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THE CURRENT STATE OF THE SOIL COVER OF THE SOUTHERN BALKHASH REGION

The article considered the current state of the soil cover of the Southern Balkhash region. Morphological features of soil images are described, mechanical and chemical composition is determined. According to the morphological characteristics of the soil, it was found that the first image soil is gray soil, the second image soil is grayish yellow sandy soil, and the third image soil belongs to the Sandy orange soil type. The composition of all soil images was dominated by fine sand and coarse dust fractions. Since the chemical composition of the soil is one of its main agrochemical properties, the content of nutrient elements has been determined. As a result, it was found that nitrogen – low, phosphorus – medium, potassium – was sufficiently contained. The content of nutrient elements was higher in the surface layers of the soil than in the lower layers. The humus content is very low. It was found that the reaction of the soil medium is alkaline. The alkalinity of soils increased with the depth of the soil. Soil images on absorbed bases were characterized by a set of absorbed bases of low size (5 – 10 ml- eqv/100 g of soil). The water filtration of the soil was dominated by bicarbonate (NSO_3-) ions and CA cation. In terms of the set of salt content, all soil images belong to the category of unsalted, that is, the set of salts was below 0.2%.

Key words: humus, nutrient elements, soil morphology, absorbed bases, soil environment reaction, soil salinization, water filtration.

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Оңтүстік Балқаш өңірінің топырақ жамылғысының қазіргі жағдайы

Мақалада Оңтүстік Балқаш өңірінің 3 түрлі координаттарынан алынған топырақ жамылғысының қазіргі жағдайы қарастырылды. Зерттеу нысаны болып отырған Оңтүстік Балқаш маңы топырақтарында далалық зерттеу жұмыстары жүргізіліп, белгіленген нысандарда топырақ кескіндері қазылып, топырақтардың морфологиялық сипаттамалары жасалды, сонымен қатар лабораториялық зерттеулерге топырақ үлгілері алынып, механикалық және химиялық құрамы анықталды. Топырақтың морфологиялық сипаттамалары бойынша бірінші кескін топырағы боз топырақ, екінші кескін топырағы сұрғылт сары құмды топырақ, үшінші топырақ кескіні құмды сарғыш топырақ типіне жататындығы анықталды. Барлық топырақ кескіндерінің құрамында ұсақ құм мен ірі шаң фракциялары басым болды. Топырақ ортасының негізгі қоректік элементтеріне азот, фосфор және калий жататындықтан, зерттеліп отырған аймақтың топырақтарының қоректік элементтермен қамтылуы анықталды. Зерттеу нәтижелері азот – төмен, фосфор – орташа, калий – жеткілікті дәрежеде қамтылғандығын көрсетті. Топырақ құнарлылығын анықтайтын негізгі көрсеткіштерінің бірі болып табылатын гумус мөлшері өте төмен дәрежеде. Топырақ ортасы реакциясы сілтілі, сіңірілген негіздер жиыны төмен мөлшерде екендігі анықталды. Топырақтардың сілтілігі топырақ тереңдігіне қарай артты. Зерттелген топырақ кескіндерінің барлығының құрамында гидрокарбонат иондарының (HCO_3^-) басым екендігі анықталды. Одан кейін барлық топырақ кескіндерінде Ca мөлшері жоғары, ал ең төменгі мөлшерде CO_3, Cl′ сниондары және K^+ катионы болды. Топырақ кескіндеріндегі тұздар жиынтығы бойынша барлық топырақ кескіндері тұзданбаған болып шықты, яғни тұздар жиынтығы барлық топырақ үлгілерінде 0,2 %-дан төмен болды.

Түйін сөздер: гумус, қоректік элементтер, топырақтар морфологиясы, сіңірілген негіздер, топырақ ортасы реакциясы, топырақтардың тұздануы, су сүзіндісі.

