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THE CURRENT STATE OF THE SOIL COVER FORMED ON THE DRIED-UP BOTTOM OF THE ARAL SEA

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Annotation

The article discusses the results of studies of the current state of the soil cover formed on the dried bottom of the Aral Sea. In the drained part of the bottom of the Aral Sea, a complex of sandy-desert, hydromorphic and semi-hydromorphic sandy-desert soils, as well as sandy-desert and sandy salt marshes has developed. All soils have different degrees of salinity, and the occurrence of salinity is due to the accumulation of salt deposits of the tertiary period in the depths of the soil and strong evaporation.

Key words: Drained bottom, saline areas, salinity, soils, mechanical composition, chemical analysis.

Currently, the problem of intensive anthropogenic impact on the ecosystems of the Aral Sea region has affected not only the countries of Central Asia, but almost all regions of the world. Evidence of this is the current state of the Aral Sea, which has been drying up since the 1960s. Saline underwater sediments are composed of low-power brackish alluvial deposits with a predominance of primary rocks of various ages (clay, sandy, loamy, etc.) [5, 6]. In the newly formed "Aralkum desert", it is currently possible to observe the processes of primary soil formation. Many experts have noted that these processes began in the territories freed from seawater 50-60 years before, gradually forming the primary soil. In modern conditions, the process of soil formation began in those parts of the sea that were previously discovered [1, 6, 17].

It should be noted that together with the process of soil formation on the dried-up bottom of the Aral Sea, the deflationary process, the process of Aeolian removal of the surface layer does not stop, which leads to degradation of the emerging soil cover. All these negative phenomena occurring on the dried-up bottom have a negative impact on the overall ecological condition of the entire region of the Southern Aral Sea region. In this regard, there was a need to develop soil and environmental measures aimed at preventing the negative impact of the newly formed salt marsh desert on densely populated areas of the Southern Aral Sea region.

