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LAND-IMPROVEMENT OF THE SOILS OF THE MIL PLAIN

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PREFACE

The Mil plain is an endless desert with full of cracks because of thirst, having changed to dustbowl in windy days, with boiling sun and bleating together snakes wide plain!

1930. There is a great reviving in the Mil. Here is built an arterial canal for irrigation of great areas. People are coming to the Mil from surrounding regions. Large-scale farms are created in the Mil. Waterless steppes become alive. Fertile soils are planted rapidly. The Mil changes into a tulip-garden. Cotton fields, grain fields, grapes and fruit gardens give special beauty to the Mil.

Such is the brief notion about the past and present of the Mil plain with 340 thousand *ha* of area. However, it doesn't create a complete notion about the nature of the plain. In order to imagine and understand its motley nature thoroughly, one must know the soils of this area, giving live to this nature and forming its base and some processes and changes, going on in these soils. It is expedient to know salts, playing an active role in creation of changes of these soils, especially their combinations, being able to dissolve in water, the regulations of spreading of salts in the soils and taking away of these salts from the soils.

THE CONDITION OF GETTING SALINE OF THE SOILS OF THE MIL PLAIN

The Mil plain covers the area, surrounded by the Kur River from the north, by the height of the north plates of the Small Caucasus Mountains from the south, by the waters of the Araz River and Garachay River from the east. Being flat in general, this territory is sloping from south to north and from east to west. Being big in the south of the plain (0,010), the inclination diminishes very much towards the north (0,006-0,005).

The foothill zone consists of not high hillocks, valleys and ravines. Towards the north, this zone gradually becomes a flat area. A number of valleys, covered with turf, ravines and narrow Khonashin River cut the plain.

According to geological structure, the Mil plain is not very ancient one. It is said that the main part of this plain was under the sea even in the times of Strabon. The present condition of the southern part of the territory indicates that it had been freed off the sea earlier. Together with it, the Mil plain's being under the sea in the Quaternary period does not present a suspicion in any person. The latest investigations of V.Y.Khain and A.N.Shardanov especially affirm it.

Thus, it is discovered that the activities of the Ancient Caspian Sea and the genetic events had had great influence in the formation of the mentioned plain. During the regression of the Caspian Sea, it caused a number of relief forms.

According to geo-morphological structure, the Mil plain can be divided into three big regions:

1. Delluvial-prolluvial plain, forming the south part of the territory; 2. Bringing cone of the Araz and Gargar rivers; 3. alluvial plain along the shores of the Kur River.

These regions are divided into different geomorphologic half-regions separately.

Being very sloped, dealluvial-proalluvial plain covers the foothill territory part of the area with 0-160 *m* of height. As the result of the activity of the Ancient Caspian, there are existed a number of sea terraces in this area. V.R.Volobuyev, V.V. Yegorov, V.S. Muratova and G.V.Zakharina show that there are four ancient sea terraces there. Didanja mollusk remainders, having been found in the territory, prove that these terraces had been of sea origin. Having got a number of ravines and gorges in the dealluvial-proalluvial plain, caused to become complicated of the relief forms of the territory. There are big and small micro-heights and micro-cavitations here as well.

Such kind of condition causes definite influence to non-equal spreading of precipitations and to the process of soil forming in the territory.

Bringing cones of the rivers, especially of the Araz River had formed a specific relief form in the plain. According to the origin, the bringing cone of the Araz River can be divided into three parts: the upper part

with the most ancient character; the middle part, being younger; the lower part, consisting of present sediments. Each of them is divided to generative forms as well.
Covering relatively small area, the bringing cone of the Gargar River extends in the form of a strip.
The plain along the banks of the Kur River got different relief forms. There are a number of hollows of pit form, sandy hills, consisting of knots and barkhans here. The Aghgol hollow, being the bed of the ancient Kur River, is also located here.
The variety of geo-morphological structure of the territory caused the variety of rocks, forming of soils. Main soil forming rocks in the territory are ancient salty sediments. In separate areas, the upper part of these sediments had been covered by deposits of different origin of the present time. The accumulation of fine clay of the same kind is typical for the dealluvial-proalluvial plain. Such kind of objective laws is significant for fringing cones of counter way. The upper part of the bringing cones is mainly covered with river stones of different bigness. Sometimes they even appear on the surface. The surfaces of these accumulations are rarely covered by sediments with fine mechanical composition, having got very thin thickness.
Objective laws are observed with difficulty in spreading of soil forming rocks in the Kur-shore plain. In fact, here is observed the spreading of sediments with heavy mechanical composition together with sandy areas. In such areas, especially in the Aghgol hollow place is observed of sea sediments, appearing on the surface. Separate investigators (V.V.Yegorov, 1951) connect this state with the erosion of the surface of area.
Thus, here is brought to light the different composition of soil forming rocks in the conditions of the Mil plain. No doubt, that it causes the development of soil forming process in different directions.
Climate condition had also influenced to the process of soil forming in the plain. Having dry sub-tropical climate, its summer is hot, winter – mild. Average annual temperature is 14^0. Average monthly temperature in summer reaches 26^0. There are nearly not frosty days there. Positive temperature is observed even in the coldest month, January.
The average amount of precipitations is 287,5 *mm*. There is not constant snow cover there. Falling snow melts rapidly. The thickness of snow rarely reaches up to 4-6 *cm*. though spring and autumn months pass wet, drought is observed in summer. There occur cases that even 1 *mm* of wet does not fall during summer months.
High temperature and less precipitation cause the bigness of evaporation coefficient. If one takes into consideration the transpiration of plants, yearly evaporation degree contains 1000-1100 *mm*. It is about 3,5 times more than annual precipitation. Thus, soil-forming process in the territory goes on in dry climate condition and there is observed water shortage in the ground.
All of these caused the developing of plants, firm to droughty in the Mil plain. The spreading of wormwood plant group in the dealluvial-proalluvial part of the area is typical. In addition to all these, a number of saline plants' spreading is observed in the bringing cones of the rivers. Some half-bush and lawn plants spread in the Kur-shore alluvial plain. The spreading of current-like half-bush plants is typical in sandy areas. Tugay forests spread in flood-lands part of the Kur River.
Some plants, especially hullo fits, influence in a definite degree to accumulation of salts in soils.
One of the factors, defining the salinity of soils is the depth of location of subsoil waters and their mineralization degree, about which information will be given further.

