1
	35-65	0,260	0,592	11,648	12,500	9,300	1,874	1,360	12,534	2,3	X-C	0,1	C	3	1	2
	65-120	0,240	1,579	15,392	17,211	13,000	1,973	2,285	17,258	1,4	X	0,1	C	4	3	2
	under the tree	0,320	0,197	0,686	1,204	0,350	0,197	0,658	1,206	3,3	X-C	0,29	C	1	1	1
K-16	without an inscription	0,380	99,194	21,840	121,414	16,100	14,697	90,707	121,505	0,9	X	4,5	X	5	5	5
	10-25.	0,300	7,205	5,158	12,664	5,100	1,282	6,300	12,683	0,9	X	1,4	C-X	4	5	4
	25-40	0,280	1,283	1,186	2,749	0,700	0,395	1,658	2,752	1,3	X	1,1	C-X	2	3	2
	42-50	0,260	6,416	3,994	10,669	2,700	2,071	5,909	10,681	0,9	X	1,6	C-X	4	5	3
	50-60	0,300	11,844	6,323	18,467	4,200	2,466	11,822	18,488	1,0	X	1,9	C-X	4	5	4
	60-80	0,220	4,639	1,560	6,419	2,100	1,085	3,241	6,426	0,7	X	3,0	X	3	5	3
	80-100	0,360	8,686	2,122	11,167	1,400	2,269	7,505	11,174	0,9	X	4,1	X	4	5	4
K-19	0,-15	0,360	98,700	43,680	142,740	16,500	19,432	106,934	142,866	1,1	X	2,3	C-X	5	5	5
	1,5-20.	0,240	9,377	3,411	13,028	1,800	3,748	7,487	13,035	0,8	X	2,7	X	4	5	4
	20-47	0,280	10,857	2,746	13,883	1,100	2,762	10,028	13,890	0,9	X	4,0	X	4	5	4
	47-50	0,260	20,727	6,157	27,144	2,300	5,622	19,238	27,160	0,9	X	3,4	X	5	5	5
	50-80	0,280	10,857	4,493	15,630	3,000	4,340	8,301	15,641	0,8	X	2,4	C-X	4	5	4
K-20	0-2	0,320	1,974	17,264	19,558	13,500	1,973	4,137	19,610	2,1	X	0,1	C	5	3	3
	2-3.	0,300	7,896	21,840	30,036	13,800	3,748	12,548	30,097	1,6	X	0,4	X-C	5	5	5
	3-10.	0,400	3,948	43,680	48,028	11,500	0,888	35,743	48,131	9,1	C	0,1	C	5	4	5
	10-23.	0,320	26,156	27,040	53,516	12,700	7,102	33,786	53,588	1,3	X	0,97	X-C	5	5	5
	23-41	0,280	17,766	11,315	29,361	6,200	5,129	18,063	29,393	1,0	X	1,6	C-X	5	5	5
	41-61	0,240	20,727	8,653	29,620	5,300	5,820	18,525	29,645	0,9	X	2,4	C-X	5	5	5
	61-87	0,240	27,143	24,960	52,343	11,400	8,582	32,425	52,407	1,2	X	1,1	C-X	5	5	5
	87-105	0,240	34,545	27,040	61,825	12,000	11,048	38,846	61,894	1,1	X	1,3	C-X	5	5	5
K-22	0-1	0,380	51,324	11,648	63,352	10,400	3,650	49,360	63,410	1,0	X	4,4	X	5	5	5
	1-10.	0,300	19,247	8,320	27,867	6,900	2,959	18,038	27,898	0,9	X	2,3	C-X	5	5	5
	10-20.	0,380	9,377	2,122	11,878	3,100	0,592	8,199	11,891	0,9	X	4,4	X	3	5	4
	20-31	0,380	9,377	2,579	12,336	2,600	0,493	9,255	12,349	1,0	X	3,6	X	3	5	4
	33-64	0,300	9,377	5,824	15,501	5,800	2,170	7,551	15,522	0,8	X	1,6	C-X	4	5	4
	64-90	0,340	28,623	10,982	39,946	5,500	9,568	24,905	39,973	0,9	X	2,6	X	5	5	5
	90-130	0,320	14,312	4,826	19,457	4,600	3,156	11,719	19,475	0,8	X	3,0	X	4	5	4

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From the results obtained, it can be seen that, according to the type of salinization, the soils are mainly chloride or sulfate-chloride. Chloride-sulfate and sulfate types of salinization are also found to a small extent.

According to the degree of salinity, soils have mainly a strong and very strong degree of salinity, there is an average degree of salinity and only a slight degree of weak salinity, and in sections K-7 and K-14 soils are practically not saline.

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