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AMELIORATIVE STATE OF SOILS AND WAYS OFTHEIR IMPROVEMENT IN SIYAZAN-SUMQAIT MASSIVE

Speciality: 3103.02 – **Amelioration, recultivation and soil protection**
Science: **Agrarian**

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ABSTRACT

of the dissertation submitted for the Doctor of Philosophy degree

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The dissertation was realized in the laboratory of "Amelioration of soils" in the institute of Soil Science and Agrochemistry, Ministry of Science and Education of the Republic of Azerbaijan.

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INTRODUCTION

The subject actuality and elaboration degree. Recently, the reforms performed in agrarian sector caused radical changes in all the areas of agriculture. A good condition is created for protection of soil fertility under the agricultural crops in the republic, increase of the plant productivity by ensuring their protection and formation of the food abundance in the country. So, recently destruction of the ecological environment under an influence of the natural and anthropogenic factors has led to productivity decrease in soils useful for agriculture of some zones. In our country, several legislative documents have been adopted to protect soils and enhance its fertility. These include the "State Program on Reliable Provision of the Population of the Republic of Azerbaijan with Food Products for 2008-2015", the "Strategic Roadmap for the Production and Processing of Agricultural Products in the Republic of Azerbaijan", and others. The main goal of the adopted state documents is to create food abundance in the country, increase the volume of agricultural products, develop the market of production tools, improve the quality of scientific support and education in agriculture, improve the mechanisms of sustainable use of natural resources, improve the business environment, and increase the welfare of the population in rural areas[1]. Recent changes in climatic characteristics have impacted the ecosystem in various ways. It has been estableshed that the agricultural sector continues to be affected by climate change and high temperatures[2]. It is known that one of the main factors negatively affecting the agricultural plant productivity is salinization and solonetzification of soils. The soil salinization spreads in all the valley and foothill plains under Azerbaijan conditions. In the country deluvial and deluvial-proluvial salinized soils spread in many foothill zones and cover large areas[3].

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[1] https://president.az/az/articles/view/21953

[2] https://www.adb.org/sites/default/files/projectdocuments/45353/45353-001-tacr-az.pdf

[3] Abduyev M.R. Deluvial salinized soils and their amelioration issues. Baku, 2012. 279 p.

The researches indicated that the deluvial shaped soils spread in the Siyazan-Sumgait massive. The deluvial shaped salinized soils have unfit properties, characterized by predominance of the layers consisting of sand and gravel beginning from a depth 1.3-1.7 m. Nowadays the study of changes in reclamation of Siyazano-Sumgayit massif and their improvement is an actual issue, improvement of the population's agricultural activity and increasing their income by means of growing the fertility of soils is of great practical importance.

Object and subject of research. The soils of the Siyazan-Sumgait massive have been taken as a research object. The experimental areas have been selected in the characteristic places of the Shurabad and Gilazi village of Khizi region and complex field laboratory studies were carried out to study the ameliorative condition of soils. For this purpose, soil and water samples were systematically taken for analyses from the experimental areas, coordinates of their places were determined by CPS.

Aim and duties of research. The main aim of the work is to study modern ameliorative state of soils of the Siyazan-Sumgait massive and prepare measures to improve it. The following issues have been studied in order to achieve the aim: to study main factors which affect the ameliorative state in the irrigated soils considering the specifics of agriculture, determine location depth of ground-waters, change of their mineralization dynamics and water-salt regime, fix a quantity and composition of salts, define a salt type and investigate an influence of these indicators on crop productivity.

Research methods. The intend issues, field studies were conducted on the basis of generally accepted methodologies, including chemical analyses of soil and water samples taken from the study areas, in laboratory conditions with methods widely used in amelioration practice. The fund materials have been used and systematized in order to perform the compartive analyses. At the same time, the relief and inclination map was composed by using the soil map about the research area.

Defense of theses to investigate modern ameliorative state of soils in the Siyazan-Sumqait massive;

- definition of the spread and degree coverage of the salinized soils in the research zone;
- to study salinization type;
- to investigate factors which affect agricultural plant productivity
- grounding the proposals on methods of soils improvement over the research zone.

Scientific innovation. Taking into account modern climate changes and human economic activity, the ameliorative state of soils of Siyazan-Sumgait massive has been studied and a complex system of substantiated agro-ameliorative measures for their improvement has been developed.

Practical importance of dissertation. As a result of the researches, a quantity and type of salts in the soils with heavy granulometric composition were determined; the measures were prepared in order to develop ameliorative state of soils in the Siyazan –Sumgait massive.

Approval and application of the work. The innitial results of dissertation were reported in the materials of the International and Rebuplican conferences mentioned below: the XXIV International Scientific Conference of the Students, Postgradutes and Young Scientists. Lomonosov (Moscow, 2018), theme of the "Actual scientific-technical and ecological problems of the land melioration" dedicated to the 110th anniversary of academician V.R.Volobuyev. Materials of the scientific-practical conference (Baku, 2020), the theme of "Problems of the environment and its conservation strategy: vision of the future" which was held among the students, magisters and doctorates (dissertants) dedicated to the "Science Day", materials of the scientific – practical conference (Baku, 2021). In the international scientific-practical conference (Baku, 2023) on a theme of "Yesterday, today and tomorrow of the Soil Science" dedicated to "World Soil Day" which was held jointly by the institute of Soil Science and Agrochemistry and Khazar University (Baku, 2023), international conference of "Heydar Aliyev and Azerbaijan Nature" (Baku, 2023), and they were discussed in the laboratory of amelioration (07.06.2024) and scientific- seminar of the

Institute of Soil Science and Agrochemistryof the Ministry of Science and Education, AR (05.03.2025).The research results are applied in projects, realised on improvement of meliorative condition of saline lands of Siyazano-Sumgait massive.

Name of the institution where the dissertation was carried out. The dissertation was implemented in the laborotary of amelioration in the institute of Soil Science and Agrochemistry of the Ministry of Science and Education, Azerbaijan Republic.

Publication. 7 articles and 8 theses according to the dissertation topic have been printed in the scientific journals.

A total bulk of the dissertation with a mark, indicating the volume of the structural sections of the dissertation separately. The dissertation consists of 5 chapters, conclusion and proposals, recommendations for production and 158 used references. 17 pictures, 48 tables have been included in the work. The introduction is about 5 pages, 8692 signs, there are 21 pages, 37532 marks the in the 1st chapter, the 2nd chapter is about 14 pages and 16857 signs, the 3rd chapter consists of 28 pages and 45157 marks, there are 41 pages and 60902 marks in the 4th chapter, the 5th chapter is about 33 pages and 58529 signs, the conclusion and proposals are about 2 pages and 1754 signs, recommendations for production consist of 2 pages and 2634, the reference list is about 18 pages and 27173 marks. A total bulk of the dissertation is about (a quantity of the total marks is 225650) 165 pages.

GENERAL CHARACTERISTICS OF THE WORK. CHAPTER 1. NATURAL-CLIMATE CONDITION OF THE RESEARCH ZONE

Siyazan-Sumqait massive in the coastal zone of the north-east of Azerbaijan is a part of the foothill plain. It extends to the Caspian Sea and is located at the eastern end of the Great Caucasus. From low flow of the river Sumgait to north and a part which stretches from coastal line to north is valley-plain. This

area is known as Boghaz plain and most part of the area is located below sea level. An area of the Siyazan-Sumgait massive is approximately 60 000 hectares. The massive zone is subjected to change to a noticeable degree in connection with vibration of the Caspian Sea level. So, although the level of the Caspian Sea in 1985 compared to the Baltic system was 27.97 meters[4], in 2024, the average monthly sea level was 28.67 meters[5]. The upper layer in the area from the Atachay to the Keshchay is composed of hard aluvial-deluvial sediments of 5-10 m thick. A climate of the Siyazan-Sumgait massive belongs to the subtropical type according to I.F.Figurovsky[6] and A.M.Shichlinsky"s[7] information. A modern relief of the massive was formed in the IV period. The investigated (Siyazan) zone geomorphologically include in Davachi-Gilazi districts. This is geomorphologically single low and foothill region.The blocs and mountains in the region consist of Miocene and Pliocene sediments. Samur-Absheron Takhtakorpu-Jeyranbatan canal, Atachay and Gilgilchay are rivers in the hydrographic network of the zone. Debris of the Valvala, Gilgilchay and Atachay mainly consists of chalk sediments and they are rich in carbonates. The vegetation in the Siyazan-Sumgait massive belongs to the semi-desert type which creats a situation for strong salt collection. A.A.Grosgeim[8] (1939), L.I. Prilipko[9]. (1961) and others find out desert and semi-desert plants. A group of desert plants thrive in highly saline areas. The most common of them are: *suaeda microphylla, salsola dendroides, salsola ericoides* and *salsola erassa.* The soil

[4] Abbasova R.Y. Methods ensuring the reversibility of the salinization process in natural solonchaks of the Siyazan-Sumgait massive, abstract of diss. for the degree of candidate of agricultural sciences. Baku, 2009, p.39.

