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Analysis of the assessment of the salinity degree of irrigated lands in Karmakshy District of Kyzylorda region

Abstract. *The article examined a comprehensive analysis of the modern reclamation state of irrigated lands of Karmakshy District of Kyzylorda region, located in the lower reaches of the Syrdarya River, studied the causes and degree of salinization of soil cover. The territory of Kyzylorda region is located in the Turan lowland. Over the past half century, large changes have taken place in the entire natural complex due to the decrease in the flow of the Syrdarya River in the Aral Sea region. As a result of the drying up of the Aral Sea, a desert with an area of 21.4 thousand km2 was formed in its Kazakh Part. The work was carried out to compile a soil map of Kyzylorda region. When creating a map, we used GIS technologies. By compiling a soil map, we conducted a survey of the soil of Karmakshinsky district. In addition, the soil cover of irrigated lands of Karmakshy District in Kyzylorda region is grouped by types of salinization, the features of their development and distribution are described, and ways to improve the soil-salt regime of irrigated lands are considered.*
Key words: *irrigated lands, analysis, soil, mapping, salinization, GIS, soil-salt regime.*

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Introduction. The development of environmental processes in an unfavorable direction for wildlife did not bypass the Aral Region. The territory of Kyzylorda region is located in the Turan lowland. Over the past half century, large changes have taken place in the entire natural complex due to the decrease in the flow of the Syrdarya River in the Aral Sea region. As a result of the drying up of the Aral Sea, a desert with an area of 21.4 thousand km2 was formed in its Kazakh Part. In the lower reaches of the Syrdarya river, adjacent to the Aral Sea, 2582 large and small lakes remain 155. In the agricultural part of the river delta, the incoming items of the groundwater balance were reduced, which led to an increase in their mineralization from 1 to 10 g/l and a 3-fold increase in land area with groundwater mineralization to 10-25 G/L.

In this regard, in order to further develop irrigated agriculture in this region, the problem arose of a detailed study of the history and modern halogenesis of the soils of the Kyzylorda region. In this case, there is a need to study the qualitative and quantitative characteristics of the salinity of the soils of this region and map their areas.

Karmakshinsky District of Kyzylorda region is an administrative-territorial division located in the central part of Kyzylorda region. Founded in 1928. The land area is 31.0 thousand km^2. The district center is the village of Zhosaly [4].The territory of the district is completely occupied by the Turan lowland. From the far north are the hilly Sandy basins of the Aral Karakum Yızıshkekum and Kolkudykkum, in the center-the Aktogay and Zhosaly steppes of the Alakay, in the south-the hilly sands of the Kyzylkum. The highest point of the district is in the North (Mount Targul, 160 m). Construction materials were explored from the bowels of the Earth. The Syrdarya river flows through the middle part of the district. From it are the Karmakshy and Shieli canals. In the South pass the ancient channels of the Syr Darya — Zhanadarya, Inkar Darya, etc.[1].

The climate is very continental, winters are quite cold, summers are hot and dry, and legend has it. The average annual air temperature in January is 9-13°C, in July — 27-29°C. The average annual precipitation is 100-150 mm. The soil in the North is gray, Sandy-Gray, barren and barren, in the central part-Sandy-gray, pale gray, in the Syr Darya Valley and floodplain-Meadow and Meadow-swampy soils. They grow gray Wormwood, yerkeshop, bayalysh, buygun, tasbuyyrgun, kokpek, Shi, Kara saksaul, sarsazan, reeds, reeds, karatal, Zhide, zhingyl, shengel, etc. From animals live wolves, foxes, badgers, sand rabbits, from birds-geese, ducks, pheasants, Bluebirds, etc. The Syrdarya River is rich in fish.

The climate of karmakshy district is sharply continental. The flat area of the district is open for cold air masses from the North, dry dry winds from the South. The remoteness of the area from the World Ocean also plays an important role. The average annual temperature is 8°, the average January temperature is 26.1°. In winter, when arctic air masses invade, the temperature drops to -34°. The highest temperature reaches in June (+42°). In summer, there is dryness of the air and cloudlessness. The average annual rainfall is 118 mm, with the greatest amount (61 mm) falling in March, April and may. In winter, precipitation decreases to 57 mm and falls in November, December and January. Annual rainfall is insufficient for the development of crops, so irrigated agriculture is developed in the area.