Factors, influencing salinity of soils

As it was above mentioned, the Kur-Araz lowlands, including of the Mil plain, had been under seawaters once, composed the west bay of the Caspian. Getting free of seawaters caused the accumulation of easily soluble salts in the soils of the plain. According to our investigations, it was defined that, in the areas below nil horizons of the Kur-Araz lowlands, after the last pulling away of the waters of the Caspian Sea, there was accumulated 74 milliard tones of salt there. 101 million tones of this amount fall to the amount of the Mil plain.
When the sea moved away completely, there were formed big lagoons in the area. Such lagoons can be met in the Mil plain at present too. The biggest among them is considered salty-watered Sarissu Lake. The influence of these lagoons to salinity, of the having mentioned soils, is great.

Geo-chemical flows, beginning since very ancient times and going on at present as well, have a role of getting saline of the soils of the Mil plain. As the amount of salts is much in these solutions, the cause the salinity of soils of the plain as the ancient sea sediments.
As it is known, chemical composition and salinity of any plain area and subsoil waters is connected on definite scale with the chemical composition of sediments of mountainous part, surrounding this territory. In fact, sediments in these mountains including salty deposits undergo to the process of erosion because of outward influence and brought to the plain area by subsoil currents. The main part of surface waters in the Mil plain is rivers' waters and dealluvial-proalluvial waters. According to investigations and calculations, there were defined that only by the waters of the canal, once named after Orjenikidze, which takes its waters from the Araz River, 174 thousand tones of salt are brought to the Mil plain annually. Apart of it, plenty of salts are brought to the territory by dealluvial-proalluvial streams. According to our investigations, there had been defined that the annual amount of these waters in the Mil plain is 9 million 0,32 cubic meters. Those waters annually bring 78328 tones of salts to the plain yearly. The majority of these salts is chlorine (29711 tones), sulphate (18007 tones), sodium (12875 tones) and bio-carbonates (10534 tones). The amount of calcium (3961 tones), magnesium (1801 tones) and normal carbonates (450 tones) is relatively less than the first group.
One of the factors, having influenced the salinity of soils in a high degree is subsoil waters, existing in the territory of the Mil plain. The influence of these waters to salinity of soils depends on their critical level, i.e. of their depth. According to the results of the investigations, there was defined that the critical level of subsoil waters for the soils of the Mil plain is the depth of 1,3-1,8 *m* (G.V.Zakharina, 1958; V.S.Muratova, 1962). Obviously, if the level of subsoil waters is in that depth, they are subjected to surface evaporation, getting saline of upper layers of soils.
According to the relief, geo-morphological structure and degree of inclination of the territory, subsoil waters of the Mil plain had located in different depths. In general, the depth of subsoil waters here increases from the banks of the Kur River towards foothill area (from 2-3 *m* up to 10-15 *m*). At the same time, such objective laws display itself in the areas of brining cones of the Araz and Gargar rivers. So, the depth of subsoil waters here also increases from the low zone of bringing cones increases towards the upper zone (from 0,5-10 *m* up to 8-10 *m*). Together with all these, depending on the forms of the relief structure, sometimes these objective laws are effaced. Not depending on the Kur-Araz lowlands, including their locating zones in pit-formed relief areas, being typical for the Mil plain, subsoil waters are mainly located in shallow levels (0,5-1,0-1,51). Subsoil waters are even located shallower than irrigated soil areas of the plain (1,5-2,0-3,0 *m*).
All of these indicate that the subsoil waters of the Mil plain are mainly located in the depths being able to saline soils.
At the same time, the influence of subsoil waters depends on mineralization degree of those waters. In this case, the critical degree of mineralization of subsoil waters is taken as the basic standpoint. According to the generalization of existing materials, it can be said that the critical mineralization degree of subsoil waters is generally considered as 2-3 *g* in each liter of water. This figure can be accepted up to 5-6 *g* in each liter of water for the conditions of Azerbaijan. The changing of the degree of critical mineralization in the limits of such bigness here is connected with chemical composition of those waters. So, as waters with sodium influences negatively to the growth of plants, the critical level of mineralized waters is 1*g* in each liter, there was accepted 5-6 *g* for mineralized waters in sulphade-chloride and chloride composition and 9-10 *g* for mineralized waters with chloride-sulphate and sulphate composition.
It means that, if the mineralization of subsoil waters goes beyond the mentioned degree, there is going on the process of salinity in the soils in their critical level. If the mineralization degree of those waters is lower than the critical degree and subsoil waters are located shallow, they can't influence the salinity of such soils.
As their depths, the mineralization degree of subsoil waters is very different in the Mil plain. G.V.Zakharina (1958) and V.S.Muratova (1962) learned the objective laws of distributing mineralization degree of subsoil waters here. According to their information, the mineralization degree of subsoil waters of the foothill zone of the plain and in the upper part of the bringing cone of the Araz River does not mainly go beyond 5-10 *g* in each liter of water. It can rarely reach up to 20-25 *g*. Average mineralization degree in each liter contains 4-5 *g*. The mineralization degree of subsoil waters increases very much in the low part of the foothill zone and in the region of the bringing cone of the Garachay River. In this area, an average mineralization degree appears 30 *g* and sometimes more in each liter.