[5] https://eco.gov.az/az/nazirlik/xeber?newsID=23503

[6] Figurovsky I.V. Climatic regionalization of Azerbaijan. Materials on regiolalization of Azerb.SSR, edition 4, Baku, 1936.

[7] Shikhlinsky E.M. Azerbaijan climate. Pub. AS Azerb SSR, Baku, 1968, 343 p.

[8] Grossheim A.A. Analysis of the flora of the Caucasus. Proceedings of the Botanical Institute of Az-FANSSR, T-1, Baku, 1936, 257 p.

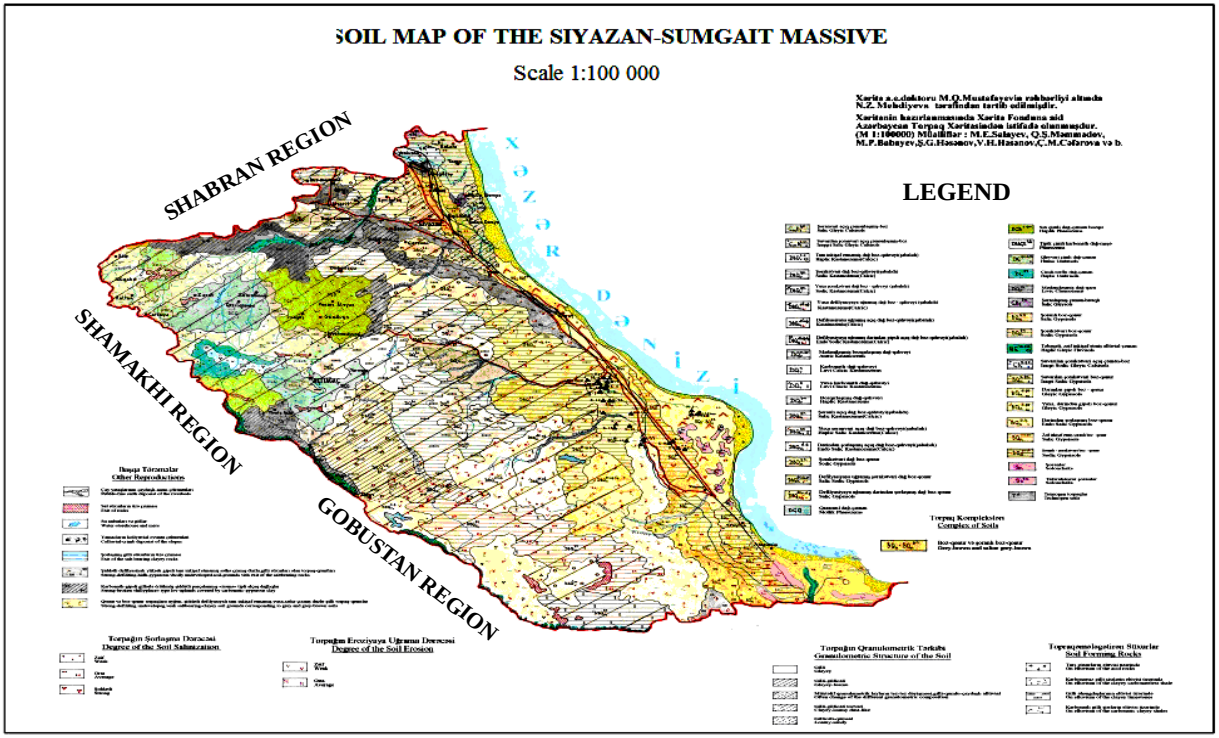
[9] Prilipko L.I. - Vegetation cover of Azerbaijan. Pub. "Elm", Baku, 1970, 172 p.

cover in the Siyazan-Sumgait massive is rather different and is mainly represented by grey-brown (Calcic Cypsisols), grey (Haplic Calcisols), takyr and salines. The soil researches were carried out by V.M. Smirnov-Loginov (Absherion, 1927, 1928, 1935, 1942), N.A. Kachinsky (Boghaz, 1937), A.I. Shulga (Boghaz, 1938), E.M. Salayev (along Samur-Davachi canal, 1941), M.R.Abduyev (in the deluvial plain of the massive, 1941), R.H.Mammadov[10] (1965, 1969) and others. V.R.Volobuyev[11] (1965) and M.R.Abduyev's (1968) researches showed that the saltness degree in the foothill deluvial-proluvial plains correspondingly rises from upper zone (saltcollector) towards plume (the salt collecting zone, i.e. plume zone is rich in chloride). Grey-cinnamon soils (*Calcic Cypsisols*) are characterized with low humus. The color of the humus layer in these soils is gray-brown, grayish and density of humus layer is observed at 40-50 cm. Depth of groundwater is 2-5 m and mineralization is by 3.0-17.6 g/l. The irrigation source is Absheron canal. The natural soilforming processes, changes under the anthropogenic influence, cultivating degree, formation and hardening of the sowing and undertillage layer and other factors affect to the irrigated gray-brown (*Calcic Cypsisols*) soils The morphogenetic indications of virgin and irrigated grey-cinnamomic soils have been seen the same zones comparatively studied in order to determine a character and direction of the cultural soil-formation process by M.P.Babayev[12]. The soil on the whole profile is calcerous (it strongly boils with chloride acid). The hygroscopic humidity is higher in these soils; it is 5-6%. According to M.A.Kachinsky's information the rate of water absorption is 1.5 mm/min in the grey-cinnamomic soils.

[10] Mamedov R.H. – Agrophysical characteristics of soils. The Araz stripe. Pub. "Elm", Baku,1970, p.6-35

[11] Volobuyev V.R. – Washing of salinized soils. "Azerpub", Baku, 1948, p.46.

[12] Babayev M.P., Hasanov V.H., Jafarova Ch.M., Huseynova S.M., Morphogenetic diagnostics, nomenclature and classification of Azerbaijan soils. Baku, "Elm" pub. 2006, p.359 (209-212).



Pic. 1 Soil map of the Siyazan-Sumgait massive

The velocity of absorption is 0.036 mm/min in the strongly solonetzificated and saline soils. The last researches show that the water absorption rate of soils in these areas was 0.036-2.1 mm/min[13]. Heavy granulometric composition on profile is observed in the soils. A quantity of physical clay on soil profile changes by 72-90 %, and this shows systematic collection of the small-measured fractions which are brought by the surface flows. Salinization of these soils is higher. A great collection of salt is observed in upper and bottom layer of soil (1.3-2.6 %). The bottom layers are relatively observed with less amount (0.5-1.3 %). The Azerbaijan Soil Map concerning the map fund of the institute of Soil-science and Agrochemistry of AR MSE was used in composition of the maps in the research zone of the Siyazan-Sumgait massive. The authors: M.E.Salayev; Q.Sh.Mammadov; M.P.Babayev; Sh.G.Hasanov; V.H.Hasanov; Ch.M.Jafarova and others. Other maps: on the basis of Soil Map (1:100000) Arc GIS, ArcMap 10.5, Google Earth Pro programs have been used (Pic.1, 2)

CHAPTER 2. RESEARCH OBJECT AND METHOD

The soil of Gilazi and Shurabad villages of the Khizi district in the Siyazan-Sumgait massive have been selected as a research object. The field research works were performed in irrigated and non-irrigated areas in 2018-2023, the chemical analyses were implemented in the laboratory according to the far-reaching method in the republic. So, the full water weight analyses were fixed by E.B.Arinushkina's[14] metod, the water-physical features of soils by

[13] Pashayev N.E. Ways to improve the efficiency of irrigated soils use in the zone of influence of the Samur-Absheron irrigation system reconstruction project (by the example of Khizi, Siyazan, Shabran districts), agrarian sciences Ph.D., dis. abstract Baku, 2022, 23 p.