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Современное состояние почвенного покрова Южного Прибалхашья

В статье рассматривается современное состояние почвенного покрова Южного Прибалхашья. Описаны морфологические особенности снимков почв, определен механический и химический состав. По морфологическим характеристикам почвы первый тип почвы серый, второй тип почвы серо-песчаный, третий тип почвы песчано-оранжевый. Во всех почвенных образованиях преобладали мелкий песок и крупная пыль. Поскольку химический состав почвы является одним из основных ее агрохимических свойств, было определено содержание питательных веществ. В результате установлено что в составе почвы: азот – низкий, фосфор – умеренный, калий – достаточно. Количество элементов питания в поверхностных слоях почвы было выше, чем в нижних слоях. Количество гумуса очень низкое. Установлено, что реакция почвенной среды щелочная, набор поглощаемых оснований низкий. Щелочность почвы увеличивалась с глубиной почвы. В фильтрате почвенной воды преобладали ионы гидрокарбоната (HCO3-) и катион Ca. По общему количеству солей все образцы почв относятся к категории незасоленных, т.е. общее содержание солей менее 0,2%.

Ключевые слова: гумус, питательные вещества, морфология почвы, приобретенные базы, реакция почвы, засоление почвы, фильтрация воды.

Introduction

Lake Balkhash is located in an emerging tectonic depression between the semi-deserts of SouthEastern and central Kazakhstan. After the drying up of the Aral Sea, Lake Balkhash became the largest lake in Central Asia with an area of 17,000 km2. 70% -80% of the annual water entering Lake Balkhash comes from the Ili River. [1]..

The Lake consists of small hills and plains of central Kazakhstan from the North, and sandy plains of South – Eastern Kazakhstan, stretching from the southern shore of Lake Balkhash to the foothills of the Tien Shan and Semirechye Alatau.

Significant dimensions of the territory, its closed position within the Asian continent, orographic and climatic heterogeneity contribute to the diversity of natural conditions of the Balkhash lake basin.

According to its orographic nature, the basin of Lake Balkhash is divided into three parts: 1. The territory that occupies the main region of the northern and Northwestern Balkhash region (the terrain is a plain complicated by hills); 2. The central territory, connecting from the south of the Kazakh Upland to the mountains in the south and Southeast; 3. The Southeastern and southern part, occupied by the Tien Shan upland region, the Northern Spurs of the Ili and Semirechye Alatau Upland system [2].

Small ridge regions of the Balkhash lake basin, that is, the northern Tien Shan ridges, the Inter – Mountain Ili lowland, the Balkhash lowland and the southern end of the Paleozoic platform of central Kazakhstan (the north-western Balkhash suburb) can be distinguished. In these 14 different structural and geological regions, deposits of all eras-from the lower Paleozoic to the present – are found [3].

On the plain near Balkhash stretches the sandy desert Taukum, Saryesik Atyrau sands and bakanas baldly, clay-sandy plains, which are crossed by numerous dry channels (Bakanas). The Balkhash plain is dominated by crevices and fortified sand dunes, hilly sands and clay-sandy areas alternate with ordinary dunes [4].

In the desert zone of the South Balkhash region, the most common are fixed and semi-fixed, jagged and bumpy Sands. The vegetation cover is very sparse, consisting of ephedra, Wormwood and shrubs. Along the ancient valleys of the Ili and Karatal rivers, barren soils are formed, on which small shrub Soran (lateral) and black saxaul grow. The surface of the barren soil is 60-70% bare and divided into polygons with cracks. Along the length of the Ili River in a narrow strip, in the lower reaches there are floodplain – Meadow soils covered by thickets of Kogas, reeds and Groves. Lake Balkhash is bordered by Meadow salt marshes, on which reeds, salt marshes, sorghum grow [5-9].

On low – lying areas, mountainous dark-pink and light – pink soils are located, covered with shrubs and plants of the seleu-fescue group. The foothill plain is characterized by light gray soils. The vegetation cover is represented by a mixture of ebelek, kokeshop, poetess with wormwood and, in rare cases, Seleucus [10].

In general, soil is the largest store of organic carbon in an ecosystem on earth, containing more carbon than the one stored in the atmosphere and living biomass. Its structure is due to the presence of stable aggregates, which usually consist of primary particles and binders. The aggregate can conserve soil pores, limit the diffusion of oxygen and water, regulate microbial communities, protect organic matter, and store nutrients [11]. The soil provides plants with nutrients and a habitat for microorganisms. Northcliff (1988) found that the properties of the soil are formed by both weathering and biological activity in which microorganisms play an important role. Soil type is an important factor in soil fertility due to its biological, chemical and physical properties [12].