The mineralization degree of subsoil waters s higher in the ancient delta of the Kur, in alluvial plain of the Araz and in depressions among the bringing cones of the rivers. The mineralization degree of those waters in these areas can reach to 100-130 *g* in each liter. An average mineralization degree of subsoil waters of alluvial plain of the Araz contains 45 *g* in each liter, but in the ancient delta of the Kur and in the lowlands among cones it reaches up to 70 *g* in each liter.

The changing of mineralization degree of subsoil waters this way, in its turn, could find its reflection in the changing of chemical composition of those waters. There was defined that in subsoil waters, having got 0,3-0,5 g in each liter, the mineralization degree, prevail calcium-bio-carbonate salts. Chemical composition of subsoil waters with the mineralization degree of 0,5-2 *g* is mainly with sodium-bio-carbonate. When the mineralization degree of subsoil waters reaches 2-5 *g* in each liter, though sodium-sulphate prevails in its composition, nevertheless, these waters are of mixed composition. The rise of mineralization degree of subsoil waters causes the enriching of their composition by sodium-chloride salts. All of these are considered as the main factor, regulating the influence of salinity of soils by subsoil waters. So, depending on the critical level of subsoil waters, the mineralization degree of these waters and their chemical composition, the speed of salinity of soils gets rapid or weakens.

Thus, it comes forth from all mentioned that a number of factors play role in salinity of the soils of the Mil plain. According to the geo-morphological condition of the plain, each of these factors plays prevailing role in this or that part of the territory. So, if surface currents mainly influence the salinity of soils in the upper part of the foothill zone, irrigation influences it in the lower part very much. In the regions of the delta of the ancient Kur and bringing cones of the rivers, salinity occurs in the result of the influence of subsoil waters. Nevertheless, the influence of the factors to salinity of soils can’t be indicated as having isolated from each other in all cases. As these geo-morphologic regions are relatively connected with each other, no doubt, that there are some definite link or mutual influence among them.

The role of migration (movement) of salts, remaining in soils and clay since ancient times (since the period of moving away of the sea) in salinity of upper layers of soils is very great. In such case, the role of artificial irrigation in the background of initial salinity of soils draws an attention. We have mentioned above that the lower layers of the soils of this territory had got saline highly. In many cases, water-permeability of these layers is very weak. Because of it, absorbed water during the irrigation of soils can’t penetrate to deeper layers, accumulating in the middle layers of soils and dissolving salts, keep them in dependent state. Thus, there is formed a salty solution in the soil. Rising to the upper layers of soils in hot periods under the influence of surface evaporation, they cause more than once salinity. This state especially comes forth in the result of disordering of irrigation rules, when there is occurred additional water lost.

The process of diffusion has a big role in the circulation of salts in soil profile. When saying ‘the diffusion of salts’, it is considered their equality in soil solution. There are sometimes suitable conditions for the process of diffusion of salts in the soils of the plain. When saying ‘a suitable condition’, we consider heavy mechanical composition of soils, weakness of water permeability, difference of water and salt rations in this or that layer of these soils.

This state is openly expressed in non-irrigation part of the foothill zone of the territory. Majority of soils here is of heavy mechanical composition and main part of salts had accumulated in lower layers of them. Humidity is less in these layers of soils and relatively more in the upper layers. Namely because of it, humidity in the lower layers of soils move there by diffusion way and causes the rise of salts from there to the upper layers of soils. Thus, there is going on a regular process of diffusion of humidity and salt diffusion in lower and upper layers of soils, i.e. the process of equalization. This causes salinity of upper layers of soils because of salts of lower layers. This process is sharpened by the growth of amount of humidity in the soil. According to our exact experiences and investigations, we had defined that, when the amount of damping of the soil is 16,5%, their average daily diffusion coefficient during 15-days experiment is 0,133 cm^2 and the amount of salts, having risen to 10 *cm* of height (according to chlorine ion), contains 0,023%. When the amount of humidity is 30%, these figures correspondently reach 0,388 cm^2 and 0,451%.

One of active factors of migration of salts in soil profile is their biological circulation. As we know, assimilating a number of substances from their feeding sphere y their roots, plants accumulate them in their trunks, branches and leaves. When they finish their lives, they return those substances to soils anew. Thus, in the result of accumulating of substances, including easily soluble salts from the low layers of soils to upper layers and their washing to lower layers under the influence of surface waters anew, there occurs a definite period, which is called *the biological circulation of salts*.