[14] Arinushkina E.V. Soil chemical analysis guide. MSU, 1970, p.483.

N.A.Kachinsky[15] and granulometric composition based on the classification by R.H. Mamedov, the absorbed bases by K.K.Hedroyts's[16] method, but the soil reaction to the environment was determined using a pH meter. An exactness of the obtained results were specified by the mathematic method. Some scientists performed soil researches in the various directions of the Siyazan-Sumgait massive (M.A.Abduyev, A.K.Alimov, M.I.Iskenderov, I.A.Akberov, N.R.Suleymanov, I.N.Shirinov, S.T.Hasanov, G.A.Khasayev, M.F.Gurbanov, J.M.Ismayilov, R.Y.Abbasova, E.P.Pashayev, N.E.Pashayev and others). M.P.Abduyev performed a large-scaled researches in the massive 1968, the author studied physical, physical and chemical characters of the deluvial salinized soils in the massive and gave his suggestions for improvement. Recently, I.P.Gerasimov[17] offered separation of grey-cinnamon (*Calcic Cypsisols*) soils as a free soil type. It is known that the granulometric composition strongly affects soil-formation process and usage of soils in agriculture. The cultivation condition, time of the field work, fertilization norm, location of the agricultural plants changes depending on granulometric composition of the soil. The granulometric composition of soils in the experimental area selected during the research was determined in 4 characteristic soil sections and the results were indicated on Table 1. As it is shown from the table, a quantity of physical clay (<0.01mm) was 36.00 -82.79 %, but an amount of silt fractions (<0.001mm) was 11.60-42.20 %. The same soils were light clayey, medium and heavy loamy by granulometric composition[18].

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[15] Kachinsky N.A. Soil-ameliorative essay of Boghaz plain in Azerbaijan. Ed.MSU, edition.17.M., 1937.

[16] Gedroitz K.K. Selected essays. T.N.M.,1955.

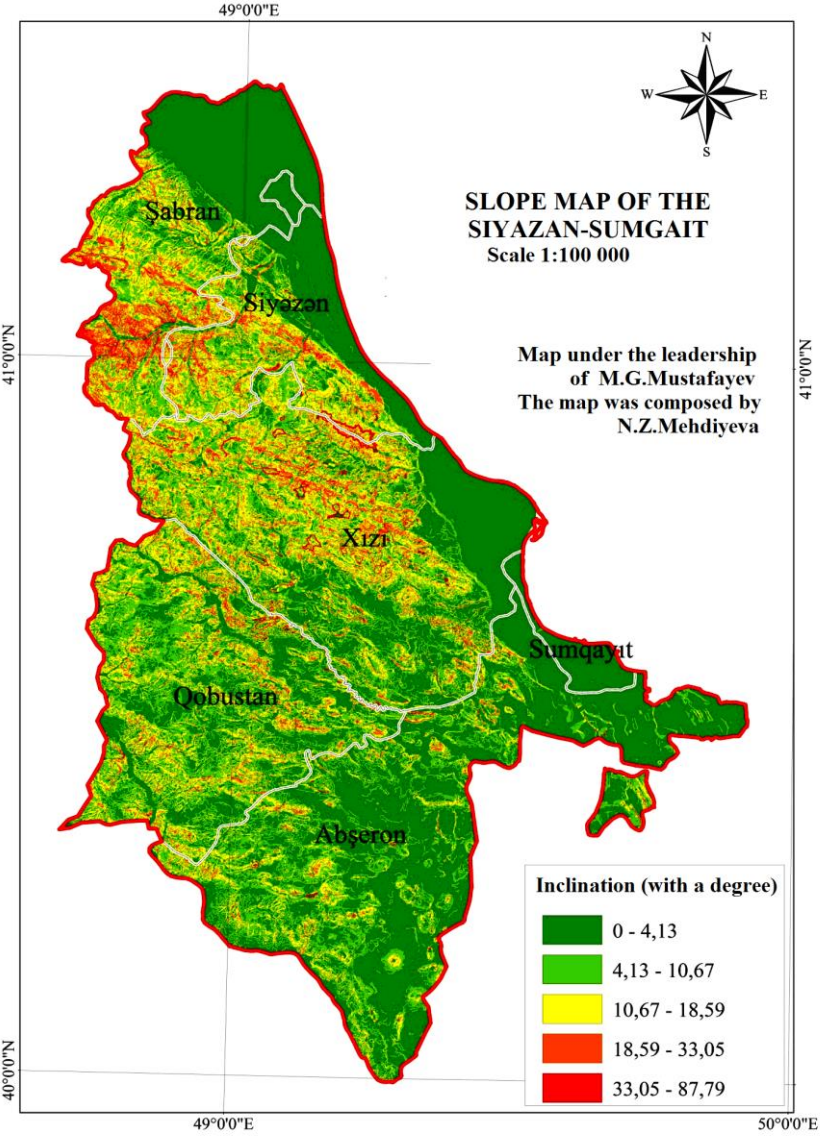
[17] Gerasimov I.R., Ivanova E.H. About geographical types of salt balance and forms of salt exchange in the weathering crust. Prob. physic. Geography, III, 1936.

[18] Mehdiyeva N.Z. Study of some indications in the main zone (Siyazan-Sumqait massive). XXIV Inter.Scien.Conf.of Students, postgraduates and young scientists. Lomonosov-Moscow, Max pess, 2017, p. 180-181.

Table 1.

Granulometric composition of soils of soils of reserach zone, % (2019)

Section No	Coordinates	Depth, cm	Particles mm						Physical clay (<0.01)	By gradation (R.H.Mamedov)
			1,0-0,25	0,25-0,005	0,05-0,01	0,01-0,005	0,005-0,001	< 0,001		
K-2	N 40° 46′4.96″ E 49°26′ 0.28″	0-25	0,29	22,11	41,60	3,60	8,00	24,40	36,00	medium loamy
		25-50	0,37	10,43	40,00	3,60	10,80	34,80	49,20	heavy loamy
		50-100	0,27	2,93	37,60	7,60	22,00	29,60	59,20	light clayey
K-4	N 40°46′4.20″ E 49° 27′ 4.55″	0-25	0,53	12,06	28,71	17,90	18,43	22,37	58,70	light clayey
		25-50	0,63	11,60	23,20	10,34	22,48	31,75	64,57	Medium clayey
		50-100	0,70	6,11	10,40	14,21	29,32	39,26	82,79	Heavy clayey
K-8	N 40°47′ 0.22″ E 49° 25′ 7.22″	0-25	1,67	16,33	34,80	7,60	25,60	14,00	47,20	heavy loamy
		25-50	0,16	13,04	31,20	12,80	30,00	12,80	55,60	light clayey
		50-100	0,10	13,10	28,40	15,20	31,60	11,60	58,40	light clayey
K-10	N 40° 47′ 5.63″ E 49° 25′ 7.67″	0-25	0,26	17,53	25,34	13,32	17,91	25,64	56,87	light clayey
		25-50	1,20	9,02	18,93	9,85	27,85	33,57	70,85	heavy loamy
		50-100	0,10	8,08	12,87	11,10	25,65	42,20	78,95	heavy loamy



Pic. 2. Slope map of the Siyazan-Sumgait

CHAPTER 3. RESEARCH OF LEVELS, HYDRO-CHEMICAL REGIMES AND USEFULNESS OF GROUND-WATERS AND IRRIGATION WATER IN THE RESEARCH ZONE