Soil fertility, which includes soil nutrients, soil structure, and other physical and chemical properties, provides the physical conditions and nutrients needed for plant growth [13].

Soil provides a wide range of ecosystem services through water treatment, reducing soil pollutants, nutrient cycling, carbon sequestration, and contributing to the production of food, fiber, and fuel. These services are very important to the biosphere, especially those that support food and agriculture, as well as environmental interaction. As a non-renewable resource, soil must be preserved to ensure a sustainable future [14].

The aim of the study was to describe the current state of the soils of the South Balkhash region.

Objects and methods of research

The main object of the study was the soils of the Southern Balkhash region. The climate of the southern Balkhash region is characterized by an abundance of sunlight and warmth. There is a significant number of cloudless open-air days (100-129) and a large set of positive air temperatures, which make up about 3500°C during the period of vegetation growth. The average monthly air temperature of the hottest month – July-ranges from 20° to 24 °C. With increasing altitude, it decreases by 0.6-1.2 °C every 150 m and reaches 7-10°C at an altitude of 2500-3000 m above sea level. The transition of air temperature to negative values is observed in the northern regions in the first decade of November, in the southern areas at the foot of mountain 15 – in the second half of November. The duration of the period with an average daily air temperature of 0 °C in the southern flat part is 8-8.5 °c per month [15]. The distribution of precipitation in the area of Lake Balkhash by the area of the basin is very uneven. On the shores of Lake Balkhash, about 200 mm of precipitation falls, and near the northern and South Balkhash-200-250 mm [16].

Field research work was carried out on the soils of the South Balkhash region, which are the subject of research, soil images were excavated at the established sites, morphological characteristics of soils were made, as well as soil samples were taken for laboratory research [17]. Chemical composition and physical properties of soils were analyzed in the laboratory of the Kazakh Research Institute of Soil Science and agrochemistry named after O. O. Ospanov.

The following physico – chemical indicators of the soil were determined: total nitrogen – according to the Keldal method (GOST 26107-84); total phosphorus (GOST 26261-84) and total potassium (GOST 26261-84) according to the Machigin method; humus – by the Tyurin method (GOST 23740 – 79); ph – by the pathonsiometric method from the water supply of the soil (GOST 26423-85); absorbed bases – by GOST through 27821-88, SA and mg were determined by the method of Arinushkina, na and K by the method of karataeva and mametova. The granulometric composition of the soil is determined by GOST 12536-2014 and the classification by the skeleton of the soil is carried out by Na. According to the Kachinsky method, the amount of salts was determined by the full composition of the water filter, i.e. anions (CO32 -, HCO3, Cl -, SO4-) and cations (Ca2+, Mg2+, Na+, K+) according to GOST 26425-85.

Research results and their analysis

Morphological features. According to the analysis of morphological features, it was found that the first image soil belongs to gray soil types, the second image soil belongs to grayish yellow sandy soil, and the third image soil belongs to Sandy orange soil type.

First soil image coordinates: N: 43.224444°; E: 76.922778°. Height above sea level H: 870 m. design vegetation cover 50-60%. The depth of the image is 100 cm.

A_1 0-22 cm. Blond color, dense, dry, powdery – dusty, sandy loam, thin-slotted, with thin veins, with salt crystals, with spots of brownish gray and whitish shades.

22-40 cm. Pale color, very dense, prism-shaped powdery, sandy loam, thin slotted, veins are rare, there are salt crystals.

40-65 cm. Light pale color, slightly compacted, prismatic powdery, sandblasted, finely slotted, no veins, no salt crystals.

65-100 cm. Light pale, slightly compacted, nutty dusty texture, sandblasted, finely slotted, no veins, no salt crystals. It boils very strongly from acid.

Second soil image coordinates: N: 43.224444°; E: 76.922778°. Height above sea level H: 870 m. design vegetation cover 60-70%. The depth of the image is 100 cm.