Table 1

Biological circulation of easily soluble in water salts in spreading plant groups of the foothill part of the Mil plain

Biological mass	72	92	63
including:			
green part (metric centner/ha)	8	72	4,3
from biolog. mass by %	11	29	7
perennial part, centner/ha	14	6	8,7
from biological mass by %	19	6,5	14
roots (centner/ha)	50	59	50
from biological mass by %	70	74,5	79
Debris (centner/ha)	28	55	25
from biological mass by %	39	60	40
including:			
green mass	29	49	17
perennial part (centner/ha)	3	0,5	11
root remainders (by %)	68	50	72
Easily soluble in water in biological mass			
salts (kg/ha)	526	331	504
easily soluble in water salts (kg/ha)	214	198	201
returning to soils with debris			40
relatively to salts in biolo-gical mass by %	40	60	

The role of biological circulation in the salinity of soils, especially of the conditions when subsoil waters are located deep, catches the attention very much. Namely because of this, the influence of this factor had been learned by us in the Mil plain with subsoil waters, having located deeply. It was brought into light that the biological circulation of salts obeys definite regulations. So, the accumulation of salts by biological way relatively increases from the lower part towards the upper one (table 1). It is explained by the increase of biological mass of plants in that direction (look at table 1). There was defined that in the soils, having spread in the foothill part of the Mil plain, 613 *kg* per ha salt is accumulated yearly by vegetations. According to the results of investigations, we had defined that the direct influence of life activities of plants to the biological circulation of salts is relatively big than the amount of having accumulated salts after the death of vegetations. It is known that the plants accept this or that food substance in the form of having dissolved in water together with water. In this case, evaporating the humidity of a soil layer by the way of transpiration, they increase substances, including the dirt of harmful for plants salts and therefore they cause the accumulation of those salts as sediments there. Thus, there is observed the accumulation of salts in the layers where the root system of plants had spread widely.

Geographical spreading of salts in the soils of the Mil plain

To learn the amount of salts in the composition of soils, easily soluble in water has significant value from agricultural pint of view. In fact according to the amount of salts in the composition of soils there is defined what agricultural plant can be cultivated there and carrying out of what melioration works is needed.

Root system of agricultural mainly can go up to one-meter depth. That's why, when valuing soils agro-ecologically, there must be defined the regulation of spreading of salts in one-meter upper layer of soils and their amount as well. It is expedient to learn salts in the second one-meter layer too. In fact, if salts are much in that layer, during convenient condition they rise to the surface of soils and give anew salinity to the layer of soils with root system of plants.

The degree of salinity of soils of the Mil plain and their spreading along the profile are very different.

The amount of salts in one-meter upper layer of these soils averagely hesitates from 0,1% up to 4%. According to the calculation of V.S.Muratova (1962), the soils of the Mil plain were divided as following on salinity degrees (table 2)

Obeying some definite regulations, these soils were dispensed in different ways in this or that part of the territory (table 1).

The soils of dealluvial plates are generally defined by the small amount of salts. The amount of salts in one-meter upper layer in un-irrigated part of this area is very little. In this case, if the amount of salts in one-meter layer averagely contains 0,1% in the upper part of the foothill zone (its un-irrigation part), then the amount of salts increases a little, reaching 0,2-0,3%, sometimes even reaching 0,5% in the middle of the zone and especially in its low train part.

Table 2

Distribution of sols of the Mil plain according to the degree of salinity

1 -	Saline lands	<0,3	<40	<80-
2 -	Strongly saline lands	0,3-0,6	40	80-160
3 -	Weakly saline lands	0,3-0,6	40-80	80-160
4 -	Averagely saline lands	0,6-1,0	80-125	160-250
5 -	Strongly saline lands	1-2	125-250	250-500
6 -	Very strongly saline lands	2-3	250-400	500-800
7 -	Salt-ridden lands	3-4	400-500	800-1000
8 -	Salt-ridden lands	>4	>500	>1000

Picture 1. The scheme of salinity degree of soils in the Mil plain (V.S.Muratova, 1962). The explanation conditional signs had been given in table 2.

Relatively high salinity comes across in the soils of western and eastern parts of the zone. However, high salinity was distributed in the forms of different spots there. We consider that this state can be explained because of joint influence of dealluvial currents and rivers' bringing materials.

The amount of salts in relatively high eastern soils of the irrigated part of the foothill zone is little (0,1%), but in northern part with small height – is much (1% and sometimes even more). The western part of the territory got more salinity than the eastern one. Salinity nearly is absent, i.e. completely absent in the soils of the eastern part (the part to the east nearly after the 5th water-distributor). The amount of salts here hesitates between 0,1 – 0,2%. This amount can very rarely reach 0,3-0,5% (in pit areas).

The soils of northern part of the foothill zone (northern part of the irrigated area) are considered the most saline lands within this zone. The amount of salts in one-meter layer of the soils here reaches up to 1%, sometimes even 2%. The second one-meter layer of the soils is completely saline in high degree (the amount of dry remainder is 2-3%). The amount of salts in the soils of the Kur banks in the Mil plain is very high. The soils here had got saline averagely. Apart of it, high, even severe-degree of salinity is spread in large area here.

In the soils of the area, covering the bringing cones of the Araz River is defined objective laws the rivers' bringing cones of other areas of the Kur-Araz lowlands. So, salts here gradually grow from the upper part of the bringing cone towards the lower one. If the soils in the upper part are not saline, in the lower part they are completely saline. The amount of salts in the upper one-meter layer of the soils in the upper part mainly does not go beyond 0,2%. This amount can reach 1% in the middle part of bringing cone. The amount of salts in one-meter layer of different fields of lower areas composes 2-3%. Having mineralized in high degree subsoil waters, locating shallow, become a cause of the soils being sated by damping and getting saline because of the evaporation of subsoil waters.

Thus, it becomes clear that the soils in the Mil plain are different according to their degree of salinity.

According to the chemical composition of the salts, having accumulated in them, the soils of the Mil plain are very different as well. According to this omen, these soils can be divided into three groups: with hydro-carbonate, with sulfate and with chloride composition saline lands. According to the comparison of different anions and cations, being in them, these soils themselves are divided into different groups as well (picture 2).