Groundwater formed in the area influences the water-salt regime of the soil, a number of its indicators and, as a consequence, the productivity of agricultural crops. The researches indicated that a level of ground-waters is 10-16 m the south-west part of Boghaz plain in the Siyazan-Sumgait massive. A level of the ground-waters in the Khizi district is 1-18 m from surface, but it is 0.5-16.5 and 0.3-8.5 m in the Shabran and Siyazan regions. The water samples were taken from soil sections during research period, the chemical analyses were performed and the obtained results were shown on Table 2. As it seems CO_3^- ion wasn't observed in water sample taken from the drain (N-3, does not work). A quantity of HCO_3^- ion in anion composition is 0.317 g/l, Cl^--3.178 g/l, SO_4^{2-} ion- 0.648 g/l. An amount of Ca^{2+} in cation is 0.210 g/l, Mg^{2+}-1.062 g/l, $Na^+ + K^+$ ion -0.242 g/l, the water mineralization degree in drain is 5.66 g/l. A quantity of HCO_3^- ion in anion is 0.195 g/l, Cl^--0.060 g/l, SO_4^{2+}-0.192 g/l in the water sample taken from the Takhtakorpu Water reservoir (N-6). An amount of Ca^{2+} in cation is 0.060 g/l, Mg^{2+}-0.054 g/l, $Na^+ + K^+$ ion -0.029 g/l. Mineralization degree in the water sample taken from Takhtakorpu Water reservoir is 0,58 g/l. A quantity of CO_3^- ion is 1.60 g/l, HCO_3^- ion is 0.488 g/l, Cl^- is 0.329 g/l, SO_4^{2-} ion is 0.672 g/l in anion composition of the water sample taken from Section 2 (H=1.80 m). An amount of Ca^{2+} is 0.050 g/l, Mg^{2+} is 0,051 g/l, $Na^+ + K^+$ ion is 0.566 g/l in cation composition. A mineralization degree of water is 3.75 g/l in this section. A quantity of CO_3^- is 0.014 g/l, HCO_3^- ion is 0.408 g/l, an amount of chlorine is 0.303 g/l, SO_4^{2-} ion is 0.97 g/l in anion composition of the water sample taken from Section 1 (H=1,78m). A quantity of Ca^{2+} is 0.068 g/l, Mg^{2+} is 0.063 g/l, but $Na^+ + K^+$

ion is 1.764 g/l in cation composition. The mineralization degree in water sample taken from the section is 3.278 g/l. A quantity of CO_3^- ion is 0.014g/l, HCO_3^- ion is 0.436g/l, Cl^- is 0.308 g/l, an amount of SO_4^{2-} ion is 0.679 g/l in anion composition of the water sample taken from Section 4 (depth H=1.90 m). $Ca^{2+}$is 0.082 g/l, Mg^{2+} is 0.074 g/l, $Na^+ + K^+$ ion is 2.105 g/l in cation composition. The mineralization degree is 3.684 g/l in the water sample taken from the section CO_3^- ion is 0.015 g/l, HCO_3^--ion is 0.393 g/l, $Cl^-$is 0.432 g/l, SO_4^{2-} ion is 0.730 g/l in anion composition of the water sample taken from Section 5 (depth H=2.10 m). Ca^{2+} in cation composition is 0.084 g/l, Mg^{2+} is 0.088 g/l, $Na^+ + K^+$ ion is 1.252 g/l. The mineralization degree in water sample taken from the section is 2.974 g/l. (Table 2).

Table 2.

Anion and cation composition in water samples taken from drain, groundwater and Takhtakorpu irrigated canal through the experimental area.(2022)

Section No.	CO_3^-	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	$Na^+ + K^+$	Salt quantity, g/l	Dry residue, g/l
	Mg.ekv/g/l								
N-3-drain (doesn't work) N40°48.373′ E 49°27.965′	No	5,20 0,317	90,8 3,178	13,49 0,648	10,05 0,210	88,5 1,062	10,49 0,242	5,66	5,97
N-6- TWR incoming irrigation channel N40°51.609′ E49°19.273′	no	3,20 0,195	1,60 0,056	3,997 0,192	3,00 0,060	4,50 0,054	1,297 0,029	0,58	0,71
Groundwater									
N-2- H=1,80m N40°48.380′ E49°27.972′	0,40 1,60	8,00 0,488	9,40 0,329	13,99 0,672	2,50 0,050	4,25 0,051	24,64 0,566	3,75	3,82
N- 1 H=1,78 m N40°48.458′ E49°27.788′	0,45 0,014	6,70 0,408	8,65 0,303	13,99 0,971	3,42 0,068	5,25 0,063	76,69 1,764	3,278	3.372
N-4 H=1,90 m N40°51.49′ E 49°19.59′	0,48 0,014	7,15 0,436	8,80 0,308	14,15 0,679	4,12 0,082	6,18 0,074	91,52 2,105	3,684	3.825
N-5 H=2,10m N40°51.438′ E49°20.078′	0,50 0,015	6,43 0,393	9,00 0,432	15,20 0,730	4,23 0,084	7,35 0,088	54,34 1,252	2,974	3.053

The salt type was determined in the taken water samples. The salt type was defined according to V.R.Volobuyev's classification. According to Cl/SO_4 ratio the salt type is sulphate-chlorine in drain, irrigation canal from Takhtakorpu water reservoir and water samples taken from the sections is chlorine-sulphate (table 3). S.U.Wali, M.A.Gada and other researchers note that it is important to study qualitative indicators of the irrigated water in order to improve irrigation agriculture.[19]

Table 3.

Definition of salt type in drain, in the irrigation canal running from Takhtakorpu water storage and groundwater for Cl/SO_4 (2022)

Sections	for Cl/SO_4	Salt type
N-3 drain (doesn't work)	0,36	Sulphate -chlorine
N-6 irrigation canal to TWR	0,29	Chlorine-sulphate
N-1 H=1,78m	0,31	Chlorine
N-2 H= 1,80m	0,49	Chlorine
N-4 H=1,90 m	0,45	Chlorine
N-5 H= 2,10m	0,59	Chlorine
N-1 H=1,78m	0,31	Chlorine

According to the obtained figures SAR was 1,49 in drain; 0,67 in the Takhtakorpu irrigated water reservior; but in the water sample taken from the soil section it was 13,39; 36,87; 40,23; 22,55, respectively As it is seen, the waters in samples taken from irrigation canal running from drain and Takhtakorpu water storage are useful for irrigation. The water sample taken from N-2 (H=1.80 m) section is useful for irrigation, the water taken from N-1 (H=1.78 m), N-4 (H=1.90 m) soil sections is useless for irrigation and N-5 (H=2.10 m) is less useful (table 4).

The degree of groundwater mineralization varies in the region. The least mineralized waters are in the near the Beshbarmaq rocky place. The average mineralization degree of the ground-waters vibrates by 35-45 g/l on seasons. The mineralization degree of ground-waters in the region changes from 0.6 to 95.2 g/l.

[19] S.U.Wali, M.A.Gada, K.J.Umar, A.Abba, A.Umar. Understanding the causes, effects and remediation of salinity in irrigated fields: a review, International Journal of Agriculture and Animal Production, Vol: 01, No. 01, Malaysia, 2021. p.9-42.

Table 4.
Assessment of water quality for relative potential coefficient of sodium in water samples taken from the research zone (2023)

S/n	Names of samples	SAR	Usefulness of water for usage
1	N-3 drain (doesn't work)	1.49	Completely useful
2	N-6 TWR irrigation canal	0.67	Completely useful
3	N-2 H=1.80 m	13.39	Useful
4	N-1 H=1.78 m	36.87	Useless
5	N-4 H=1.90 m	40.32	Useless
6	N-5 H=2.10 m	22.55	Less useful

The soils in the Khizi and Siyazan districts are sulphate-chlorine-natriume, chlorine-sulphatic-natrium for chemical composition of groundwater.[20,21].

CHAPTER 4. SOIL SALINATION CONDITION, TYPE AND WATER-SALT REGIME IN THE RESEARCH AREA

The soil resources are considered as one of the main elements of the development in all countries and its potential opportunities. The soil is a surface fertile layer of the earth which is a main production means of the agrarian field. Though the natural the natural and climatic conditions allow cultivation of all agricultural crops throughout the year, 55.2% of the total soil fund is useful for agriculture[22]. Production of the agricultural crops isn't possible without irrigation because of humidity shortage as more regions of the same zones belong to the arid zone .Disturbance of ecological balance, agrotechniques leading to reduction of soil fertility and other factors lead to reduction of plant productivity and

[20] Ismayilov J.M., Pashayev N.E. Agricultural crops planted in the irrigated soils of the Siyazan-Sumgait massive and their productivity. Work collection of ATJ. XV volume, 2019, p.334-342.

[21] Mehdiyeva N.Z. Regularity of changes in the groundwater regime of the north-eastern slope of the Great Caucasus based on long-term observations. I Intern.Sci.Pract. Inter Conf. "Modern ecological state of the natural environment and scientific-practical aspects of the rational nature use. Salty pond, Astrakhan region., Russia, 2016, p. 335-338.

