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AMELIORATION STATE OF SOILS AT THE MOUTH OF THE KUR RIVER

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МЕЛИОРАТИВНОЕ СОСТОЯНИЕ ПОЧВ В УСТЬЕ РЕКИ КУРЫ

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Abstract. The analysis of the melioration state of soils at the mouth of the Kura River in the Salyan district was carried out in 2019-2024. The territory is mainly covered with gray-brown, gray, gray-meadow, meadow and meadow-marsh soils. In all areas of cotton and grain crop cultivation, the soils are saline and solonchakous to varying degrees, crusted, swamped, etc. Regardless of the depth of groundwater, there are various types of salinization depending on the agrochemical composition of the soils. In the territory through which the Kura River flows, there is an inappropriate use of its waters, discharge of industrial and domestic wastewater into the river. This is manifested to a greater extent at the mouth of the Kura River, causing floods that pose a threat to the population living here, and creating environmental problems in the marine area. A detailed study of environmental violations at the mouth of the Kura River is relevant. The existing hydrological condition has been analyzed, the causes of melioration problems have been determined, and recommendations have been proposed. The results obtained serve the development of sustainable agriculture and long-term conservation of soil resources in the region.

Аннотация. Выполнен анализ мелиоративного состояния почв в устье реки Куры в Сальянском районе в 2019-2024 гг. Территория в основном покрыта серо-бурыми, серыми, сероземно-луговыми, луговыми и лугово-болотными почвами. Во всех районах возделывания хлопчатника и зерновых культур почвы в той или иной степени засолены и солончаковые, коркуются, заболачиваются и т.д. Независимо от глубины залегания грунтовых вод встречаются различные типы засоления в зависимости от агрохимического состава почв. На территории, по которой протекает река Кура, наблюдается нецелевое использование ее вод, сброс в реку промышленных и бытовых сточных вод. В большей степени это проявляется в устье реки Куры, вызывая наводнения, представляющие угрозу для проживающего здесь населения, и создавая экологические проблемы в морской акватории. Детальное изучение экологических нарушений в устье реки Куры — актуально. Проанализировано имеющееся и гидрологическое состояние, определены причины мелиоративных проблем, предложены и рекомендации. Полученные результаты служат развитию устойчивого сельского хозяйства и долгосрочному сохранению почвенных ресурсов региона.

Keywords: water and soil resources, ameliorative state, salinization, ground-waters, collector-drainage systems.

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Ключевые слова: водно-почвенные ресурсы, мелиорация, засоление, грунтовые воды, коллекторно-дренажные системы.

The river of Kur which is one of the main water basins in Azerbaijan, plays a great role in formation of the water and soil resources in Salyan and Neftchala regions. These regions located at the mouth of the Kur, have large alluvial plains and are of strategic importance in the country's agriculture. But productivity and agro-technical state of soils in these regions directly depend on their ameliorative state. The ameliorative state of soils in these regions has worsened as a result of the climate change, unequal distribution of the water resources and human's activity.

The researches carried out in 2019-2024 indicate that the soils salinization, the uselessness of the drainage systems, increase of level of the under-ground waters, irrational usage of irrigative waters in Salyan and Neftchala regions caused aggravation of the ameliorative condition.

Before, the zones with the different vegetation take a monotonous form. The soil fertility decreases as a result of change of the agrochemical peculiarities of soils, the reason for this is salinization. The salinized soil loses its structure, it is blown by the winds because of weak structure and as a result salinization happens. Especially, increase of flooding cases during the spring-autumn irrigations negatively influences agricultural productivity.

Research object and method

2.0 hectares of zone under cotton and grain plants (near the concrete irrigative canal) of the farmer farming "Vatan" which is situated in the zone called PMK-31 was taken as a research object in Neftchala.

Analysis and discussion

The regions of Salyan and Neftchala which are included in mouth of the river of Kur are located in the plains around the Caspian Sea and the relief is characterized with the least slope. The soil cover in the zones consist of grey-meadow, alluvial-clayey, sandy soils [1-3].

The performed long-term researches indicate that productivity of the agricultural plants, soil fertility, water-physical characters depend on their mineralization. For this purpose, the composition of the soil and water was determined as a result of the performed researches in the zone (Table 1-3).

According to the results of the analyses, a quantity of SO_4 ion changes by 0.072g/l-0.624 g/l, Cl ion — 0.049 g/l-0.21 g/l, HCO_3 — 0.0915 g/l- 0.124 g/l, Ca — 0.11 g/l-0.12 g/l, Mg — 0.006-0.204 g/l, Na +K — 0.098 g/l-0.011 g/l, but a totality of the salts — 0.46 g/l – 1.28 g/l. It is shown from the table that mineralization of the irrigation and drain water is 0.50 — 1.30 g/l.