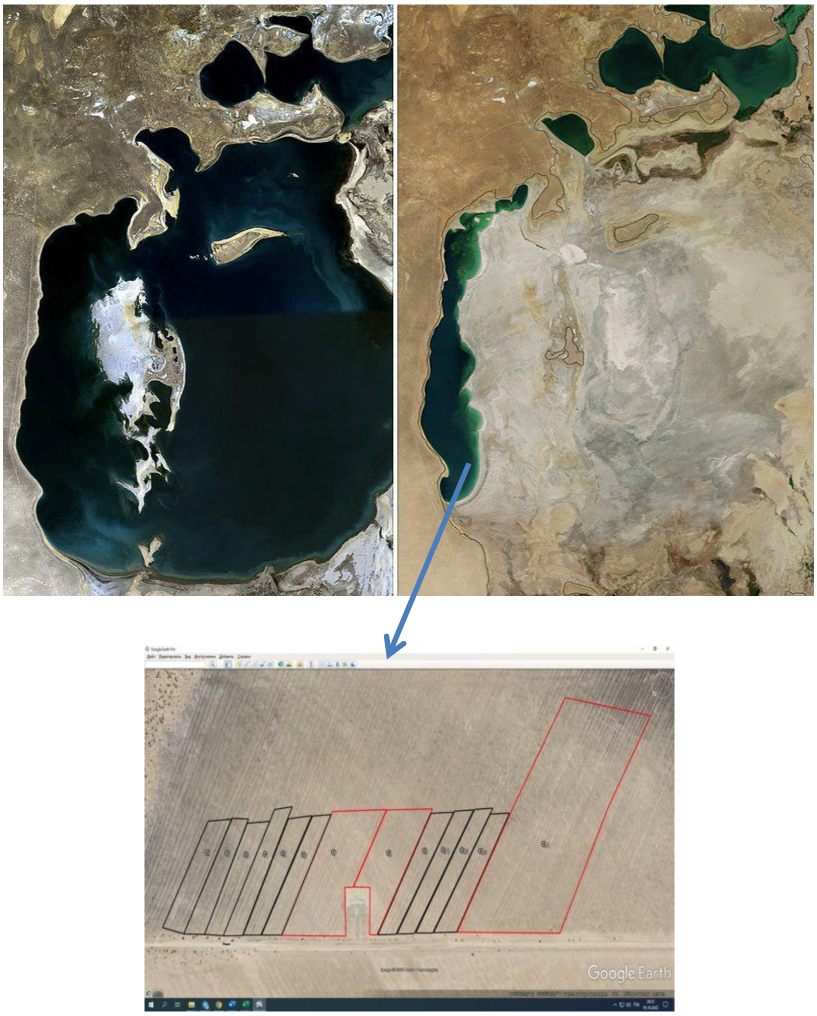

Fig. 1. Map-scheme of the study

The methodological basis of the conducted research consists of geochemical, laboratory and analytical methods of analysis published by various authors [2, 3]. The main purpose of obtaining soil sections is to determine the structure of the soil cover, to study changes in the properties of the soil cover and soils in one direction or another under the influence of desertification processes, geomorphological structure, the formation of new types and types of soils. Soil samples were taken in December 2022 at the zero point of the drained bottom of the Aral Sea (N: 44° 7'36.84"C, E: 58°50'39.25"C) (Fig. 1).

In the samples from the soil section, the following analyses were performed:

- Mechanical composition of the soil – by sedimentation method (Stokes method)
- Measurement of soil pH
- Measurement of the electrical conductivity of the EC in an aqueous extract of 1:5, (recalculated in ECe), dS/m, The degree of soil salinity was assessed according to the FAO methodology
- Determination of the total amount of salts (dense residue), % - by evaporation

▫ Determination of the ionic composition of the soil HCO'3, Cl', SO"4, Ca, Mg.,. Na', K' - according to the generally accepted method in an aqueous extract of 1:5, expressed in % and in mg-eq per 100 g of soil

Chemical analyses of samples taken from soil and water during the research period were performed on the basis of generally accepted methods.

Table 1

The results of the analysis of the mechanical composition of the soil of the studied area

Horizon, sm	Weight of fractions (mm), in %								Score
	>0,25	0,25-0,10	0,10-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	Physical Clay, <0,01	
0-20	6,7	48,4	23,4	6,4	1,6	8,0	5,6	15,1	Sandy loam
20-40	3,8	39,5	32,2	8,0	1,6	8,7	6,4	16,7	Sandy loam
40-60	2,8	18,8	23,5	24,2	6,8	12,7	11,1	30,6	Medium loam
60-80	4,9	28,2	27,2	14,3	4,0	11,5	9,9	25,4	Light loam
80-100	5,1	41,6	27,9	11,1	1,6	7,6	5,2	14,3	Sandy loam

According to A.B. Myrzambetov, A.U. Akhmedov, Zh.M. Turdaliev, G.T. Parpiev, the chemical composition of soil salts and groundwater of the draining bottom of the Aral Sea differs in the amount and composition of salts [4].

According to the results of the analysis of the mechanical composition of soils, they have a layered composition. Sandy loam lies in a layer of 0-40 cm, loam is medium and light from 40 to 80 cm, and below 80 cm, sandy loam layers lie again (Table 1).

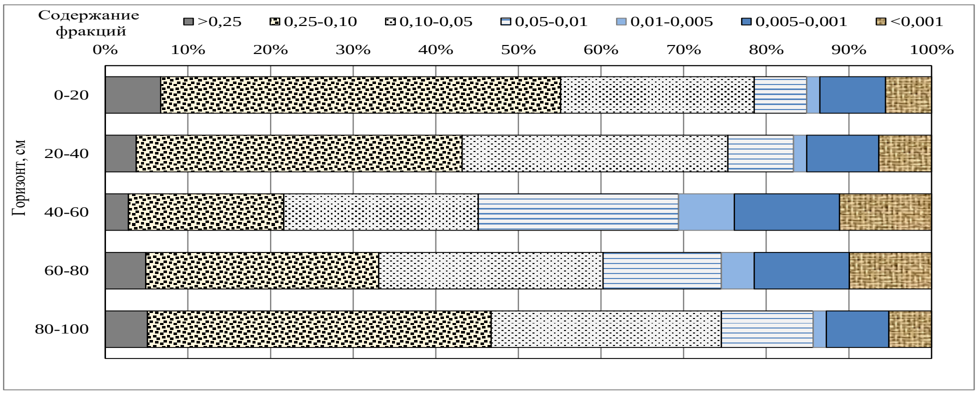

Рис. 2. Количество содержания фракций в механическом composition of the soils of the studied territory