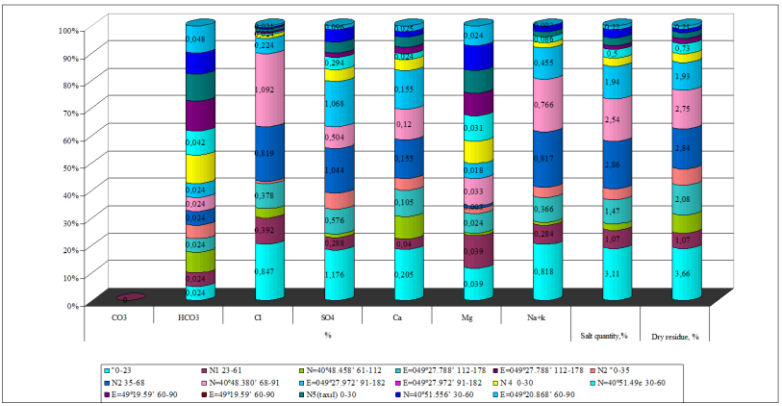
[22] https://www.agro.gov.az/en/technology-and-innovation

its quality indicators.[23] Reclamation-irrigation systems that don't meet modern requirements, water shortage, unplanned and over-used the cultivated fields like pastures and hayfields, difficulties in the sale of manufactured products, sometimes location of the cultivated fields far from the settlement, incorrect usage of the cultivated fields lead to such negative processes as salinization, solonetzification, eroding of soils. According to the specialists' calculations and statistical information, about one million hectares is out of crop rotation as a result of salinization every year all over the world. Soil salinization reduces crop yields, increases desertification, destroys rare plants and radically changes the natural landscape.[24] During the research, the result of the analysis of soil samples taken from the Gilazy and Shurabad villages of the Khizi district show that the salt quantity in the zonal soils was 0.200-1.795 % in 0-25 cm soil layer, but it was 0.215-2.235 % in 60-90 cm soil layer. An amount of HCO_3^-in sections was accordingly 0.024 -0.073 % on upper layers, but it was 0.018 - 0.0073 % on the lower layers (table 4, 5). Cl^- ion was 0.056 – 0.644 % on the upper layers, but it was 0.035-0.896 % on the lower layer[25]. It is seen from table 6, CO_3^- ion wasn't observed in anion content of salts in the research soils, HCO_3^- was 0.024-0.048 % on genetic layers, Cl^- ion was 0.021-0.84 %, SO_4^{2-} was 0.096-1.176 % (pic. 3).

[23] https://www.azerbaijan-news.az/az/posts/detail/heyder-eliyev-azerbay_canin_-meliorasiya-ve-su-teserrufati-kompleksinin-inkishafina-misilsiz-tohfeler-vermishdir-193472

[24] Jalilova L.Z., Mustafayev F.M. Modern state of soils in the Garabagh plain. Republic Scientific conf.mater.on the topic of "Urgent problems of soil-science" dedicated to the 110th anniversary of the birth of outstanding scientist and public figure Hasan Alirza oglu Aliyev. Baku, 2017, p.124.

[25] Mustafayev M.G., Mustafayeva N.Z. Modern state of soils in the Siyazan –Sumqait massive. Journal of Soil Science and agrochemistry №1 (March), Kazakhstan, 2018. p. 47-54.



Pic. 3. Change graphic of salt quantity in the soils of the experimental area from the Gilazy village of Khizi (2022).

Table 4

Change of salt quantity in the soils of the Shurabad village, Khizi region (2017)

№ of Section	Depth, cm	HCO_3^-		Cl^-		Dry residue, %	pH	Degrees of salinization
		mg-ekv/%						
K-1	0-25	0,80	0,049	8,30	0,291	0,380	8,8	Moderately salinized
	25-50	0,40	0,024	9,30	0,326	0,850	8,7	
	50-100	0,60	0,037	10,40	0,364	0,760	8,8	
K-2	0-25	0,40	0,024	9,90	0,347	0,625	8,1	Strongly salinized
	25-50	0,50	0,031	9,60	0,336	1,290	8,3	
	50-100	0,40	0,024	10,60	0,371	1,285	8,3	
K-3	0-25	0,60	0,037	12,00	0,420	0,655	8,4	Strongly salinized
	25-50	0,40	0,024	15,20	0,532	1,200	8,5	
	50-100	0,30	0,018	14,80	0,518	1,600	8,6	
K-4	0-25	0,50	0,031	18,40	0,644	1,795	8,5	Strongly salinized
	25-50	0,40	0,024	20,20	0,700	1,985	8,3	
	50-100	0,40	0,024	25,60	0,896	2,235	8,4	
K-5	0-25	0,70	0,043	1,40	0,049	0,600	8,2	Moderately salinized
	25-50	0,70	0,043	3,20	0,112	0,300	8,3	
	50-100	0,40	0,024	3,80	0,133	0,565	8,3	
K-6	0-25	1,20	0,073	3,00	0,105	0,215	7,9	Weakly salinized
	25-50	0,50	0,031	1,40	0,049	0,465	7,8	
	50-100	0,60	0,037	1,00	0,035	0,215	7,9	
K-7	0-25	0,40	0,024	9,20	0,322	1,490	7,8	Strongly salinized
	25-50	0,60	0,037	7,60	0,266	0,550	7,8	
	50-100	0,60	0,037	15,20	0,532	1,770	8,0	
K-8	0-25	0,40	0,024	8,40	0,294	0,870	7,9	Strongly salinized
	25-50	0,40	0,024	9,00	0,315	1,675	8,0	
	50-100	0,60	0,037	5,20	0,182	0,950	8,1	
K-9	0-25	1,20	0,073	1,60	0,056	0,200	8,2	Weakly salinized
	25-50	1,20	0,073	3,00	0,105	0,390	8,1	
	50-100	1,20	0,073	2,00	0,070	0,360	8,1	
K-10	0-25	0,80	0,049	9,80	0,343	0,590	8,1	Strongly salinized
	25-50	0,40	0,024	11,80	0,413	1,105	8,1	
	50-100	0,60	0,037	10,80	0,378	1,970	8,3	
K-11	0-25	1,00	0,061	2,80	0,098	0,240	8,2	Moderately salinized
	25-50	0,80	0,049	6,60	0,231	0,855	8,3	
	50-100	1,20	0,073	4,20	0,147	0,340	8,2	

Note: In Section 11, the top and bottom layers of the soil were not saline, and moderate salinity was observed in the 25-50 cm layer.

Table 5

Change of salt quantity in the soils of the Gilazi village, Khizi region (2021)