The soil and vegetation cover of karmakshinsky district is a typical semi-desert zone.

The soil of Karakhov and Zhuankum sands near the island is characterized by a low content of nutrients: nitrogen, phosphorus, potassium and humus (less than 1%). In some places, saline-salt and thakyr-like soils are found. For farming, they are less suitable and are used as spring-summer pastures.

The soil cover of the district is divided into groups: moist soils of the agricultural belt and complex soils.

Agricultural land is represented by the following types of soils (%): Sands – 45.6; Brown – 24.4; desert – like thakyr-11.1; swampy and Meadow – swampy-11.0; gray – brown-2.9; floodplain-Meadow 3.6.

In terms of mechanical composition, sandy loam (46.6%) and medium loam (33.1%), sandy loam (18.1%), heavy and medium loam (1.8%), heavy loam (0.2%), light loam (0.1%) predominate among them.

The main backgrounds of the area are sands and brown soils, then Desert thakyr-like, swampy and Meadow-swampy, floodplain-Meadow, gray-brown, salt marshes are reduced.

In the delta areas, Meadow intrasonal soils (Meadow-swampy, floodplain-meadow) with different complexities were formed, which are 8.4% of the territory where most of the irrigated arable land and hayfields are located.

Under the pasture is the widest set of soil groups, from sands to salt marshes and salt marshes.

All soils of the studied territory have some common features: low reserves and content of humus, weak anti-erosion and deflation resistance, a sharp impact on salinization and salinization processes, low supply of nitrogen and phosphorus compounds available to plants, sufficient reserves of potassium, predominance of an alkaline reaction and high carbonate content.

The surface water resources of the karmakshinsky district are represented by the lower reaches of the Syrdarya River, which has the character of a flat river, strongly meandered, divided into branches and channels. The river bed passes in its accumulative sediments and rises in relation to it and the surrounding surface. The nutrition of the Mixed River is snow and Glacier, rain and soil. Flat lake-full of elders. The average annual water loss is 444 m3/sec, the maximum annual loss during the flood period is 1070 m3/sec, and the minimum is 1.68 m3/sec. The river water reaches 560.6 million tons per season. the volume of M3 is used for regular irrigation, including 362 million for rice production. M3[2].

Research methods: expert decryption, standard statistical methods of correlation analysis of remote recordable parameters (NDVI, LST, etc.) and Terrestrial information. Methods for clustering and classifying satellite data.

Scope of application and implementation of results: salinization of irrigated fields and degradation of agricultural land in the south of Kazakhstan.

Current results: 2002-2022 historical data of the period (based on the materials of hydrogeological and reclamation expeditions of the Ministry of Agriculture of the Republic of Kazakhstan, relevant regions and other sources).

At the main sites, a kind of surface study of the salinization of irrigated fields of the project territories was carried out, which included the selection of soil samples, analysis of the composition of salts and, as part of Route Studies, an expert, rank description of the state of agricultural land by FAO salinization classes.

The available open archive data were analyzed, it was obtained that various cartographic materials have been stored in the system of the state institution «Department of land relations» at the regional level since the Times of the former USSR (since 1972). Archives are stored in non-digitized and paper form.

Mapping the salinity of irrigated fields faces significant technical challenges. A review of the scientific literature showed the presence of only individual works related to this task. Salinization of irrigated fields has significant variability throughout the season. The cards of spring and autumn salting are practically of interest. To solve the task of mapping the salinity of irrigated fields in the south of Kazakhstan, the following satellite products were used:

NDVI vegetation index. The format of individual scenes is Sentinel — 2, with a resolution of 10m. monitoring data for the period from 2003 to the present (source-fews NET), decade update, resolution up to 250m, on scales: absolute values of NDVI; deviation from the average; assessment of the depth of deviation, on the scale of historically recorded variations (perennial minimum-maximum) at this time here.