According to the US classification adopted by FAO, except for the soil of the horizon of 40-60 cm (called loam,- L), soils are characterized as desalinated loam (SL) (Table 2).

Table 2
Analysis and evaluation of the mechanical composition of the soil according to FAO

Горизонт, см	Содержание фракций (мм) по треугольнику США, в %			Название по ФАО	
	Песок, 0.05-2.0	Пыль, 0.002-0.05	Глина, < 0.002		
0-20	79	13	8	SL	Sandy Loam
20-40	76	15	9	SL	Sandy Loam
40-60	46	39	15	L	Loam
60-80	61	26	13	SL	Sandy Loam
80-100	75	18	7	SL	Sandy Loam

Примечание: **Sandy Loam**-опесчаненный суглинок (супесь)

Chemical analysis data show that due to the different toxicity of salts in the soil profile in the upper 0-30 cm layer, saline soils containing more than 0.6% soda, more than 0.1% chlorine, more than 2.0% sulfates are salt marshes, and this amount negatively affects the growth and development of plants. Indicators of soil salinity: Electrical conductivity, the content of dense residue (the amount of salts), individual ions, the amount of toxic salts, as well as the hypothetical composition of salts, are shown in Table 3.

Tab 3
Results of measurements of pH, electrical conductivity and determination of the ionic composition of the soil by the method of water extraction

Horizont, sм	pH	ECe, dS/m	Dense residue, %	*The content of soluble ions, in % / mg-eq. per 100 grams of soil*						
				HCO'_3	*Cl'*	*SO''_4*	*$Ca^{\cdot\cdot}$*	*$Mg^{\cdot\cdot}$*	*Na^+*	*K^+*
0-20	8,7	38,0	4,298	0,015	1,159	1,360	0,328	0,098	0,840	0,046
				0,240	***32,670***	***28,288***	***16,400***	***8,088***	***36,540***	***1,150***
20-40	8,8	22,6	2,054	0,023	0,760	0,446	0,084	0,056	0,460	0,033
				0,380	***21,418***	***9,277***	***4,200***	***4,636***	***20,010***	***0,825***
40-60	8,9	19,0	1,636	0,026	0,627	0,360	0,172	0,044	0,300	0,031
				0,420	***17,667***	***7,488***	***8,600***	***3,650***	***13,050***	***0,775***

60-80	9,0	24,2	2,138	0,013	0,704	0,536	0,140	0,079	0,360	0,029
				0,220	***19,839***	***11,149***	***7,000***	***6,510***	***15,660***	***0,725***
80-100	9,0	19,4	1,812	0,021	0,525	0,610	0,168	0,050	0,340	0,026
				0,340	***14,805***	***12,688***	***8,400***	***4,143***	***14,790***	***0,650***

Example: ** The electrical conductivity is determined in an aqueous extract of 1:5*
*** Electrical conductivity of saturated soil extract, the value used to assess the degree of salinity in international practice (see classification, Table 2)*

The pH of the aqueous extract from soil samples ranges from 8.7 to 9.0. With these indicators, the soil of all soil profile samples is estimated as strongly alkaline pH (8.5 - 9.0).

Usually all trace elements are well absorbed by plants at a pH of less than 8.4, that is, the pH of the soil is unfavorable. In the part of the dried-up bottom of the Aral Sea studied by us, halophytic plants are found, the vegetation of which develops singly, these include plants such as wormwood, saxaul, tamarix, salt-bearing Caspian, adapted to development in harsh arid conditions.