№ of cuts	Coordinates	Depth, cm	HCO_3^-		Cl^-		SO_4^{2-}		$CaCO_3$, %	Dry residue %-	pH	Degrees of salinization
			mg-ekv	%	mg-ekv	%	mg-ekv	%				
K-12	N 40^0 50′3.41″ E 49^0 20′4.11″	0-30 30-60 60-90	0,60 0,80 1,00	0,037 0,049 0,061	1,00 0,60 1,00	0,035 0,021 0,035	4,48 5,02 7,08	0,215 0,241 0,340	17,296 17,509 13,239	0,410 0,455 0,565	7,5 7,6 7,8	Weakly salinized
K-13	N 40^0 50′4.30″ E 49^0 20′1.27″	0-30 30-60 60-90	0,80 0,80 1,00	0,049 0,049 0,061	3,60 1,80 3,00	0,126 0.063 0,105	5,16 7,68 10,78	0,248 0,369 0,518	9,822 15,161 14,947	0,545 0,650 0,955	7,9 8,1 8,2	Moderately salinized
K-14	N 40^0 49′9.05″ E 49^0 20′ 2.15″	0-30 30-60 60-90	1,20 1,00 1,20	0,073 0,061 0,073	4,00 1,40 1,20	0,140 0,049 0,042	2,58 1,89 5,56	0,124 0,091 0,268	24,342 23,275 21,993	0,440 0,280 0,515	8,2 8,1 8,1	Weakly salinized
k-15	N 40^0 48′6.33″ E 49^0 21′0.95″	0-30 30-60 60-90	1,00 0,80 0,60	0,061 0,049 0,037	0,60 2,20 1,60	0,021 0,077 0,056	1,56 4,98 6,16	0,075 0,239 0,296	14,947 12,812 14,520	0,200 0,395 0,520	8,3 8,3 8,0	Weakly salinized
K-16	N 40^0 48′8.26″ E 49^0 21′6.69″	0-30 30-60 60-90	0,60 0,60 0,60	0,037 0,037 0,037	11,0 16,0 13,0	0,413 0,567 0,476	4,75 8,60 11,97	0,228 0,413 0,575	18,791 17,082 21,566	0,785 1,130 1,280	8,6 8,7 8,7	Strongly salinized
K-17	N 40^0 49′0.83″ E 49^0 22′5.53″	0-30 30-60 60-90	0,80 1,00 0,80	0,049 0,061 0,049	6,00 6,20 8,00	0,210 0,217 0,280	3,33 5,16 10,37	0,160 0,248 0,498	16,015 11,744 8,328	0,465 0,660 1,000	8,2 8,3 8,4	Moderately salinized
K-18	N 40^0 48′6.68″ E 49^0 22′5.50″	0-30 30-60 60-90	0,40 0,40 0,80	0,024 0,024 0,049	7,00 8,40 9,20	0,245 0,294 0,322	4,66 5,85 10,85	0,224 0,281 0,521	21,139 13,452 14,306	0,605 0,725 1,050	8,8 8,7 8,7	Moderately salinized
K-19	N40^0 47′8.74″ E49^0 22′0.48″	0-30 30-60 60-90	1,20 0,80 1,20	0,073 0,049 0,073	4,80 3,60 3,20	0,168 0,126 0,112	3,10 5,23 7,60	0,149 0,251 0,365	21,566 14,306 16,655	0,450 0,555 0,685	8,3 8,4 8,5	Moderately salinized
K-20	N 40^0 47′1.79″ E 49^0 23′1.49″	0-30 30-60 60-90	0,80 1,00 1,20	0,049 0,061 0,073	2,60 2,60 3,40	0,091 0,091 0,119	1,77 3,50 7,37	0,085 0,168 0,354	16,555 16,015 19,645	0,310 0,435 0,670	8,7 8,8 8,7	Weakly salinized
K-21	N 40^0 47′6.90″ E 49^0 23′4.81″	0-30 30-60 60-90	1,20 0,40 0,60	0,073 0,024 0,037	3,80 4,20 2,80	0,133 0,147 0,098	2,19 11,47 8,64	0,105 0,551 0,415	17,082 18,577 20,926	0,375 0,860 0,680	8,5 8,7 8,7	Moderately salinized

Table 6.

Change of salt quantity in the soils of the experimental area (2022)

№ of cuts	Depth, cm	mg-ekv/%							Sum of salts ,%	Dry residue,%
		CO_3^-	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	$Na^+ + K^+$		
N-1	0-23	No	0,40	24,2	24,48	10,25	3,25	35,58	3,11	3,66
			0,024	0,847	1,176	0,205	0,039	0,818		
N40º48.458′	23-61		0,40	11,2	5,996	2,00	3,25	12,34	1,07	1,07
			0,024	0,392	0,288	0,040	0,039	0,284		
E49º27.788′	61-112		0,60	3,80	1,998	4,50	0,25	1,648	0,39	1,31
			0,036	0,133	0,096	0,090	0,003	0,038		
	112-178		0,40	10,8	11,99	5,25	2,00	15,94	1,47	2,08
			0,024	0,378	0,576	0,105	0,024	0,366		
N-2	0-35	No	0,40	1,00	7,745	2,25	0,50	6,395	0,63	1,13
			0,024	0,035	0,372	0,045	0,006	0,147		
	35-68		0,40	23,4	21,74	7,75	0,25	37,54	2,86	2,84
N40º48.380′			0,024	0,819	1,044	0,155	0,003	0,817		
	68-91		0,40	31,2	10,49	6,00	2,75	33,34	2,54	2,75
E49º27.972′			0,024	1,092	0,504	0,120	0,033	0,766		
	91-182		0,40	6,40	22,24	7,75	1,50	19,79	1,94	1,93
			0,024	0,224	1,068	0,155	0,018	0,455		
N-4	0-30	No	0,82	1,49	5,410	2,15	2,30	3,265	0,51	0,62
	30-60		0,050	0,052	0,260	0,043	0,027	0,075		
N40º51.49′	60-90		0,68	0,70	6,125	1,20	2,56	3,745	0,50	0,73
			0,042	0,024	0,294	0,024	0,031	0,086		
E49º19.59’			0,85	0,65	2,109	1,32	2,24	0,049	0,23	0,35
			0,052	0,023	0,102	0,026	0,027	0,002		
N-5(wheat)	0-30	No	0,80	1,40	5,246	2,00	2,25	3,196	0,49	0,41
			0,048	0,049	0,252	0,040	0,027	0,074		
N40º51.438′	30-60		0,60	0,60	5,996	1,00	2,50	3,696	0,48	0,28
			0,036	0,021	0,288	0,020	0,030	0,085		
E49º20.078′	60-90		0,80	0,60	1,998	1,25	2,00	0,148	0,22	0,21
			0,048	0,021	0,096	0,025	0,024	0,003		

Ca^{2+} in cation content of salts is 0.020-0.205%, Mg^{2+} was 0.018-0.039 %, $Na^{+} + K^{+}$ was 0.003-0.818 %. (pic. 3) A quantity of salts was 0.22-3.11 %. It is shown that the soils in the experimental area issalinized, weak, average and strong[26]. A relation between water-salt regimes with the plant production in the soils of the experimental area was defined and the elements included in water regime were studied. One of the intended issues in the research area is to be learned the salt quantity removed from the zone and forecasting, elements including the water regime – i.e. irrigation waters, atmospheric precipitations, evaporation, the waters entering the area with drainage.

A quantity of the salts entering the experimental area with irrigation waters was determined. During the research, an average indication was fixed and an amount of the irrigation waters was considered for this purpose. Taking into account the quantity of the given irrigation waters (3200-3300 m^3/h, an amount of salts entering with the same waters can be calculated by the following formula:

$$S_{water} = V \cdot S_m/1000$$

Here, S_{water}– a salt quantity entering with the irrigation waters, t/h; V- an amount of irrigation waters, m^3/h; S_m – mineralization degree of irrigation waters, g/l. The salts can be fixed by the shown formula:

In 2017

$$S_{water} = V \cdot S_m = \frac{3200 \times 0{,}82}{1000} g/l = 2{,}62 t/h$$

In 2022

$$S_{water} = V \cdot S_m = \frac{3300 \times 0{,}58}{1000} g/l = 1{,}91 t/h$$

[26] Mehdiyeva N.Z. Definition of salinized process and salt type in the soils of the Siyazan-Sumgait massive. Journal of Scientific News. № 1/46, Ganja 2024,p. 75-80

The obtained consequences show that if 2.62 t/h of salt entered the experimental area with irrigation waters in 2017, 1.91 t/h of salt entered in 1.91.

An amount of the salts removed with drainage waters was fixed by using the average values of the drainage flow and mineralization degree. The analysis results indicate that the values of the drainage flow in the research zone is 1650-1700 m^3/h, their mineralization degree is 5.82-5.66 g/l. The salt quantity removed by drainage was calculated by the following formula:

$$S_d = D \cdot S_{dm} / 1000$$

S_d- a quantity of salts removed by drainage, t/h;
D – an amount of drainage flow, m^3/h;
S_{dm} – mineralization degree of drainage waters, g/l.
In 2017

$$S_d = D \cdot S_{dm} \frac{1700\ m^3/ha\ x\ 5{,}82}{1000}\ g/l = \ 9{,}89\ t/h$$

In 2022

$$S_d = D \cdot S_{dm} = \frac{1650 m^3/ha\ x\ 5{,}66}{1000}\ g/l = 9,\ 34\ t/h$$

A quantity of the salts removed by drainage in the research area was 9.89 – 9.34 t/h. The results show that a quantity of salts removed by drainage is more than the amount of salts entering with irrigation water[27]. The most important indicator of the crop yielding which determines the development agriculture, is productivity. The experiment shows that the most fertile soil can be degraded; productivity can be partially

[27] Mustafayev M.G. Study of water-salt balance in the ameliorated soils of the Mughan plain. Collection of the scientific works of "Azh and M". Baku, "Elm", vol.XXXII, 2012, p. 84-89.

or completely lost under the external and internal factors[28]. From this point of view, G.Azizov and A.Guliyev's[29] ideas and considerations about increase of reclamation and fertility of the salinized soil are of scientific-practical importance. Proper placement of agricultural plants in any area, determination of washing norms, etc. it is important to study mapping in order to know the extent of soil salinization in solving such issues. For this purpose the hypothetic salts were fixed in the soil sections (4) taken from the characteristic places in the Shurabad and Gilazy villages regions. The salt content of the experimental soils and a quantity of toxic salts in them was compared with I. Akberov's researches. The researches performed in 1986 indicate that an amount of salts from totality was 59.03 -87.67 %. But according to our research results it was 50.52 -76.8 %. During the researches also studied grain yield on saline soils of the experimental area, and it was found that there was a direct relationship between salinity and yield. When the salt amount is <0.25%, winter wheat productivity is 25,82 c/h, when the salt quantity is 0.25-0.5 % is 23,35 c/h, the productivity becomes 19,12 s/h but when it is 0,5-1.0 %, the productivity is 4,86 c/h, when salinization is 1.5-2,0%, the productivity is 1,85 c/h when salinization is 2,0-3,0% (table 7, pic. 4).