The salt number is 1.30-2.02 g/l for dry residue in irrigation and drain water, SO_4 is 0.288-0.624 g/l, HCO_3 — 0,170-0.124 g/l, Cl — 0.231-0.211 g/l, Ca is 0.150-0.11 g/l, Mg — 0.096-0.006 g/l, but a total of salts is 1.84-1.28 g/l compared to last years, layer of 0-25 cm, 0.079-0.116% in a layer of 75-100 cm, Ca is 0.025-0.02% in a layer of 0-25 cm, 0.02-0.04% in a layer of 75-100 cm, Mg is 0.009-0.009% in a layer of 0-25 cm, 0.006-0.003% in a layer of 75-100 cm, SO_4 is 0.036-0.048% in a layer of 0-25 cm, 0.024-0.012% in a layer of 0-75 cm, Na+K is 0.001-0.053% in a layer of 0-25 cm, 0.014-0.007% in a layer of 75-100 cm, a totality of salt is 0.14-0.29% in a layer of 0-25 cm, 0.15-0.19 % in a layer of 75-100 cm, the number of salts for dry residue is 0.16-0.33% in a layer of 0-25 cm, 0.16-0.21% in a layer of 0.75- 100 cm, pH is 8.07-8.95 in 0-25 cm, pH — 8.19-8.79 in 75-100 cm.

A quantity of salts for dry residue in irrigative and drain waters is 0.60-1.77 g/l, SO_4 is 0.72 - 0.624 g/l, HCO_3 is 0.0315-0.124 g/l, Cl is 0.049-0.21 g/l,Ca — 0.11-0.15 g/l, Mg — 0.006-0.0204 g/l, but the salt totality is 0.40-1.28 g/l compared to the previous years.

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Table 1

CHANGE OF THE SALT QUANTITY IN SOILS OF THE EXPERIMENTAL AREA
(Neftchala region 2022)

Depth, cm	*HCO_3*	*Cl*	*SO_4*	*Ca*	*Mg*	*Na+K*	*Dry residue,%*	*Salts %*
k-1 (Mg-eq)								
0-25	0,6	7.54	11,24	6,5	9.75	4,79		
25-50	0,8	7,71	8,54	3.5	5.25	6,99		
50-75	0.8	7.70	10,20	3.5	5.25	10.8		
75-100	0,6	7,65	10,41	4.0	6.0	9,81		
k-1 %								
0-25	0,0366	0,322	0.54	0,13	0,117	0.11	1,28	1,25
25-50	0,0488	0,224	0.41	0,07	0,063	0.16	1,23	1,19
50-75	0.0488	0,301	0.49	0,07	0.063	0.24	1,25	1,22
75-100	0.0366	0,308	0.50	0,08	0,072	0.22	1,27	1,22
k-2 (Mg-eq)								
0-25	0.2	7,29	10,41	3,25	4.87	11.6		
25-50	0.6	7.42	8,74	3.25	4,87	11.7		
50-75	0.4	7.62	10,83	2.0	3,0	11.0		
75-100	0.5	7.51	8.35	2.5	1.30	12.56		
k-2 %								
0-25	0.0122	0,322	0.50	0,06	0.058	0.26	1,45	1,22
25-50	0,0366	0,329	0.42	0.06	0.058	0.27	1.42	1,17
50-75	0.0244	0,168	0.52	0.04	0.036	0.25	1,26	1,04
75-100	0.0305	0.263	0.401	0.050	0.016	0.289	1.09	1.05

Table 2

MINERALIZATION OF THE GROUNDWATER IN THE EXPERIMENTAL AREA
(Neftchala region 2022), g/l

Section	*CO_3*	*HCO_3*	*Cl*	*SO_4*	*Ca*	*Mg*	*Na+k*	*Dry residue*	*Totality of salts*
K-1 groundwater	0,036	0,3172	3.02	1,08	0,08	0,01	0,11	5,00	4,65
K- 2 groundwater	0,048	0,2928	2,74	1,09	0,5	0,2 2	0,08	4,95	4,89
Irrigative water	0,084	0,0376	0.03	0.89	0,04	0,2 0	0.024	1,68	1.53
Drain water,	0.024	0,1952	6.43	1,03	0,38	0,0 3	5.96	14.05	13.85

In the last 5 years (2019-2024) the salt gathering is observed in soil profile of the irrigated areas, and this decreases productivity of agricultural plants. A level of the underground waters changes by 1.0-2.5 meter, and this negatively influences water-physical peculiarities of soils and causes salts to rise to the surface through capillary action.