The studied soil contains a high salt content, defined in the analysis as a "dense residue in an aqueous extract". The values of the total salt content in the samples range from 1.636% (in the horizon of 40-60 cm), up to 4.298% by weight of the soil (in the upper horizon of 0-20 cm), In all soil samples, the highest content of ions: chlorine, sodium and sulfates (Fig.3 and 4).

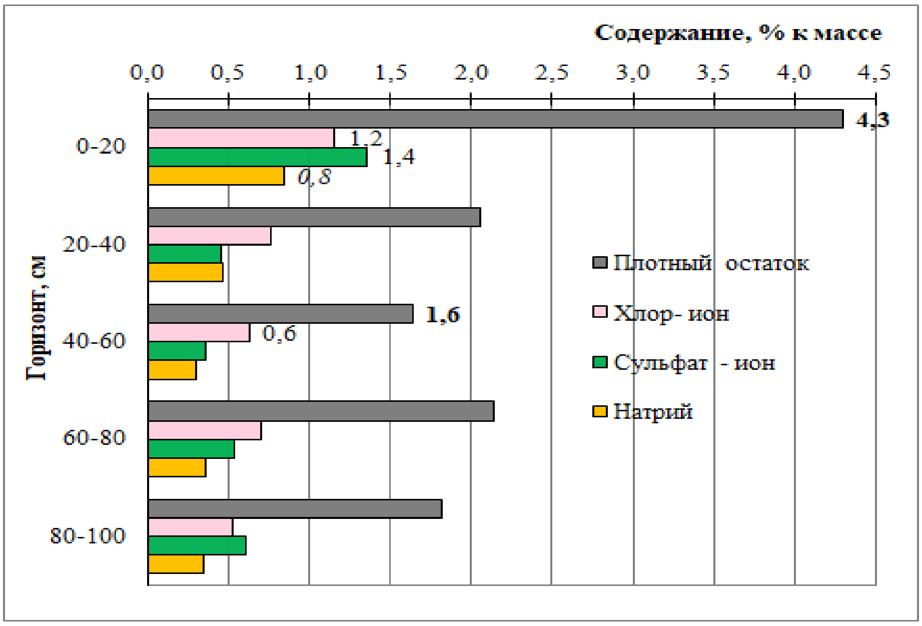

Fig. 3. Profile of the content of dense residue and predominant ions

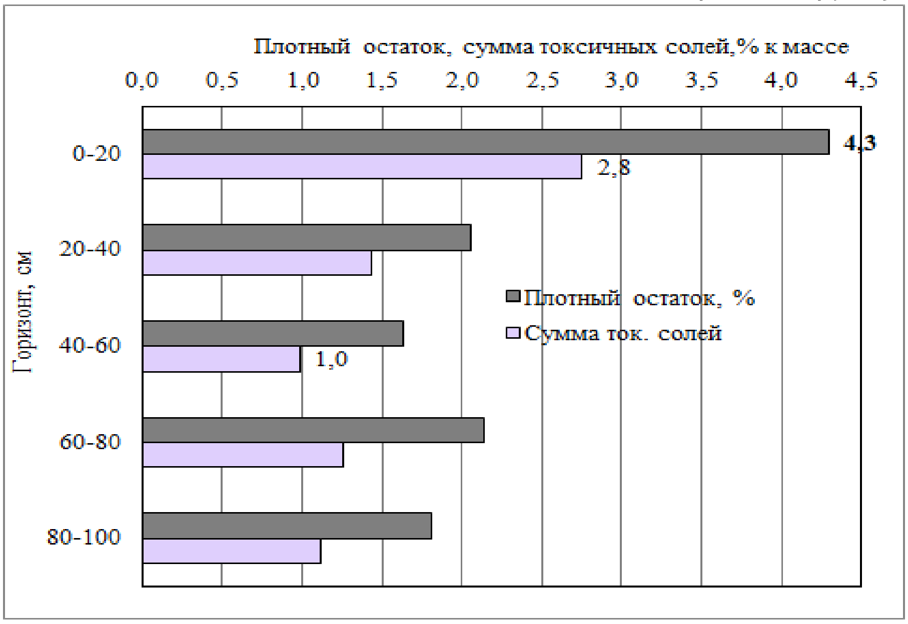

Fig.4. Profile of the dense residue content and the amount of toxic salts