Salinity indices (the selection of indices continues). The format for individual scenes of Sentinel-2 and (or) Landsat -8 Is resolution (10-30 m) during the spring period (March-April).

Sentinel-2, Landsat-8 images with resolution (10-30 m) optical channels. The format of individual scenes for assessing the spectral characteristics of the bottom surface, detecting flooding and waterlogging of irrigated fields throughout the year, restoring rice crop rotation and assessing the autumn-winter washing of fields, monitoring the area of water mirrors of the main reservoirs of the region (assessment of the current fullness of reservoirs and operating modes for diagnosing the wateriness of the season).

Surface temperature (Land Surface Temperature). In the format of monitoring the period from 2003 to the present (source — FEWS NET), ten-day update, 5 km resolution; on the scale: absolute values; deviation from the average; quantitative assessment of the amount of cooling due to irrigation of the field (Irrigation Cooling Effect).

Height of snow cover (Snow Depth). In the format of monitoring the period from 2001 to the present (source — FEWS NET), ten-day Update, 1 km resolution.

The practical significance of the described phenomenon is associated with the demand for a long-term forecast of the water of the rivers of Central Asia. The forecast of the volume of river flow affects the planning of acreage under various crops. «Long memory in the mountain snowy perennial mode on the Tien Shan justifies the use of a simple inertial» forecast. At the same time, it is assumed that the snowfall next year will be close to the level of the current year.

In the process of conducting research activities of this stage of the project, documentation was developed on geoparal, a web Geoinformation service of operational monitoring, which includes recommendations and software solutions on architecture for the development of a Geoinformation system for quantitative assessment of soil salinity[3].

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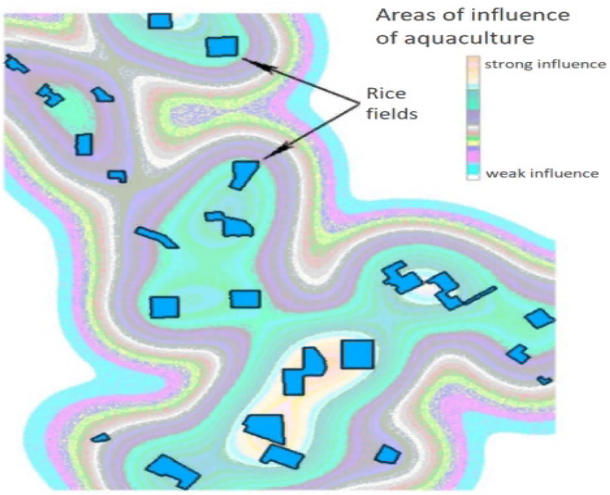

Fig.1. Reconstruction of rice crop rotation in the massif

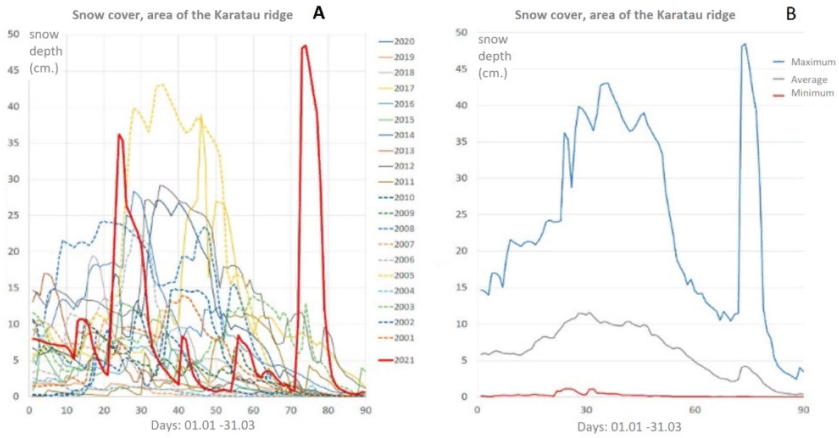

Fig.2. Satellite monitoring SD FEWS NET

Research methods and discussion of the results obtained. In other equal conditions, the predominance of the salinity factor mainly depends on the type and intensity of soil use and taking into account the complexity of the soil-reclamation and environmental conditions of the kazaly-Aral irrigation Massif, as well as in accordance with the objectives of scientific research and to determine the degree of salinity of the soil, a field study was conducted.