Soils with hydro-carbonate composition mainly cover dealluvial plates and bringing cone of the Araz River. The amount of calcium bio-carbonate salt prevails both in the upper and lower layers of these soils.

The amount of bio-carbonates is especially much (2-3 m/equiv.) in the soils, having spread in the bringing cone of the Araz River. The amount of HSO_3 is about two times more than the general amount of Sa and Mg cations. Such kind of state indicates the accumulation of soda in definite amount in those soils. The accumulation of soda is connected with the existence of subsoil stream with soda along the Araz River. Supposedly, this was formed because of weathering of gronodiorit and porfirit, widely spread in the mountain rocks of the Small Caucasus.

Picture 2. The scheme of salt composition of the soils of the Mil plain (V.S.Muratova, 1962). 1 –with hydro-carbonate mainly; 2 – with hydro-carbonate (chloride)-sulfate; 3 – with hydro-carbonate (sulfate)-chloride;
4 – with sulfate and chloride-sulfate; 5 – with sulfate and chloride;
6 – with chloride (magnesium)-sodium; 7 – with chloride (magnesium) ad with sodium.

Saline lands with hydro-carbonate-chloride-sulfate composition spread in the south of the plain and hydro-carbonate soils – in the north-west part of the region. In the areas with spreading of such composition of salty lands, subsoil waters are mainly observed in shallow. Sodium-sulfate prevails in the chemical composition of salts.

Saline lands with hydro-carbonate-sulfate-chloride composition are observed very little in the plain. The soils of this part got mainly saline in average and severe degrees. Our having described soils can be met in the central part of the plain. Saline lands with sulfate-chloride composition can be met in the areas, where subsoil waters locate in 2-3 meters of depth. Subsoil waters of this part got mineralized more, in comparison with subsoil waters of salty lands.

Saline lands with sulfate composition are considered the most spreading ones in the Mil plain. These soils cover the north part of the foothill zone and the Kur-banks alluvial plain.

Saline lands with chloride composition are not in the form of fields, but spread in different spots. Such kind of soils is observed in the alluvial part of the Kur-banks of the plain. Prevailing of chlorides in these lands, obviously, is connected with ancient geo-chemical flow, existing in the area.

In other to judge correctly about having got saline lands, it is necessary to learn the distribution character of salts in soil profile. Distribution of salts in soil profile permits to make clear in some degree the increase of direction of salinity.

V.V.Polnov indicated that the learning of salt profiles creates very correct imagination about the sate of water-salt regime. Taking it into consideration, we have composed the map of plain profile types of the soils of the Mil plain (picture 3).

Picture 3. The map of plain profiles of the soils of the Mil profile (M.R.Abduyev, 1966). The explanation of conventional signs is given in pages 21-22 (?) of the work.

Picture 4. The types of plain profiles in the soils of the Mil plain (the names of the types are given in pages 21-22 -?- of the work).

Six salt profiles had been defined for the soils of the plain (picture 4). According to amount of salts, their distribution in soil profile and their chemical composition, these profiles differ from each other sharply. Short character of these profiles is as following:

1. Salt profile of little amount with hydro-carbonate-calcium-sodium, having distributed in the profile equally, covers vast area in the Mil plain. Soils with such salt profiles occupy the eastern part of the territory, embracing the upper part of dealluvial plates. Though the amount of salts changes in some degree during different times of a year, nevertheless, it can’t change the general distribution character in the profile of salts.
2. Maximal amount of salts with hydro-carbonate-sulfate-calcium-sodium composition, having accumulated in very deep layers of the soil is salt profiles, having got saline lands. Such salt profiles cover the upper part of the bringing cone of the Araz River in the southeast of the Mil plain. Soils, having such profiles are observed partially in the southwest of the territory as well. The amount of salts in the upper 1,5 meter layer is little and in lower layers – much.
3. Majority of salts is typical for lower part of the upper zone of dealluvial pates of salt profile of saline lands with hydro-carbonate-chloride-sulfate and sulfate-chloride-calcium-sodium (with sodium-calcium) composition, having settled to relatively deep layers of the soil. Salts gradually increase up to 80-*cm* depth and then sharply – lower than that depth.
4. Saline lands with maximum amount of salts of sulfate-chloride (with chloride-sulfate-sodium) and calcium-sodium composition, having settled in relatively less depth cover great territory in the Mil plain. These soils mainly cover the middle zone of delluvial plates, the Kur-bank plain and the low part of bringing cone of the Araz River. The amount of salts in 30-35-*cm* upper layer is little, in low layers – much in the soils, having such salt profile.
5. Saline lands with chloride-sodium composition and not saline of upper layer, spread in two big counters in the train zone of dealluvial plates and in the south of the Kur-bank plain. The significant feature of these soils is their being relatively little in the upper 10-15 *cm* layer and much – in the low layers. The shortage of salts in upper layer of these soils is not absolute, but of relative character, i.e. the amount of salts in this layer is equal to the amount of salts in the low layers of very saline soils, having spread in the upper zone of delluvial plates. This approximately composes 0,5-1,0%.
6. Soils with saline salt profile cover small area in the Mil plain. They spread as separate spots. Such lands mainly are observed in alluvial plain of the Kur-bank. Chemical composition of these lands is mixed. They mainly have a composition with sulfate-chloride-magnesium-calcium-sodium. They are mainly formed under the influence of subsoil waters, being close to the surface.