The same distribution of salts along the profile, as well as over the dense residue, is observed in terms of the electrical conductivity of the saturated soil extract of the ECe (Fig.5). The distribution of ions and salts along the soil profile shows that the maximum salinity of the studied soil is 0-20 cm in the horizon

Figure 5 shows the relationship of electrical conductivity with the content of the total amount of salts and individual ions. It can be seen from the graphs that the electrical conductivity reflects well enough the content of ions and salts, the degree of salinity of the soil.

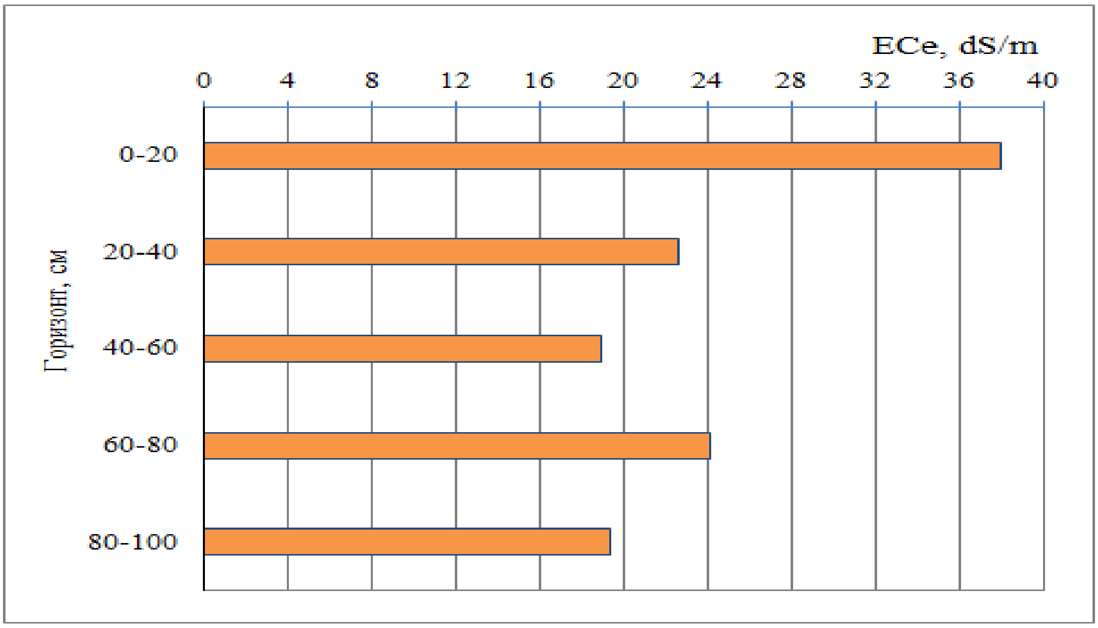

Fig.5. Soil salinization profile by electrical conductivity of saturated soil extract