In order to solve the tasks set, the calculation sites for sampling Salt soils of the Karmakshy district with an area of 95.25 km2 were selected, in particular, the territory of the Abay settlement, 5 km from the Karmakshy station, the basykara settlement, 10 km from the Kazaly station and the Orkandeu settlement, located 30 km away. The following soil sampling points were distinguished: 1-3 sampling points – 1, 3.5 km and 6 km southeast of the settlement of orkandeu, 4 points 5 km south of the Abay settlement irrigated lands, 5-7 points 2-6 km southeast of the Abay settlement, 8 points 1 km north-east of the basykara settlement, 9 points 1.5 km south of the Aiteke bi settlement and 10 points 1.5 km northeast of the Altai settlement were selected.

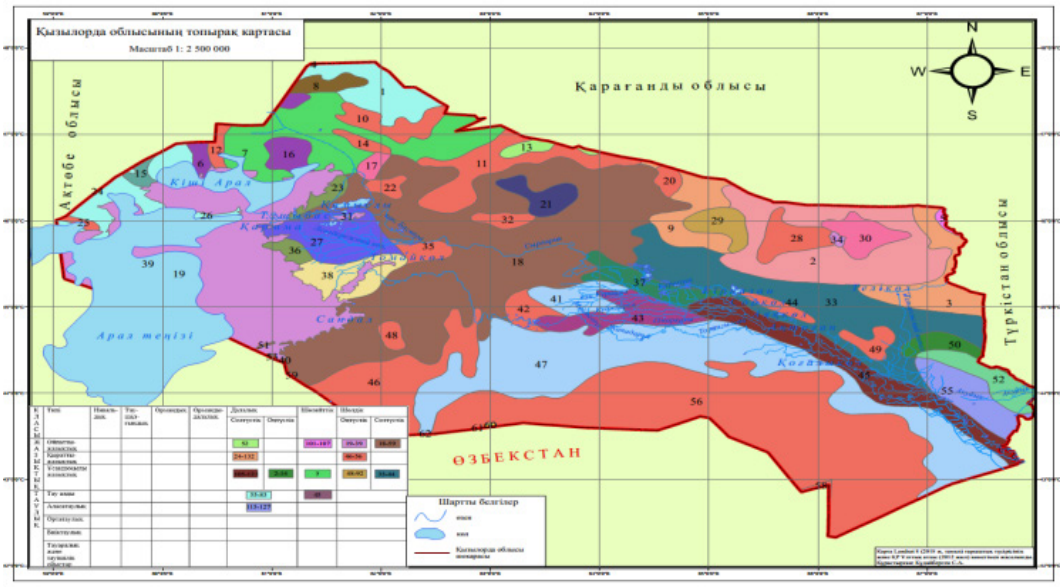

Fig.3. Soil map of Kyzylorda region

Assessment of saline soils according to the methodology of V. A. kovdu and V. V. Egorov according to 3 main criteria: chemistry, degree of salinity and depth of the Salt horizon. The chemistry of saline soils was determined by the content of anions and cations. Especially the anions, the magnitude of their relationship in the water pumps of the soil were taken into account[4].

In Kyzylorda region in 2022, 24,099. 2 thousand hectares were used (including the territory of Kyzylorda region – 22,601. 9 thousand hectares, leased land of Ulytau District of Karaganda region – 2,210. 8 thousand hectares), including:

- agricultural land – 2,788. 2 thousand hectares (2022 – 2,701. 6 thousand hectares, increase 86.6);
- land of settlements (cities and rural settlements) -838.3 thousand hectares 2022 – 838.3 thousand hectares);
- industrial, communications, defense and other non – agricultural land – 254.6 thousand hectares (2022-256 thousand hectares, decreased by 1.4 thousand hectares);
- lands of specially protected natural areas – 161.2 thousand hectares (2021 – 161.2 thousand hectares);
- lands of the Forest Fund – 6 510.3 thousand hectares (2021 – 6 510.3 thousand hectares);
- lands of the Water Fund – 2 288.1 thousand hectares (2022 – 2 287.2 thousand hectares), an increase of 0.9
- lands of the fund-11 258.5 thousand hectares (2022 - 11,289. 8 thousand hectares), decreased by 31.3 thousand hectares in 2022, the largest share of the land fund of the Kyzylorda region is occupied by the lands in the fund and the lands of the Forest Fund (figure 4).