0-6 cm. Light blond, dry, scattered dewy sand, thin roots predominate, with salt crystals, dusty, powdery, strongly boiling from acid.

6-32 cm. Pale, very dense, dry, sandy, thin-slotted, powdery, with salt crystals, small stones are found, there are thin veins, very strongly boiled from acid.

32-100 cm. Light pale, less compacted, dry, with a clear transition to the next layer, sand, roots are rare, there are salt crystals, very strongly boil from acid.

Third soil image coordinates: N: 43.224444°; E: 76.922778°. Height above sea level H: 870 m. design vegetation cover 55-60%. The depth of the image is 100 cm.

0-4 cm. Light color, dry, powdery – dusty, sandy loam, with salt crystals, plant roots are found.

4-25 cm. Light gray in color, dry, compacted, sandy loam, nutty-powdery, with plant roots, salt crystals are found.

25-60 cm. Light gray color, compacted, dry, nut-tile-like, sandy loam, veins are found, traces of Bunak-flesh, salt crystals.

60-100 cm. Whitish, dry, slightly compacted, calcareous, powdery-dusty, plant roots are rare, with salt crystals.

Granulometric composition.

Land cover and soil structure play an important role in meteorological modeling, as they determine the structure of vegetation and soil, which interferes with the exchange of energy, moisture and momentum between the Earth's surface and the atmosphere. In addition, soil structure is the corresponding input data set in meteorological models, affecting their results and future use in weather research and air quality modeling [18]. Soil structure is an important component of soil research to assess the possibilities and limitations of land use and management. It is valued as an important predictor of many soil processes [19].

The mechanical composition of the soil is of great importance in soil formation, the use of soil for agricultural and other purposes. The mechanical composition of the soil and its properties are closely related, such as porosity, water capacity, moisture permeability, high moisture retention properties, the ability to accumulate substances, and air – heat modes [20,21]. Natural properties such as soil structure and mineralogy have a major impact on carbon retention, nutrient content, natural pH, aggregation, realization of water retention capacity, etc. [22].

The granulometric composition of the first soil image was dominated by a fraction of fine sand (0.25-0.05 mm) (in terms of image depth in the range of 61.1 – 72.1%), followed by a fraction of coarse dust (in the range of 11.26-16.6%). In the second soil image, the priority was shown by the fractions of fine sand (1.0-0.25 mm) and coarse dust (0.25-0.05 mm) (62.07-69.7 and 15.2-26.2 %). The third soil image is dominated by fine sand (0.25 – 0.05 mm) and coarse dust (0.005 – 0.001 mm) (50.57-57.8 and 16.1-31.5 %).

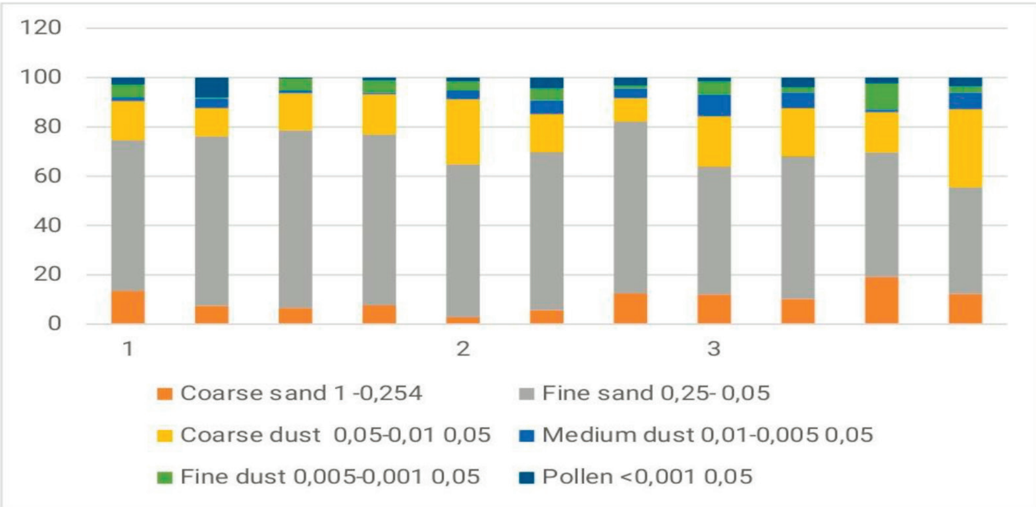

Figure 1 – Mechanical composition of soils near South Balkhash, %
(1,2,3 place where soil samples were taken)

Chemical composition

The chemical composition of the soil in general is one of its main agrochemical properties. It also plays an important role in the study of soil formation processes and soil pollution [23].