Thus, it comes forth from the above-mentioned that getting saline of soils in the Mil plain, spreading of salts in the massif and soil profile is under command of definite regulation. Firstly, this regulation indicates itself in the increase of the amount of salts in the direction of inclination of the territory and towards the deep layers of the soil. The amount of separate ions also increases in this direction and there is observed salinity with hydro-carbonate, sulfate and chloride substituting each other. Such state at the same time indicates itself in variety of water-salt regime of those lands.

WATER-SALT REGIME OF THE MIL PLAIN SOILS

Water regime of soils

As the motion of substances, including salts, is going on in the form of solution, it is closely connected with the motion of waters, existing there. That's why the description of water regime of the soils is very important.
Water regime of soils in the territory of the Mil plain, having got different natural conditions, including soil cover, has got different characters in its this or that part.
The most active role in water regime of the soils in the foothill zone of the plain plays atmospheric precipitations and surface waters, having appeared under their influence. As subsoil waters locate very deep here, they can't definitely influence to water regime of soils. All of these made definite influence to water regime of the soils of this territory and created a special regime for their getting humid and changing according to seasons. Surface waters here can relatively influence only the upper layers of soils. The upper half-meter layer of soils is more dynamic according to the amount of humidity. Because of high evaporation, the amount of humidity in this layer of the soil considerably diminishes, reaching the minimum (5-10%) during spring and summer. In the contrary, humidity of soils reaches the maximum (20%) in autumn.
The amount of humidity in lower layers of the soil is mainly constant. Practically not changing of humidity in those layers is connected with not having of influence of surface waters to those layers and subsoil waters' locating very deeply. According to the degree of humidity, the described layers are dry in all times. The amount of humidity here is mainly less than 10% and hesitates between 7-10%.
Though all of these are typical for un-irrigated soils of the foothill zone of the mil plain, nevertheless, depending on the inclination of the territory, the amount of damping gradually increases from the upper part towards the lower part of the zone. The thickness of the dry lower layer diminishes very much and the amount of humidity in that layer relatively increases. All these can be explained by the increase of the amount of surface flow of waters and subsoil waters' becoming shallow because of diminishing of inclination of the territory.
Water regime in irrigated soils of the foothill zone is completely of different character. Together with atmospheric precipitations, artificial irrigation also influence to the dynamics of humidity. In this state, artificial irrigation moves ahead as main influencing factor. This creates a condition of vegetations' being damp along all of the profile during vegetative period. At the same time, artificial irrigation caused the rise of the level of subsoil waters in the territory. Thus, because of the influence of surface damp from one side, and subsoil waters from the other, the mentioned soils had become sated of humidity during all year. That's why the dynamism of the soil is observed in all of the profile of the soil. There is noticed the diminishing of humidity in definite degree in the upper layers of the soil, being not very thick, because of surface evaporation during some short of time. There is not observed some definite regulation in changing of humidity according to seasons and distributing them on the profile. Increase of humidity in the upper layers of soil during the irrigation and relatively diminishing of it inter-irrigation periods is typical here.
Water regime of soils in the lower parts of the bringing cones of the rivers and in the Kur-bank plain carries out completely other character. Subsoil waters, having located shallow influence water regime of the soils here. Because of the influence of these waters, the soil profile here appears sated of humidity all times long. Mainly, the amount of humidity of the soil is 30-40%, sometimes more there. The amount of humidity mainly remains unchangeable during all periods of a year. In most cases, these layers are humid in high degree.
In comparison with upper layers of soils, the amount of humidity is mainly changeable. The amount of humidity is usually little in spring-summer months and less in autumn months. Because of evaporation of humidity from soils in summer, their getting dry sometimes covers deeper layers. Thus, ensuring of soils by humidity and evaporation of that humidity up to the big depth in hot times, form conditions of severe salinity of soils here.

Soil regime of soils

Matching with water regime, salt regime of the soils here is also very different. Salt regime of soils has specific character in this or that part of the territory.

As soils of un-irrigated part of the foothill zone, especially their upper layers are of little salinity, seasonal changing of salts goes on very weakly. Not any regulations are observed in having observed weak changes. Not depending on seasons, the amount of salts either increases or diminishes.

In spite of these, there is observed some regulations in seasonal changing character and the amount of salts in the direction of the inclination of the territory. It consists of the increase of salts in soils in the direction of inclination, the rise of the dynamics of those salts and thickening of soil layer in dynamic way.

Together with it, there are definite changes in the character of seasonal accumulation of salts in the soils of the territory.

Depending on regime types of humidity of soils and on irrigation regime of soils, salt store in the soils can increase or diminish during the migration of subsoil waters. Connected with it, there were defined three main directions in salt regime of the soils.

1. The amount of salts in the soils increases periodically, i.e. periodical salinity of soils goes on weaker than their seasonal salinity. This is called periodical – f i r m s a l i n i t y s a l t r e g i m e. In this case, the coefficient of seasonal accumulation of salts (DMT) goes beyond one (more than 1).

When saying *seasonal coefficient of salts*, there is intended the comparison of autumn stock from spring one.

2. The amount of salts in soils remains stable, or unchangeable, i.e. seasonal salinity and seasonal un-salinity can cover each other. Because of it, such kind of salt regime is called as seasonal – c h a n g i n g s a l t r e g i m e. the coefficient of DMT is equal to one in this regime.