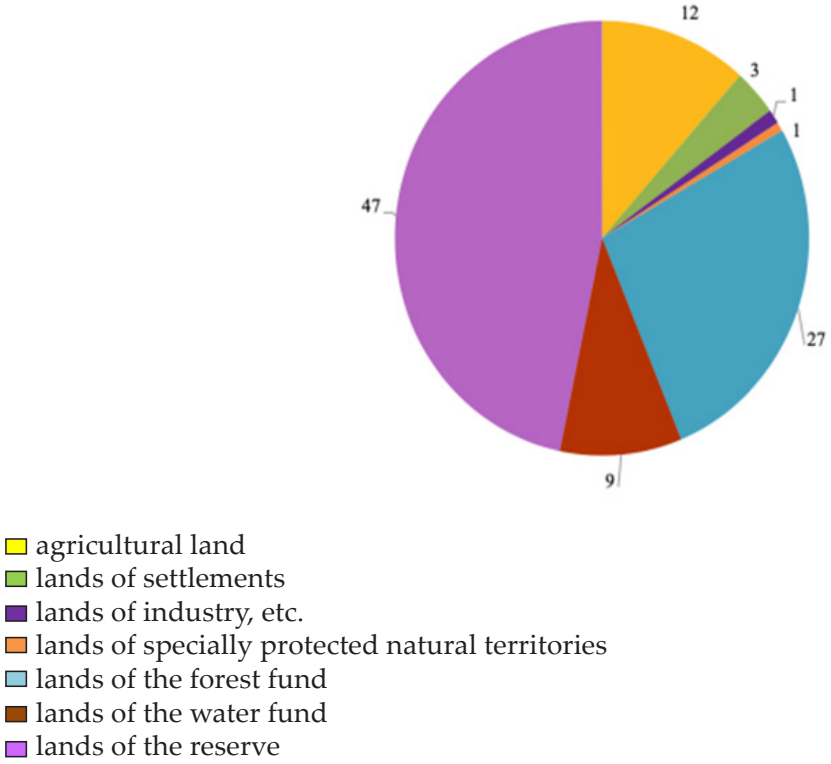

Fig.4. Distribution of the Land Fund of Kyzylorda region by Category, %

In 2022, the area of reclaimed land in the Kyzylorda region amounted to 0.711 thousand hectares.the largest share of agricultural land is pastures – 1,997.6 thousand hectares or 89%, the smallest share or 0.6% is perennial plantings.