The main nutrient elements of the soil environment include nitrogen, phosphorus and potassium. In case of a lack of nitrogen in the soil environment, the leaves of the plant will be faded green, even turn yellow and fall off prematurely. Plant growth slows down, lateral shoots are poorly formed, root branching is reduced. Usually the concentration of phosphorus in the soil solution is very low (0.1 -1 mg/l). Phosphorus accelerates the maturation of plants. In case of lack of phosphoric nutrition, the content of carbohydrates in the leaves of the plant increases. The growth of plants slows down, and the delay in the maturation of fruits is due to the insufficient amount of this phosphorus. Potassium is also one of the most necessary elements for normal plant growth. The reserves of potassium in the soil are 8-40 times more than phosphorus, and 5-50 times more than nitrogen. Plants that are well supplied with potassium are resistant to fungal and bacterial diseases. It has been observed that when potassium decreases in the cell, the content of sodium, magnesium, calcium, free ammonia, hydrogen ions, and mineral phosphorus increases. The leaves of plants grown in conditions of potassium deficiency begin to turn yellow from the bottom up [24,25]. Organic substances contained in the soil play an important role in the ecosystem [26].

Even more carbon accumulates in the soil than when adding the atmosphere and plants. Therefore, even a small change in soil organic matter affects the global carbon cycle, for which it is advisable to carefully monitor the impact of climate and environmental destruction on soil organic matter in forests [27].

In our study, the coverage of soil images with nutrient elements was different. In the first soil image, nitrogen was in low amounts of 0.028-0.056%, phosphorus in moderate amounts of 0.104-0.136%, potassium in the intervals of 2,000-2.312% was in sufficient quantities.

In the second soil image, nitrogen was 0.028-0.140 % – low, phosphorus 0.104-0.028 % – low and medium, potassium in the intervals of 1.875-2.062%, that is, in sufficient quantities.

In the third soil image, nitrogen was below 0.056-0.140%, phosphorus 0.104-0.020% between medium and low, potassium 1.812-2.062 % – in sufficient quantities.

The content of nutrient elements was higher in the surface layers of the soil than in the lower layers. All the considered soil images contain low amounts of nitrogen, moderate amounts of phosphorus and sufficient amounts of potassium.

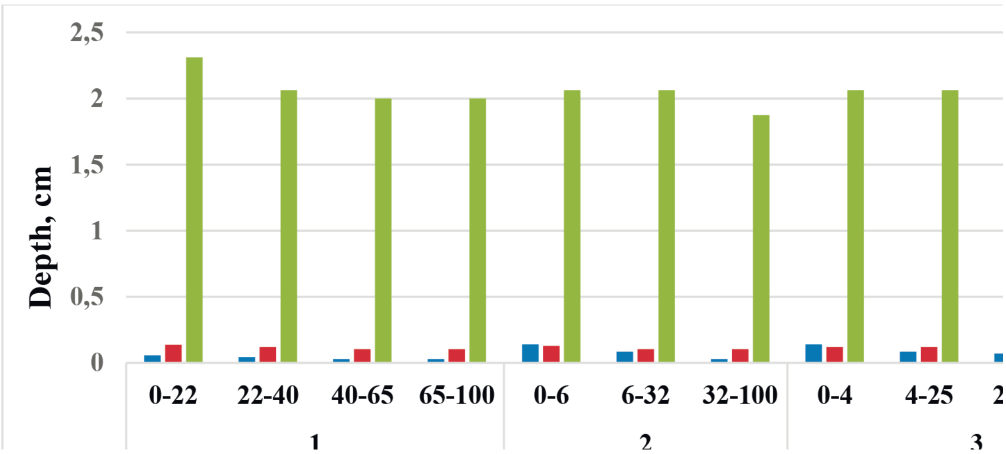

Figure 2 – Nutrient elements in the soils of the Southern Balkhash region, %
(1,2,3 place where soil samples were taken)