Table 7

Changes in winter wheat yields depending on soil salinity degree

№	Indicators	Salinity, %					
		<0,25	0,25-0,5	0,5-1,0	1,0-1,5	1,5-2,0	2,0-3,0
1	Average productivity, c/h	25,82	23,35	19,12	10,65	4,86	1,85
2	<0,25 % difference compared to salinity, c/h	-	2,47	6,70	15,12	20,96	23,97
3	<0.25 % decrease of productivity compared to salinity, %		9,57	25,95	58,56	81,18	92,84
	<0.25 % Productivity according to salinity was adopted 100%						

[28] Iskendarov M.Y. Amelioration of salinization soils and environment. Baku 2018, p.63.

[29] Azizov G., Guliyev A. Azerbaijan salinized soils, their amelioration and frtility increase. Baku, 1999, p.75

CHAPTER 5. AMELIORATIVE STATE OF SOILS IN THE SIYAZAN-SUMGAIT MASSIVE AND WAYS OF THEIR IMPROVEMENT

An agrarian area is one of the prioritet directions in all the periods, including independent Azerbaijan economy. So, more than 1.5 million or 39% out of a population of 3.8 million of population of 3.8 million work in the agrarian area. Recently, the global climatic changes occured in Azerbaijan has not gone unnoticed, so in 1999-2001, our country facedsevere drought, but in 2003-2004, it was subjected to heavy and continous rains, floods and deluges. During the both phenomena the water industryof the republic was seriously damaged. It is known the soil amelioration state is formed under the influence of natural factors and irrigative farm system[30]. As the agricultural products in the country are mainly obtained from irrigated soils, its proper management is of great importance in terms of protecting the reclamation condition of the soils. As a result of the long researches it was known that the factors reflected storage of usefulness of the degree, character and direction of increased fertility potential of soils was received like an assessment category of amelioration state of soils. M.G. Mustafayev[31] separated the soils into 4 categories taking into account the state of ameliorative indicators, an effect of natural and anthropogenic factors: “good”, “ satisfactory”, fear of “satisfactory” and “unsatisfactory”.

[30] Guliyev R.M. Landstructure. Management of soil market and soil resources, vol.II, Baku, “MBM”, 2008, p.316

[31] Mustafayev M.Q. Criteria for the evaluation of reclamation status of soils in the Mugan-Salyan massif, Polis Acad. Of Sciencesü (PAN) in Warsaw, Inst. Of Technology and Life Sciense (ITP) in Falenty, Journal of Water and Land Development, No.24 (I-III), 2015, pp.21-26

Table 8.
Assessment of the reclamation state of irrigated lands (taking into account changes in the groundwater level)

Categories of ameliorative state in irrigated soils	According to the average value of deposit depth during vegetation of level difference in groundwaters(hp)
Good	QSS> h_D
Cafe	QSS= h_D
Condition of caffeine feared to worsen	5>QSS> h_D
Insufficient	QSS< h_D

A level of groundwaters in the experimental area of the Shurabad and Gilazi is less than average value of their deposit depth, therefore the ameliorative state of irrigated soils is attributed to "unsatisfactory" category.

The ameliorative state of soils of Shurabad and Gilazi villages areas with the sections –K-6, K-9, K-12, K-14, K-15, K-20, N-3, N-4 are "satisfactory" as the soils in the areas with the sections –K-1, K-2, K-3, K-4, K-5, K-7, K-8, K-10, K-11, K-13, K-16, K-17, K-18, K-19, K-21, N-1, N-2, N-7, N-8, N-9, N-10 are "unsatisfactory". That is, the salt quantity is 0.22-3.11%.

Table 9
Ameliorative assessment categories taking into account salinization degree

Ameliorative category of irrigated soils	Salinization degree	Process direction
Good	Salinization	Salinization isn't occured in soil, or is desalted
Satisfactory (s)	Weakly salinization	Stable or weakly desalted
The state of satisfactory with the decay smell	Salinized or weakly salinized	Constantly collection of salts
Unsatisfactory	Moderately, strongly and very strongly salinized	Intensive collection of salts

A reason of less yielding of the agricultural plants are solonetzificated soils. The solonetzification degree is fixed by the percentage of exchangeable natrium, magnesium and calcium of absorption capacity of soil. As a result of the researches in the experimental area of the Shurabad village it was known that intensive collection of Na^+ and Mg^{2+} in soils and extraction of Ca^{2+} was observed. So, Na^+ and Mg^{2+}

indicators in the research zone are accordingy 0.003-0.818 % and 0.003-0.039 %. It was determined that the soils belong to "unsatisfactory" categories.

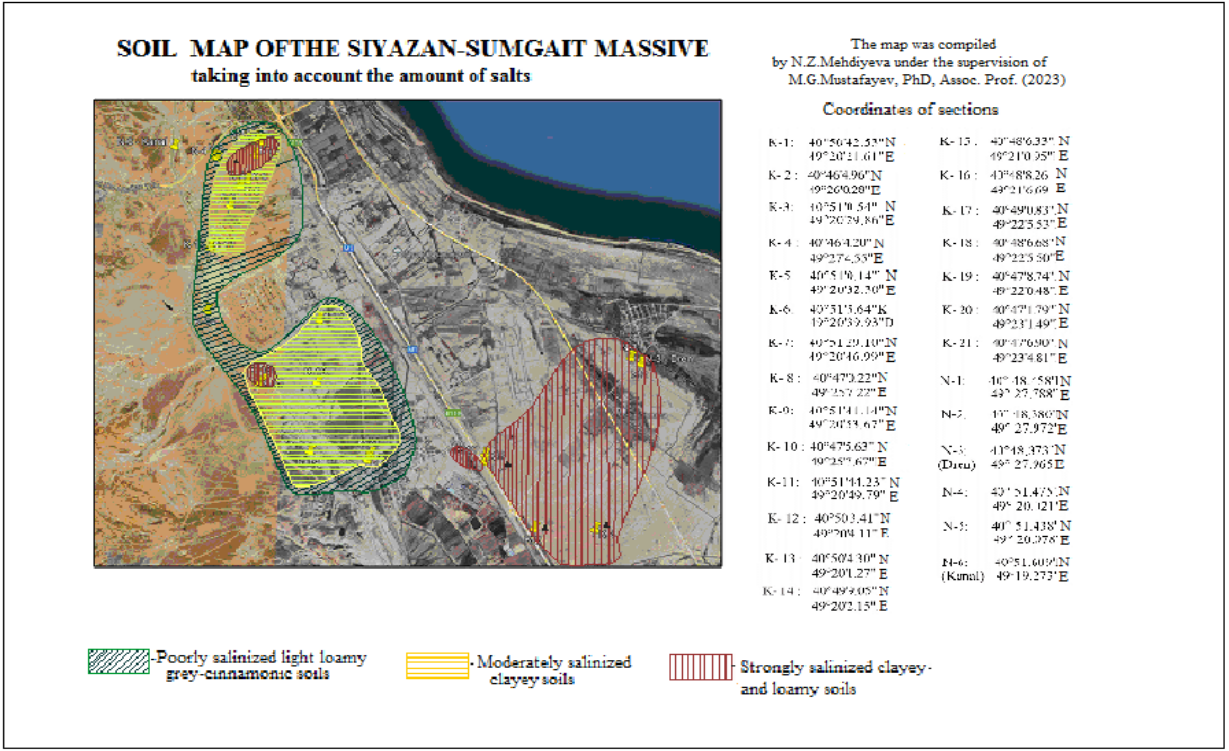
Table 10

Ameliorative assessment categories taking into account solonetzification degree

Ameliorative state categories of the irrigated soils	Solonetzification degree	Process direction
Good	Non-solonetzificated	Solonetzification isn't occured
Satisfactory	Weakly solonetzificated	Stable or non-solonetzificated
The state of satisfactory with the decay smell	Non-solonetzificated or weakly solonetzificated	Gradual collection of Na and Ca-extraction occures
Unsatisfactory	Average, strongly solonetzificated and saline	Intensive collection of Na and Mg extraction of Ca

Reliability of the results obtained from the analysis of the total amount of dissolved bases, the amount of salts and the degree of mineralization of ground-water in the degraded grey-cinnamonic soils in the Siyazan-Sumgait massive was checked by mathematical methods. The correlation coefficient r=0.94 indicates that the relation between these indications is very close. The scheme-map of soil salinization in the research area of Siyazan-Sumgait massiv is presented in picture 4.