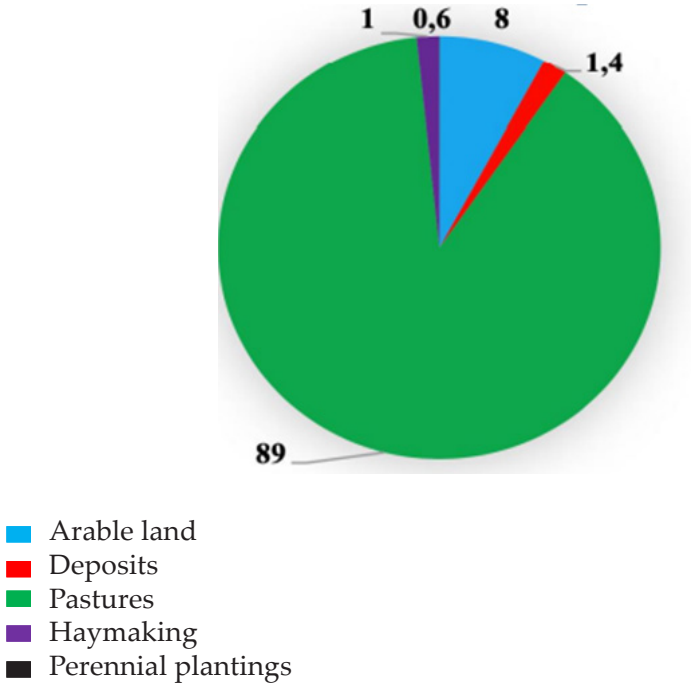

Fig.5. Distribution of the Land Fund of Kyzylorda region by Category, %

Unlike water and atmospheric air, which are only migration environments, soil is the most objective and stable indicator of man-made pollution. It clearly reflects the emission of pollutants and their actual distribution sources of soil pollution

- emissions of harmful substances into the atmospheric air from permanent

and mobile sources of pollution

- landfills of industrial and household waste;
- unauthorized landfills of industrial and household waste;
- chemical plant protection products and mineral fertilizers[5]. The growth of oil

and gas production, the high aggressiveness of the extracted raw materials affect the processes of intensive pollution of the atmosphere, surface and groundwater, and through them the soil and vegetation cover, where heavy metals, petroleum products, polychlorinated diphenyls and dioxins accumulate. In 2022, RSE «Kazhydromet» monitored soil contamination with heavy metals in the spring and autumn periods in the cities of Zhosaly, Toretam and the villages of Akai, Akzhar (table 1).

Table 1 – soil pollution by heavy metals in Kyzylorda region, mg / kg

Sampling points	chrome	lead	zinc	cadmium	copper
spring period					
Zhosaly c.	0,43-0,6	12,6-25,5	5,7-18,6	0,1-0,2	0,6-1,03
Toretam c.	0,46-3,4	15,9-26,1	5,7-6,1	0,13-0,17	0,65-2,33
Akai v.	0,19	3,4	1,5	0,08	0,25
Akzhar v.	0,16	2,1	1,6	0,04	0,32
autumn period					
Zhosaly c.	0,07-0,18	7,1-16,4	2,3-7,8	11-0,22	0,3-3,8
Toretam c.	0,04-0,13	10,7-16,3	5,9-10,9	0,08-0,19	0,46-1,2
Akai v.	0,02	2,4	2,5	0,005	0,11
Akzhar v.	0,03	3,3	2,6	0,04	0,8

In addition, a number of studies were carried out on the territory of the region on soil salinization (chlorides, sulfates), soil pollution with persistent organic pollutants (PPE) and pesticides.

According to natural and climatic conditions, almost the entire territory of the Kyzylorda region belongs to an extremely unfavorable arid zone. The region is characterized by increased solar radiation, low precipitation, strong winds and dust storms that move tons of sand for several kilometers.

The main environmental problems associated with land pollution (oil spills) by oil producing companies, as well as soil degradation and salinization.

Studies on the chemical composition of salt soils of the karmakshinsky district are conducted on calcium, magnesium, sodium, potassium and chlorine anions, sulfate anions, bicarbonates (tab. 2).

Table 2 – Studies on the chemical composition of salt soils of the karmakshinsky district