Soil fertility is the main factor affecting crop yields [28]. Soil fertility determines the growth, yield of crops and, consequently, the productivity and stability of the land. Continuous crop production uses plant nutrients in the soil, which leads to plant nutrient imbalances, thus affecting soil productivity [29].

One of the main indicators of determining soil fertility is the amount of humus in it. With the formation of humus, a number of nutrient elements (carbon, nitrogen, forfor, sulfur, potassium, etc.) accumulate in the soil. Humus is a reserve and stimulant of organic life [30,31]. The humus content ranged from 0.10-0.48% in the first soil image, 0.24-1.24% in the second soil image, and 0.21-1.41% in the third soil image. The humus coverage of all soil images was to a very low degree.

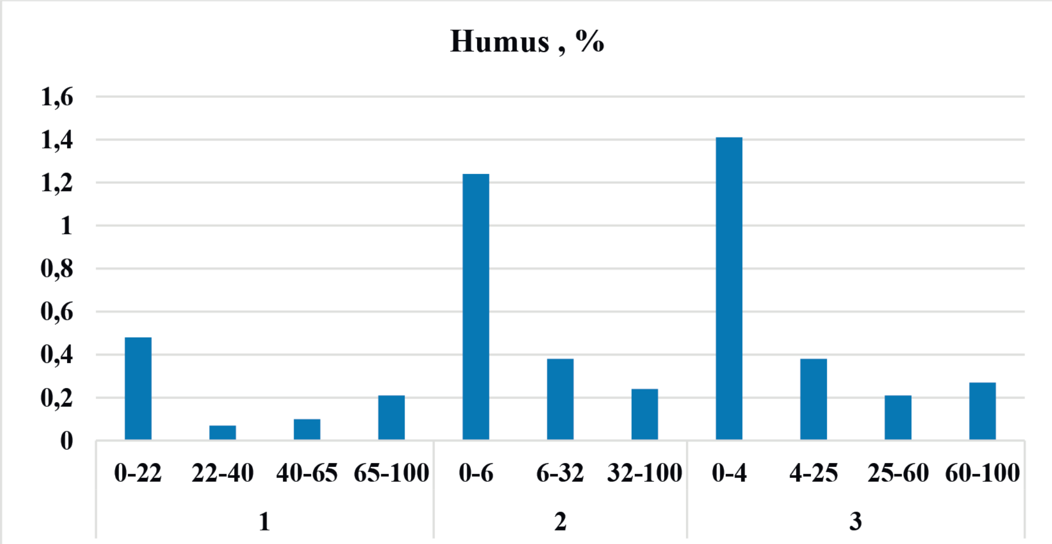

Figure 3 – Humus content in soils near South Balkhash, %
(1,2,3 place where soil samples were taken)

The reaction of the soil environment is one of the main factors affecting soil conditions, plants growing in it and microorganisms living in it, as well as soil fertility in general. The reaction of the soil medium in the first soil image showed a strong alkali in the range of 8.28-8.90, i.e., in the second soil image the pH indicator showed a strong alkali in the range of 8.43-9.27, in the third soil image the reaction of the soil medium showed a strong alkali in the range of 8.44 – 8.97. The alkalinity of soils increased with the depth of the soil.