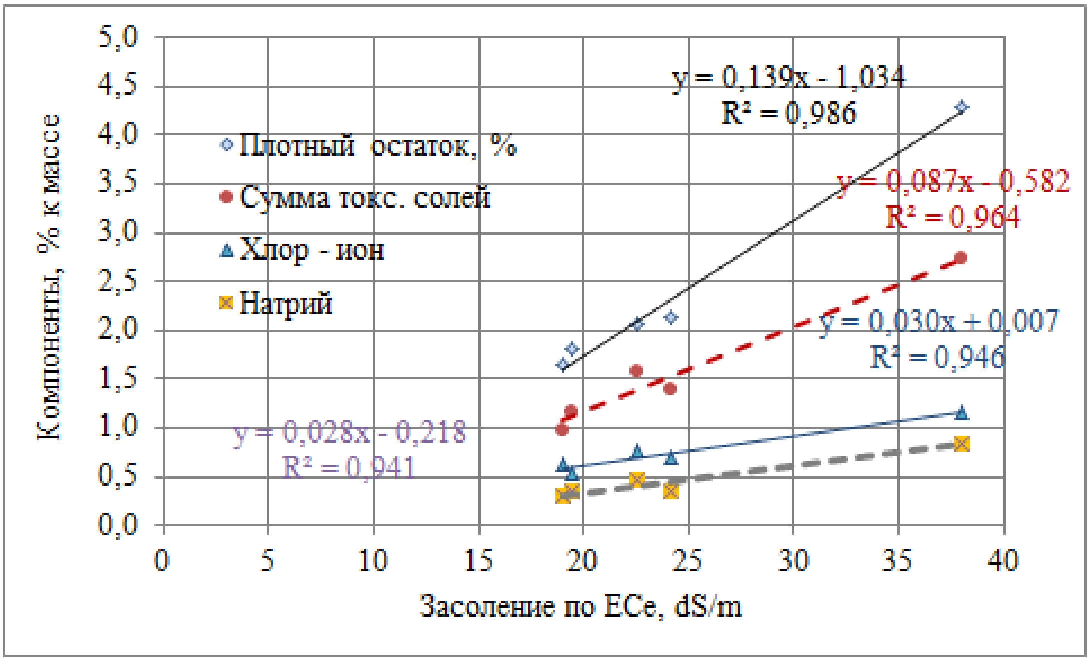

Fig. 6. The relationship between the content of individual indicators of soil salinity with the value of the electrical conductivity of saturated soil extract

Table 4 shows the classifications of the soil according to the degree of salinity. Using this table and data on the salinity of the soil profile, we conclude that the soils of the section are saline in all indicators and the degree of salinity is estimated as "very strong".

Table 4

Classification according to the assessment of the degree of salinity of the soil

N	Degree of soil salinization	ФАО	Domestic classifications					
		ECe, dS/m	Cl', %	Na', *me/100 g*	By the amount of tox. salts		By dense residue	
					Chloride	Chloride-sulfate	Chloride	Chloride-sulfate
1	Unsalted	0-2	< 0,02	< 1	<0,03	<0,10	<0,15	<0,25
2	Weak	2-4	0,02-0,035	1,0-3,0	0,03-0,1	0,10-0,25	0,15-0,30	0,25-0,40
3	Average	4-8	0,035-0,07	3,1-6,0	0,1-0,3	0,25-0,50	0,30-0,50	0,40-0,70
4	Strong	8-16	0,07-0,14	6,1-12,0	0,3-0,6	0,50-0,90	0,50-0,80	0,70-1,20
5	Very strong	>16	> 0,14	12,1-28,0	>0,6	>0,9	>0,8	>1,2

Figure 7 shows a plot of the chemical composition of the soil profile. From the plot it can be seen that the predominant ions, which are arranged in descending order as follows:

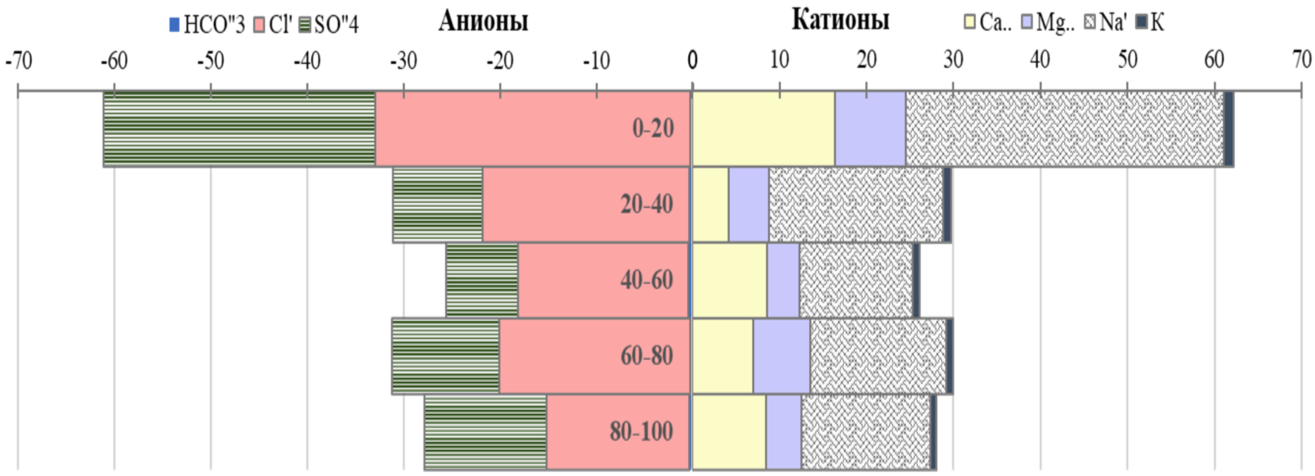

Fig. 7. Plot of the chemical composition of the soil profile.

According to Fig. 8, the ionic composition of the samples is dominated by (***v mg-./100g***)

Na'> Cl' >SO_4''> Ca > Mg, > K> HCO'_3 *(.0-20 sm)*

Cl' > Na' >SO_4''> Ca > Mg, > K> HCO'_3 *(.20-40;40-60;60-80; u 80-100 sm)*

As a result of the processes that took place on these soils, it was noted that in large areas easily soluble in water salts, chlorine and sulfate, fluctuate in different amounts in the upper layers of these soils. The amount of dry residue ranges from 3.9% to 11.5% within 0-20 cm in the upper layers, depending on the type of soil. All soils have different degrees of salinity, and the occurrence of salinity is due to the accumulation of salt deposits of the tertiary period in the depths of the soil and strong evaporation.

The studied soils have a pH from 8.7 to 9.0 and are estimated as strongly alkaline pH (8.5 - 9.0). The pH of the soil exceeds the favorable limit (pH = 8.4), above which the assimilation of nutrients and trace elements by plants from the soil decreases. To reduce the alkalinity of the soil (closer to neutral), it is recommended to acidify the soil [3, 8, 11].

In the drained part of the bottom of the Aral Sea, a complex of sandy-desert, hydromorphic and semi-hydromorphic sandy-desert soils, residual coastal salt marshes, semi-automorphic and semi-hydromorphic salt marshes, as well as sandy-desert and sandy salt marshes has developed. Despite the fact that soil salinization is considered to be a state occurring under the influence of certain factors, the issue of assessing soils and processes of total salinity by degree and types of salinity is quite complicated, the main reason for this is that the formation of salts not only changes in time and space, but also salts or ions, their components, pass from one the phases of the soil are different and are amenable to reclamation effects in different ways [9, 12, 13].

The results of agrochemical analyses of the soil indicate that they may not be considered fertile in terms of the content of humus, mobile forms of phosphorus. However, in terms of the content of mobile nitrogen, they have an increased and normal security, and in terms of exchangeable potassium, they have a high security. The content of gross forms of nutrients (NPK) indicates that there are no reserves of nitrogen, phosphorus and potassium in this soil [6, 15, 17, 18].

Saline territories formed in areas previously remote from water are now partially covered with salt-loving halophytes, but moisture-loving plants have been preserved in sediments in the territories adjacent to the surface of soil waters and on residual swamp soils. In addition, salt marshes were subjected to degradation and destruction processes (erosion and deflation) under the influence of winds, which ultimately led to a reduction in plant distribution areas.

Studies have shown that under conditions of iridizations, the transformation of soils on the drained bottom of the Aral Sea continues, trends in the development of negative processes (salinization, deflation, etc.) persist and lead to further processes of soil degradation and aggravation of the ecological situation in the Aral Sea.

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