3. The stock of salts diminishes periodically in the soil. Salt regime in the soils is considered unchangeable in this case too. In contrary with the first one, seasonal diminishing of salts goes on severely than their seasonal accumulation and salinity process in soils prevails there. This salt regime is called seasonal – u n c h a n g e a b l e s a l t r e g i m e. The coefficient of DMT is less than one in this case. In order to define the direction of salt regime in the soils of the Mil plain, we have calculated the coefficient of seasonal salt accumulation in these soils.

In the result, there was defined that in spreading soils of the upper part of un-irrigated area of the foothill zone, the coefficient of DMT in one-meter layer is mainly 1, or a little more than that. In this case, there appears a necessity to refer it to salt regime of seasonal salinity. But having got very little of absolute amount of easily soluble salts (mainly up to 0,1%) does not give us a ground to refer it to this salt regime. It will be better to refer these to the stable, i.e. to unchangeable salt regime.

Soils in the middle part of the zone have other salt regime. Salts in these soils are very changeable according to seasons. Here is observed the diminishing of salt stock in autumn months. This process strengthens from year to year. Calculations indicated that if the amount of salts in one-meter upper layer contained 0,26% on dry remainder and 0,03% on chlorine in the spring months of 1961, then, in autumn, especially the amount of dry remainder diminished about half and remained unchangeable till the spring, 1962. The amount of salts in autumn of that year diminished very much in comparison with the spring. In this case, the coefficient of DMT becomes 0,8. Following years, diminishing more and more, the coefficient of DMT became 0,5 on dry remainder and 0,4 on chlorine. All of these are observed in the second-meter layer of the soil with some little changes.

Thus, it comes forth from the above-mentioned that the soils of un-irrigated part of the foothill zone of the Mil plain subjected to the process of natural washing. This process picks up speed in the direction from the upper part of the zone towards the lower one. So, if the middle value of the DMT coefficient is 1 in the upper part of the zone, in the lower one this figure never goes beyond 0,7-0,8.

Having subjected to natural washing process, the soils of the Mil plain is explained by antiquity of the territory and connected with it, surface's becoming smoothed and sharply diminishing of erosion process of the area and bringing very little amount of salts by surface waters, having come from the mountainous part. At the same time, the ability of water permeability of the soils and the location of weakly mineralized subsoil waters very deeply have much influence to it.

Salt regime of irrigated part of soils of the foothill zone has other character. Two aspects' presence is observed in yearly salt regime of these soils. In the period of irrigation of lands, their amount of humidity increases and the flow of solutions below begin. In this state, the washing of salts occurs there. Sometimes it covers a soil

layer of two-meter thickness. In the periods between irrigations, as humidity of soils subjects a surface evaporation and transpiration of plants, the motion of solution upwards begins. This causes the accumulation of salts from the deep layers of soils to the upper ones.
Salt regime of soils during inter-vegetation periods of plants is regulated by the influence of climate elements, i.e. by atmospheric precipitations and air temperature. However, as atmospheric precipitations are of small amount here, they can’t create considerable change in the salt regime of the soil. Subsoil waters, having formed in the result of the influence of irrigation in the territory have influence to the salt regime of irrigated soils of the foothill zone of the Mil plain. However, learning of the regime of subsoil waters here indicated that these waters don’t occur danger for more than once salinity of soils in all cases. In the soils of this area, having got high water permeability and entered the artificial collector-drainage net, there is observed the washing of salts to deep layers. As we’ve mentioned above, the influence of subsoil waters to salinity of soils depends on their crisis mineralization degree. If the mineralization degree of subsoil waters is less than their crisis amount and in the case that those waters’ locating very shallow (higher than crisis level), they can’t influence repeated salinity of soils. Because of the influence of irrigation in the soils under maize, cotton, grain (barley) and alfalfa plants, subsoil waters located shallow (1,5-2,0 *m*) and mineralized very weakly (1,0-1,5 *g/l*). These waters influence the salt regime of soils very weakly. Soils haven’t got saline in all their depth. Only weak salinity is observed in deep layers of soils.
Seasonal changing of salts goes on in the soils very weakly as well. According to the observations, carried out in spring 1961, if the amount of salts in half-meter upper layer the soil was 0,1-0,2%, then, in autumn of that year it relatively increased. The increase of salts in the upper layers of the soil comes across with diminishing of them in lower layers. This indicates that if the definite-degree migration of salts occurs in the having described lands, this does not influence the changing of general stock of salts, so, there does not occur a repeated salinity. The calculation of salt balance indicated that the soils in the territory were not subjected to salinity, but to un-salinity. In fact, this process strengthens yearly and time passing, covers the deep layers of soils and clay.
The average value of DMT coefficient here is 0,83. All these are explained with that that the collector-drainage net, existing in the territory, removes the having settled to lower layers salts during the washing of soils and irrigation. This causes un-salinity of soils and subsoil waters, in its turn creates possibility for normal developing and giving high harvest of agricultural plants (though subsoil waters’ locating relatively shallow).
Here it is, the amount of salts on big depth in grey-lawn soils under maize plant doesn’t go beyond approximately 0,1%. These salts are of hydro-carbonate-chloride-sulfate-calcium-sodium composition (table 3, cut 503). As subsoil waters locate shallow (115 *cm*), soils are in the state of saturation.