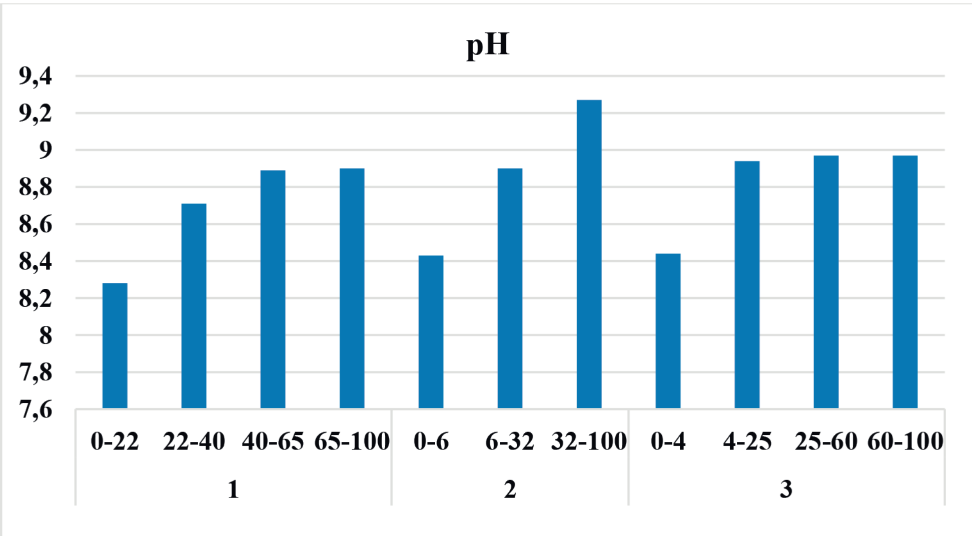

Figure 4 – Secondary reaction of South Balkhash soils
(1,2,3 place where soil samples were taken)

The salinity of the soil is formed due to different conditions. First of all, it depends on the mineral composition of the rocks, which are considered the beginning of the soil. Secondly, on the basis of salt soils, drought, desert steppes occupy a lot of space in the regions. In these regions, due to the heat of the weather, strong winds, evaporation of water from the surface of the earth is very intense, and as the soil solution in the layers of the earth evaporates and rises higher, the dissolved salts in it also rise up and accumulate when it reaches the upper surface of the soil [32,33].

As for the water filtration of the soil (mg-eq. 100 g of soil), formed the following descending series in the first soil image: HCO_3^- (0,52) > Ca^{++} (0,38-0,48) > Mg^{++} (0,19-0,29) > $SO_4^{''}$ (0,06-0,27) > Cl’ (0,04-0,07) = Na^+ – (0,03-0,07) > CO_3 (0,04) > K^+ (0,02-0,04).

The cations and anions in the water filter in the second soil image were in the next descending series(mg-eq. 100 g per soil):HCO_3^- (0,52-0,72) > Ca^{++} (0,19-0,48) > Mg^{++} (0,19-0,38) > $SO_4^{''}$ (0,12-0,21) > K^+ (0,02-0,19) > Na^+ (0,03-0,10) > Cl’ (0,04) = CO_3(0,04).

The composition of the water filter in the third soil image was in the next descending series (mg-eq. 100 g per soil): HCO_3^- (0,56-0,60) > Ca^{++} (0,38-0,48) > Mg^{++} (0,19-0,29) > $SO_4^{''}$ (0,03-0,25) > K^+ (0,02-0,19) > Na^+ (0,03-0,05) > CO_3 (0,04) = Cl’ (0,04).

It was found that all of the studied soil images were dominated by bicarbonate ions (NCO_3 -). Then all soil images had a high Ca content, and the lowest levels were CO_3, Cl’nions, and K+ cation.

Table 1 – Soil water filtration

Contour	Depth, cm	HCO_3^-	CO_3	Cl’	$SO_4^{''}$	Ca^{++}	Mg^{++}	Na^+	K^+
1	0-22	0,52	0,04	0,04	0,27	0,48	0,29	0,03	0,04
	22-40	0,52	0,04	0,04	0,08	0,38	0,19	0,03	0,04
	40-65	0,52	0,04	0,00	0,10	0,38	0,19	0,03	0,02
	65-100	0,52	0,04	0,07	0,06	0,38	0,19	0,07	0,02
2	0-6	0,52	0,04	0,00	0,21	0,38	0,19	0,03	0,13
	6-32	0,52	0,04	0,04	0,15	0,19	0,38	0,03	0,10
	32-100	0,72	0,04	0,04	0,12	0,29	0,48	0,10	0,02
3	0-4	0,60	0,04	0,04	0,25	0,48	0,19	0,03	0,19
	4-25	0,60	0,04	0,04	0,21	0,38	0,29	0,03	0,16
	25-60	0,56	0,04	0,04	0,11	0,48	0,19	0,03	0,02
	60-100	0,60	0,04	0,00	0,03	0,38	0,19	0,05	0,02

According to the composition of salts in the soil samples, all soil samples were found to be non-salinized, that is, the composition of salts was below 0.2% in all soil samples.