From hydrological point of view, the underground waters of the region spread in a level of ground waters and depend on water regime of the Kur river. The available drainage systems are outdated or incomplete, that's why they can't fully fulfill their water removal function. And that creates condition for deterioration of soils from ameliorative view [4-6].

For many years various ameliorative measures have been realized in order to water the soils and regulate water regime in Salyan and Neftchala. So, the collector-drainage systems and regulating-devices were built in some zones. But the available situation indicates that one part of this infrastructure maybe physically staled or it isn't complete functional due to insufficient attention in terms of technical service [7-9].

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Table 3

CHANGE OF THE SALT QUANTITY IN THE SOILS OF THE EXPERIMENTAL AREA
(Neftchala region 2023)

Depth	*CO_3*	*HCO_3*	*CL*	*SO_4*	*Ca*	*Mg*	*Na+K*	*Dry residue, % Salts,%*		*pH*
K-1 (Mg-eq)										
0-25	No	0,60	3,20	4.247	7.75	0.25	0.047			
25-50	No	0.70	1,30	0.749	2.25	0.25	0.249			
50-75	No	1.00	1.70	4.247	6.50	6,62	0.197			
75-100	No	0.70	2,80	6.745	4.75	5.25	0,250			
K-1 %										
0-25	No	0.036	0,112	0.20	0.15	0.003	0.001	0,55	0,511	7,61
25-50	No	0.042	0,045	0.03	0.04	0.003	0,005	0.78	0.760	7.38
50-75	No	0,061	0,059	0.20	0.13	0.079	0.005	0.62	0,538	7.60
75-100	No	0,042	0,098	0.32	0.09	0.063	0.006	0,65	0,623	7.47
K-2 (Mg-eq)										
0-20	No	0.60	1,50	10,24	5.25	6.75	0,340			
25-50	No	0.50	4,10	6.495	5.50	5.50	0.090			
50-75	No	0.60	3,40	4.996	5.25	3.50	0.246			
75-100	No	0.60	2,10	6.745	5.75	3.50	0.195			
K-2 %										
0-20	No	0.036	0,052	0.49	0.10	0.081	0.007	0,79	0,768	7.52
25-50	No	0.030	0,143	0.3 1	0.11	0.066	0.002	0,73	0,663	7,40
50-75	No	0,036	0,119	0.24	0.10	0.042	0.005	0,65	0,542	7,47
75-100	No	0,036	0,119	0.32	0.11	0.042	0.004	0,68	0.635	7,38
Drain water(The drain was mixed with irrigation water),g/l										
	no	2.80	5.60	19.98	15.5	14.0	0.080			
	no	3.20	6.60	5.596	7.50	8.00	0.420			
	0.036	0.170	0.196	0.960	0.310	0.168	0.002	2.02	1.92	7.61
Irrigation,g/l										
	0.018	0.195	0.231	0.288	0.150	0.096	0.012	1.03	0.99	7.71

During the irrigation, irrational water usage causes excessive waterlogging of the soil and shortage of oxygen in soil, structural violation and decrease of productivity. Besides, the morphological state and level differences of some canals create difficulties in delivering water to the final points.

Many of the collector-drainage systems were built in 60-80th years of the last century during the Soviet era, and they are currently in need of repair and reconstruction. A level of the underground waters increases as a result of collapse or blockage of closed drainage networks, and this creates condition for salinization and waterlogging of soil.

Besides it, there are not modern ameliorative technologies – drip and sprinkler irrigation and it prevents complete usage from ameliorative potential of the region. Not only physical reconstruction, but their management and monitoring modernization is important in order to increase rationality of the available infrastructure [10-12].

The problems in Salyan and Neftchala regions are interconnected in the last 5 years. Both natural and anthropogenic factors caused deterioration of the available state in this area.

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If the ameliorative problems are available in the soils, this can be reason for serious results. The ameliorative problems are formed from the following reasons: High level of the underground-waters (1-2 m depth); Ineffective activity or complete failure; Excessive and uncontrolled usage of irrigative waters and as a result, salts in the soil rise to th Traditionally, irrigation systems implemented using open means and flooding methods no longer meet modern requirements. More canals are covered with soil, therefore penetration losses are higher and this leads to water loss and over-wetting of the soil. At the same time: Unequal distribution of water to the fields; Restrictions on access to water for farms create great obstacles in irrigation. More than 60 years, they are traditionally managed by the drainage, collector and auxiliary means. As a result of absence of modern technics: Natural regulation of the water flow is violated; The devices were filled with sediments; The soil erosion has accelerated in more soils. During last years, the occurring climate changes – especially aridity and unequal distribution of the precipitation – negatively affect water regime of the Kur river and indirectly ameliorative state of soils. Besides: Increase of the population; Enlargement of the farming activity; Soil and its planning; Such cases cause formation of the additional problems [13].