Place of soil sampling	Depth, m	Designations	Cations			Anions			Dry residue at 105 C	The degree of salinity of soils	Type of soil salinization
			Ca++	Mg++	Na+K	HCO3	C1	SO4			
1	0.5	%	0.096	0.036	0.384	0.018	0.518	0.46	1.129	medium saline	Sulfate-chloride
	1.0	%	0.092	0.031	0.359	0.012	0.44	0.499			
2	0.5	%	0.055	0.157	0.671	0.054	0.072	1.897	3.206	highly saline	Sulfate
	1.0	%	0.063	0.165	0.738	0.036	0.1	1.957			
3	0.5	%	0.109	0.029	0.064	0.012	0.142	0.317	0.642	slightly saline	Sulfate-chloride
	1.0	%	0.07	0.029	0.191	0.018	0.163	0.422			
4	0.5	%	0.15	0.08	0.102	0.016	0.334	0.374	1.053	medium saline	Chloride-sulfate
	1.0	%	0.142	0.076	0.240	0.074	0.326	0.643			
5	0.5	%	0.062	0.158	0.671	0.053	0.08	2.497	4.107	slightly saline	Sulfate
	1.0	%	0.073	0.165	0.738	0.012	0.14	2.557			
6	0.5	%	0.12	0.05	0.584	0.006	0.951	0.422	0.938	slightly saline	Chloride
	1.0	%	0.06	0.032	0.324	0.024	0.341	0.49			
7	0.5	%	0.026	0.058	0.246	0.030	0.029	0.68	1.062	slightly saline	Sulfate
	1.0	%	0.032	0.064	0.252	0.036	0.035	0.128			
8	0.5	%	0.036	0.104	0.451	0.024	0.049	1.267	2.057	medium saline	Sulfate
	1.0	%	0.042	0.110	0.492	0.096	0.067	1.334			
9	0.5	%	0.096	0.164	0.511	0.102	0.059	1.327	2.253	medium saline	Sulfate
	1.0	%	0.102	0.170	0.517	0.018	0.065	1.333			
10	0.5	%	0.048	0.054	0.221	0.012	0.023	0.63	0.962	slightly saline	Sulfate-soda
	1.0	%	0.051	0.057	0.247	0.018	0.033	0.69			

The results of the study showed that all soils of the studied territory have a certain degree of salinity. According to chemism, soils in the form of sulfate-chloride, sulfate-soda and chloride of salinity predominate. A large area of karmakshy district (64.3%) is occupied by saline Medium-Salt soils. Further, in descending order, weak (22.6%) and heavily salted (13.1%) soil. A small area of the studied area is occupied by saline and deep saline soils. Most of the areas are salted from the surface of the Earth, which is currently the result of irreversible secondary salinization of this soil[6].

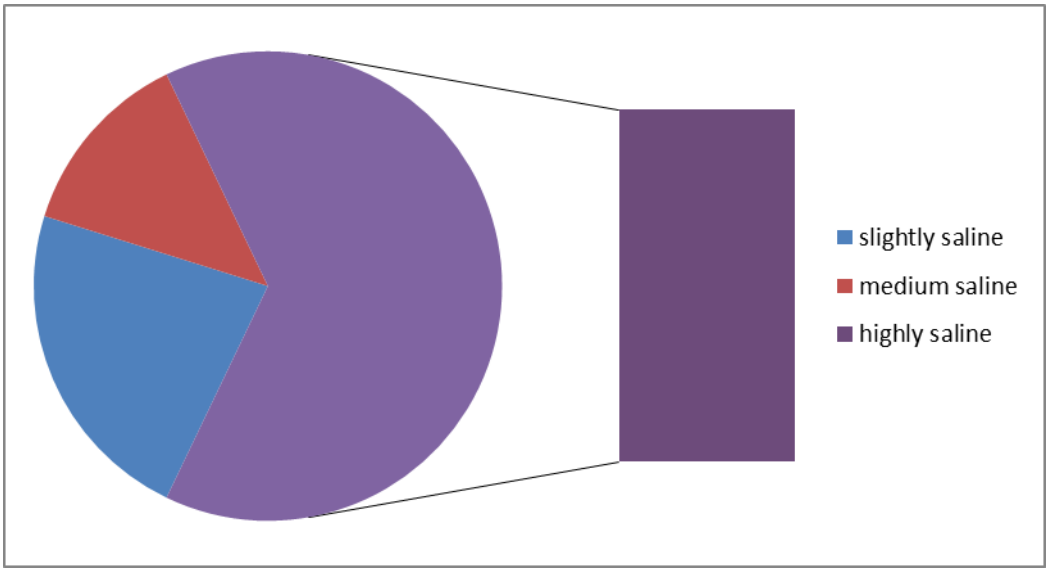

Figure 6 – distribution of soils of varying degrees of salinity at accounting sites of Karmakshinsky District of Kyzylorda region(slightly saline-22.6%; medium saline -64.3%; highly saline – 13.1%)

Conclusions:

1. Drawing up a soil map of Kyzylorda region;
2. Conducting research by drawing up a map, it is possible to solve the following problems.
3. The studied areas of irrigated saline soils of Karmakshinsky District of Kyzylorda region showed the intensification of secondary salinization processes due to an increase in the level of mineralized groundwater;
4. Sulfate-chloride, sulfate, chloride and chloride-sulfate salinization of soils occurs in irrigated areas;
5. Anionic salinization of the soil is represented by chloride ions, bicarbonates and sulfate anions;
6. In order to maintain the design level of soil fertility in these conditions, it is necessary to use more intensive technologies for its support, including biological reclamation on the basis of proper crop rotation and the use of crops adapted to these natural conditions.

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Қызылорда облысы Қармақшы ауданындағы суармалы жерлердің сортаңдану дәрежесін бағалауды талдау

Аңдатпа. Мақалада Қызылорда облысы Қармақшы ауданының Сырдария өзенінің төменгі ағысында орналасқан суармалы жерлерінің қазіргі заманғы мелиорациялық жай-күйіне кешенді талдау жүргізіліп, топырақ жамылғысының тұздану себептері мен дәрежесі зерделенді. Қызылорда облысының аумағы Тұран ойпатында орналасқан. Соңғы жарты ғасырда бүкіл табиғи кешенде Арал теңізі аймағында Сырдария өзені ағынының азаюына байланысты үлкен өзгерістер болды. Арал теңізінің құрғауы нәтижесінде оның қазақстандық бөлігінде ауданы 21,4 мың км^2 шөл пайда болды. Осыған байланысты, осы өңірде суармалы егіншілікті одан әрі дамыту мақсатында Қызылорда облысының топырақтарының тарихы мен қазіргі заманғы сортаңдануын егжей-тегжейлі зерттеу мәселесі туындады. Қызылорда облысы Қармақшы ауданының бұл жағдайда топырақтың тұздануының сапалық және сандық сипаттамаларын зерттеу қажет Қызылорда облысының топырақ картасын жасау жұмыстары жүргізілді. Картаны жасау кезінде ГАЖ-технологиялар пайдаланылды. Топырақ картасын жасау мен картографиялау кезінде Қармақшы ауданының топырағына тексеру жүргізілді. Бұдан басқа, Қызылорда облысы Қармақшы ауданының суармалы жерлерінің топырақ жамылғысы сортаңдану түрлері бойынша топтастырылды міндетті түрде, олардың даму және таралу ерекшеліктері сипатталды, сондай-ақ суармалы жерлердің топырақ-тұздық режимін жақсарту жолдары қаралды.

Түйін сөздер: суармалы жерлер, талдау, топырақ, картаға түсіру, тұздану, ГАЖ, топырақ-тұз режимі.

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Анализ оценки степени засоления орошаемых земель Кармакшинского района Кызылординской области

Аннотация. В статье проведен комплексный анализ современного мелиоративного состояния орошаемых земель Кармакшинского района Кызылординской области, расположенных в нижнем течении реки Сырдарьи, изучены причины и степень засоления почвенного покрова. Территория Кызылординской области расположена на Туранской низменности. За последние полвека во всем природном комплексе произошли большие изменения в связи с уменьшением стока реки Сырдарья в регионе Аральского моря. В результате осушения Аральского моря в его Казахстанской части образовалась пустыня площадью 21,4 тыс. км^2. В связи с этим, в целях дальнейшего развития орошаемого земледелия в этом регионе, возникла проблема детального изучения истории и современного засоления почв Кызылординской области. В этом случае возникает необходимость изучить качественные и количественные характеристики засоления почв.

Была проведена работа по составлению почвенной карты Кызылординской области. При создании карты использовались ГИС-технологии. При составлении почвенной карты проведено обследование почв Кармакшинского района. Кроме того, почвенный покров орошаемых земель Кармакшинского района Кызылординской области сгруппирован по типам засоления, описаны особенности их развития и распространения, а также рассмотрены пути улучшения почвенно-солевого режима орошаемых земель.

Ключевые слова: орошаемые земли, анализ, почва, картографирование, засоление, ГИС, почвенно-солевой режим.

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