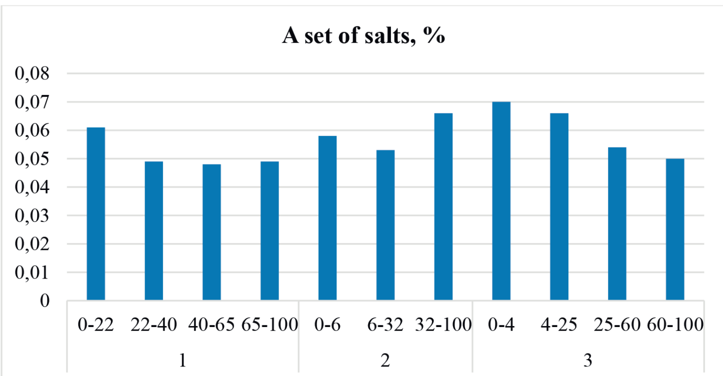

Figure 5 – A set of salts in the soils of the South Balkhash region, %
(1,2,3 place where soil samples were taken)

For absorbed bases, the set of absorbed bases in the first soil image ranges from 7.06-10.27 ml-eq (per 100 g of soil), in the second soil image – 6.09-9.08 ml-eq. In quantities (per 100 g of soil), the third soil image contained between 6.88 – 9.29 ml-eq (per 100 g of soil). The set of absorbed bases in the first soil image was at a moderate level, in the second and third soil images-at a low level. In terms of the amount of absorbed bases, the absorbed bases were inferior in all three soil images (5 – 10 ml- ml-eq / 100 g per soil). Among the absorbed bases, the absorbed Ca predominates, followed by Mg, and the amounts of Na and K are negligible.

Table 2 – Absorbed bases ml-eq.100 g to the soil

Contour	Depth, cm	Ca	Mg	Na	K	A set of absorbed bases
1	0-22	4,37	2,43	0,18	0,08	7,06
	22-40	4,37	5,82	0,18	0,07	10,27
	40-65	4,85	2,43	0,18	0,09	7,55
	65-100	3,88	1,94	0,18	0,09	6,09
2	0-6	7,28	1,46	0,18	0,16	9,08
	6-32	3,88	1,94	0,18	0,09	6,09
	32-100	3,40	5,34	0,09	0,09	8,92
3	0-4	7,76	0,97	0,18	0,38	9,29
	4-25	5,34	0,97	0,18	0,39	6,88
	25-60	4,37	2,91	0,18	0,09	7,55
	60-100	4,85	3,88	0,16	0,09	8,98

Conclusion

The morphological characteristics of the soil were developed: the first image soil was gray soil, the second image soil was grayish yellow sandy soil, and the third image soil was found to belong to the Sandy orange soil type.

The mechanical composition of the first soil image was dominated by a fine sand fraction, followed by a coarse dust fraction. In the second soil image, fine sand and coarse dust fractions predominated. The third soil image was dominated by fine sand and coarse dust.

The chemical composition was determined. In all the studied soils, the amounts of nutrient elements were similar. For example, it was found that the nitrogen content is low, phosphorus is medium, and potassium is contained in sufficient quantities. The humus content is very low. The reaction of the soil environment was alkaline and strongly alkaline. Soil images on absorbed bases were characterized by a set of absorbed bases of low size (5 – 10 ml-eq/ 100 g of soil).

It was found that all of the studied soil images were dominated by bicarbonate ions (NCO_3). Among the cations, the CA content was high in all soil images. In terms of the set of salt content, all soil images belong to the category of unsalted, that is, the set of salts was below 0.2%.

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