One of the current issues in modern times is preparation of the complex ameliorative measures system in prevention from natural and artificial problems in the reclaimed soils and achievement of their correct application in the same zones. As it is seen from the composed map-scheme that poorly salinized light loamy, moderately salinized clayey and strongly salinized clayey and loamy grey-cinnamonic soils spread in the research zone. Reduction of salt quantity is achieved in the soils of this region by using the successful method, especially precipitation that is applied in the Gilazy village. It is possible to use the sprinkler, drip and other modern methods of irrigation for the orchard and grain plants in the Shurabad village.



Pic. 4. Map of salinization of the soils of the Siyazan-Sumgayit massif research area

This will eliminate the risk of re-salinization and prevent irrigation water losses. Storage of the soil humidity at the required level, application of the crop rotation system is important to get high productivity from the crops planted in the zone. The cultivation should be correctly performed, be preferred application of organic and mineral fertilizers (local fertilizers, especially green fertilizer) according to norms depending on cultural degree of the soils with the improvement purpose of the soil fertility indications in the research zone. In moderately and strongly salinized soils and areas where groundwater with a high degree of mineralization is formed, it is possible to gradually improve their amelioration condition by using both salt-resistant-sugar beet, fodder beet, wheat soybean, corn, peas, as well as drought- resistant plants – quinoa, sorghum and others, taking into account the climatic conditions of the area in the Siyazan-Sumgait massive. Besides, we can achieve increase of the moisture retention capacity, storage of the fertilizers in the soil for a long time by applying new technologies like geo-textile and hidrogel. This also improves assimilation of fertilizers by plants and minimization of the additional fertilization need. As a result, the farmers can get a more profitable and ecologically pure production; grow production expenses, productivity and endurance of the farming. For this purpose, in 2023, the abovementioned indications were determined and the proposals were prepared with the purpose of improvement of the soil ameliorative state and they were presented to the institute named after “Azerdovsuteslayihe”.

Conclusion and proposals

1. It was determined that a quantity of physical clay (<0.01) 36.00 -82.79 %, but an amount of silt fractions (<0.001) 11.60-42.20 % in granulometric composition.

The same soils are clayey, average and heavy loamy in granulometric composition.

2. Results of researches show that heavy clayey grey-cinnamon soils with weak waterproofing ability prevail on the territory of Siyazan-Sumgait massif. The same soils were subjected to strong salinization. The density of soil is 1.14-1.50 g/cm^2, a special mass is 2.69-2.80 g/cm^3, porosity is 42.7-50.8 % and hygroscopic humidity is 8.8-9.5 %.
3. On the basis of the researches in the massive it was defined that the ground-waters spread along the zone and they are chemically sulfate-chlorine, sodium, chlorine-sulfate-sodium. The researches indicated that a level of ground water in the Khizi district is 1-18m from surface, but it is 0,5-16,5 m, 0,3-8,5 m in the Shabran and Siyazan regions. But mineralization degree of groundwater changes from 0,8 g/l to 95,2g/l.
4. It was determined that the drainage waters for salt type are – sulfate-chlorine, but they are chlorine –sulfate in the water samples taken from groundwater and irrigation canal running from Takhtakorpu water reservoir .
5. The researches showed that pH value is 7.4-8.8, this indicates that the same soils possess alkaline environment. A quantity of $CaCO_3$ is 8.328 -24.342 % in soils.
6. An amount of humus in the same soils is 1.79-1.82 % on upper layers. According to the results the soils are weakly provided.
7. It has been established that as a result of ameliorative measures the amount of salts in soils in the research area decreased by 0.39-2.01% as compared to 1968.
8. The researches indicate that it is advisable to fulfill the complex agromeliorative measures in the zones and

wide application of the progressive irrigation methods for increase of soil fertility and productivity of the agricultural plants

RECOMMEDATIONS FOR PRODUCTION

According to the ameliorative state in the research zone, fulfillment of the following ameliorative and agrotechnical measures is offered in order to grow productivity of the agricultural plants and soil fertility:

1. Increase of the available collector-drainage networks operational efficiency (repair and restoration works, application of temporary drain and water-collector in the required places), providing clearance of salts from soils in drainage background; keeping the moisture-resistance ability of soil, progressive irrigation technics and technologies (sprinkler, drip, etc.), structure improvement application of the innovative technologies like geo-textile and hidrogel in order to prevent from water loss and decrease fertilizing intensity.
2. Improving the agricultural culture of farmers, planting the drought-and salt- resistant crops (wheat, soybean, kinoa, soghum), using the chemical ameliorants with the purpose of gradual improvement of the salinized and solonetzificated soils.

A main content of dissertation is reflected in the following articles:

1. The study of regime of regime of under-ground water in the Samur-Davachi plain İntegration processes of the world science in the 21st century, Ganja, 10-14 October, 2016, p.141-142
2. Study of some indicators in a key area (an example of Siyazan-Sumgait massive). The XXIV International

scientific conf. Students, graduate students and young scientists. Lomonosov-2017, Moscow, Max Press, 2017, p.180-181
3. Modern state of the Siyazan-Sumgait massive soils. Journal of Soil Science and Agrochemistry. № 1, 2018, Kazakhstan, p.47-53 (M.G.Mustafayev).
4. Activity of hydrographic network in the Siyazan-Sumgait massive. ANAS Ganja section, News collection, № 2(72), Ganja "Elm", 2018, p. 217-220.
5. Ameliorative state of soils in the territory of Siyazan-Sumgait massive. The XXV International scientific conf. Students, graduate students and young scientists. Lomonosov -2018, Moscow, Max Press, 2018, p.221-222.
6. Change of some indicators of soils in the research zone (Siyazan-Sumgait massive). Scientific –practical conf. on the topic of "Ecology, amelioration and energetics of soils" dedicated to acad. V.R. Volobuyev's 110th anniversary. Mater. Baku, 2020, p.70.
7. Modern state of soils in the Siyazan-Sumgait massive. Scientific-practical Conf. Mater, on the topic of "Problems of the environment and strategy of its preservation: vision of the future" which was dedicated to "Science Day" held among the students, magisters and doctorates (dissertants)., ANAS Institute of Soil Science and Agrochemistry, Baku, 2021, p.42.
8. Salt quantity change in the experimental soils. International scientific-practical conf. on the topic of "Soil-ecological problems of agrocenosis and methods of their solution", Baku, 2021, p.74-78.
9. Salt type in soils of the Siyazan-Sumgait massive. Amelioration. Scientific journal, №3 (101), Minsk, 2022, p.19-23.

10. Definition of salt amount and type in the research area (Siyazan-Sumgait massive). International scientific-practical conf.,on “Yesterday, today and tomorrow of the Soil Science”, Baku, 2023, p.127-130.
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12. Methods of soil improvement in Sumgayit-Siyazan massive. Young Researcher Scientific & practical journal, Vol.IX, №3, Baku, 2023, p.65-70.
13. Mineralization of the subsoil water in the soil of the Siyazan-Sumgayit massive. Construction Engineering. Collection of scientific works 2(39), Ukraine, 2023, p.60-65.
14. Definition of salinization process and salt type in the Siyazan-Sumgait massive. Scientific News, Azerbaijan Technology University, №1/46, Ganja, 2024, p.75-80.
15. Fertility indicators of soils in the Siyazan-Sumqayit massive. Enviromental safety and natural resources. Ukraine.Vol.51. 2024, p.28-32.

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The thesis work can be found in the library of AR MSE institute of Soil Science and Agrochemistry.

Dissertation and electronic versions of the abstract are posted on the official website defterxana@tai.science.az.
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