Table 4

CHANGE OF SALT QUANTITY IN THE SOIL, IRRIGATIVE AND DRAIN WATERS OF THE EXPERIMENTAL AREA (Neftchala region 2024)

HCO_3		Cl		Dry residue, %	SO_4		Ca		Mg		$Na+K$		Totality of salts, %
Mg.eq	%	Mg.eq	%		Mg.eq	%	Mg.eq	%	Mg.eq	%	Mg.eq	%	
K-1													
1,1	0,0671	0,2	0,007	0,16	0,750	0,036	1,25	0,025	0,75	0,009	0,05	0,001	0,14
1,2	0,0732	0,5	0,017	0,24	1,499	0,072	2,5	0,05	0,5	0,005	0,2	0,005	0,22
1,3	0,0793	0,6	0,021	0,30	2,248	0,108	1,25	0,03	1,0	0,012	1,9	0,044	0,29
1,3	0,0793	0,3	0,010	0,16	0,499	0,024	1,0	0,02	0,5	0,006	0,59	0,014	0,15
K-2													
1,8	0,1098	0,5	0,017	0,33	1,749	0,048	1,0	0,02	0,75	0,009	2,3	0,053	0,29
1,0	0,061	0,4	0,014	0,19	0,999	0,048	2,0	0,04	0,25	0,003	0,14	0,003	0,17
1,6	0,0976	0,5	0,017	0,26	1,499	0,072	2,0	0,04	1,25	0,015	0,35	0,008	0,25
1,3	0,1159	0,4	0,014	0,21	0,244	0,012	2,0	0,04	0,25	0,003	0,3	0,007	0,19
Irrigative water, g/l													
1,5	0,0915	1,4	0,049	0,50	1,5	0,072	2,5	0,12	0,5	0,006	4,29	0,098	0,46
Drain water (The drain was mixed with irrigation water), g/l													
4,0	0,124	6,0	0,210	1,30	12,99	0,624	2,5	0,11	17,0	0,204	0,49	0,011	1,28

Proposals and Recommendations

It is important to fulfill complex and staged measures in order to improve ameliorative state of soils in the Salyan and Neftchala regions located at the mouth of the Kur river. Scientifically substantiated proposals and recommendations in this direction are presented:

-Inventory and rehabilitation of the available closed drainage networks should be released;

-Cleaning of the main collectors from silt and sediments and increase of hydraulic release should be provided;

-New modern drainage systems (for.ex. plastic pipe drainage) are constructed and they must be applied in flood-prone areas.

-The earthen canals should be replaced with concrete channels.

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-The drip and shower irrigation systems should be applied in the fields, farmers should be provided with technical and financial support for application of these technologies.

-The regular laboratorial analyses about salinization and water regime of soils must be performed and the consequences should be gathered in the unified database;

The monitoring systems should be constructed for a long time, at the same time the open information must be ensured for the local farming subjects;

-Beside ameliorative measures, ecological stability of soils must be taken into account, the soil-biodiversity balance should be protected;

-Restoration of the vegetation and crop rotation measures must be supported.

The rational usage of soil resources can be provided in the region as a result of proposals realization, productivity in agriculture will be increased and at the same time the ecological balance may be maintained, foundation for sustainable development will be created for a long time, both economically and socially.

Conclusion

The Salyan and Neftchala regions are situated in the zone with the reserve sources. But the last 5 years' researches indicate that the ameliorative state of soils in the region has deteriorated considerably. The soil salinization, water-flooding, drainage failure and irrational usage of water caused productivity decrease and deterioration of the agro-ecosystem balance. The salt totality in irrigation and drain waters in the experimental area is 0.920–1.842%, pH is 7.61–7.71, sand residue – 0.70-2.02 g/l, a quantity of salts in soil is 0.511–0.768%, pH -7.38-7.61, dry residue is 0/58 g/l - 0.83 g/l. According to the got results the soils of the experimental area are weakly and moderately salinized and solonetzificated. It was determined that the available ameliorative problems in the region require complex approach in technical and ecological level. The offered measures – including renewal of the drainage and irrigation infrastructure, application of the modern technologies, construction of the soil monitoring systems – will not enough to restore only soil productivity, will contribute the sustainable management of the water resources and the environment protection. The results of the investigations play a practical recommendation role for local farming subjects, and create scientific foundation for formation of the regional amelioration police at the state level. In future continuation of the systematic monitoring and complex scientific approach are important in this area, the ameliorative , agro-ecological potential of soils at the mouth of the Kur river can be completely realized.

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