Table 3

Salinity and salt composition of irrigated soils in the Mil plain

503							
0-8	0,115	0,049	0,018	0,013	0,010	0,006	0,014
		0,80	0,50	0,27	0,50	0,49	0,60
8-26	0,108	0,054	0,009	0,003	0,007	0,004	0,010
		0,88	0,25	0,06	0,37	0,37	0,45
26-43	0,080	0,052	0,007	0,003	0,010	0,004	0,006
		0,86	0,20	0,06	0,50	0,87	0,25
43-60	0,082	0,052	0,007	0,007	0,010	0,004	0,008
		0,86	0,20	0,15	0,50	0,37	0,34
60-72	0,060	0,054	0,009	0,005	0,012	0,001	0,011
		0,88	0,25	0,10	0,62	0,12	0,49
72-82	0,068	0,059	0,007	0,007	0,010	0,006	0,007
		0,96	0,20	0,15	0,50	0,49	0,32
82-97	0,030	0,054	0,008	0,010	0,010	0,003	0,014
		0,88	0,25	0,21	0,50	0,24	0,60
97-121	0,132	0,039	0,007	0,049	0,017	0,007	0,008
		0,64	0,20	1,02	0,87	0,062	0,37

504							
0-6	0,100	0,043	0,007	0,015	0,010	0,004	0,008
		0,70	0,20	0,31	0,50	0,37	0,34
6-29	0,092	0,043	0,018	0,016	0,012	0,001	0,018
		0,70	0,50	0,33	0,62	0,12	0,79
29-41	0,072	0,043	0,011	0,013	0,012	0,001	0,012
		0,70	0,30	0,27	0,52	0,12	0,53
41-52	0,064	0,089	0,011	0,015	0,010	0,004	0,008
		0,64	0,30	0,31	0,50	0,37	0,36
52-71	0,144	0,089	0,016	0,058	0,017	0,003	0,027
		0,64	0,45	1,21	0,87	0,024	1,19
71-112	0,324	0,032	0,019	0,171	0,017	0,016	0,55
		0,52	0,54	3,56	0,87	1,36	2,39
507							
0-10	0,116	0,059	0,019	0,015	0,015	0,003	0,002
		0,96	0,54	0,31	0,74	0,25	0,07
10-30	0,084	0,060	0,012	0,040	0,012	0,003	0,030
		0,98	0,35	0,83	0,62	0,25	1,29
30-51	0,088	0,057	0,011	0,005	0,010	0,003	0,019
		0,94	0,30	0,10	0,30	0,25	0,83
51-67	0,100	0,055	0,014	0,074	0,015	0,002	0,045
		0,90	0,40	1,54	0,74	0,13	0,97
67-82	0,048	0,050	0,005	0,046	0,012	0,004	0,022
		0,82	0,15	0,96	0,62	0,37	0,94
82-100	0,144	0,044	0,014	0,051	0,027	0,004	0,019
		0,72	0,40	1,06	1,36	0,37	0,82
100-123	0,388	0,039	0,009	0,235	0,085	0,018	none
		0,64	0,25	4,89	4,26	1,52	
123-155	0,820	0,037	0,016	0,425	0,190	0,033	“
		0,60	0,45	3,84	9,49	4,75	
155-175	1,232	0,034	0,009	0,777	0,250	0,073	“
		0,56	0,25	16,18	12,51	6,05	
175-200	1,076	0,034	0,011	0,726	0,188	0,181	0,130
		0,56	0,30	15,11	9,41	15,09	6,56

Note: **There was not CO_3 ion in the soils.**

Maize plant, having grown here is very dense and of large stature (3-4 *m* of height). Being very strong, the root system of plants developed up to the depth of subsoil waters (picture 5, a). That plant is directly fed from subsoil waters. As these waters are not salty (mineralization degree is 2,4 *g* in each *l*), they positively influence to growth of maize.

The amount of salts in grey-lawn soils under cotton plant is little and their composition is as in previous soil (table 3, cut 504). Though subsoil waters are located shallow (110 *cm*), they are not very saline (3-5 *g* in each *l*) and can’t influence negatively to growth of cotton. The root system of the plant, especially its mother-root developed up to the surface of subsoil waters. As the soil is necessarily damped, the root system of plant is very strong (picture 5, b).

Although in other cotton fields, subsoil waters are located relatively deeper, nevertheless, those waters make humid a big layer of soils up to 60-70 *cm* depth. These soils are not salty as well (table 3, cut 507).

Namely because of it, the root system of cotton could spread sufficiently depth (140-150 *cm*). (Picture 5, v). This state caused the plant’s being firm, developing well and giving high harvest.

Picture 5. Maize (a) and cotton (b, v) plants’ root systems, having placed in shallow subsoil waters.

None of these can be concerned to all irrigated soils of the Mil plain. Subjecting of soils to washing during irrigation is only for that condition, where the soils are used in the background of collector-drainage net.

Our investigations indicated that in the conditions without collector-drainage net, soils have completely other salt regime. Although, sometimes here is also observed the seasonal un-salinity of soils. However, this is not replaced by other regime in annual dynamics of salts. The process of salinity goes on in these soils because of annual regime of salts.

In one-meter upper layer of these soils, the amount of salts on dry remainder was 0,35% and on chlorine – 0,10% in spring 1961. In the same period of 1962, the amount of salts increased, containing 0,38% on dry remainder and 0,12% on chlorine. One more year after it, the amount of dry remainder reached 0,47% and chlorine – 0,14%. The increase of salts in the soil went on and was 0,51% on dry remainder and 0,16% on chlorine in summer 1964.

Changing character of salts, corresponding with the having said is observed in the second one-meter layer of the soil as well. Thus, it is openly seen from the figures that the soils without collector-drainage net are regularly subjected to salinity process, if they are used in irrigation cropping. The repeated salinity of soils here gets stronger and stronger yearly.

All of these indicate that the having described soils refer to salt regime with unchangeable seasonal one. Having got a salt regime with such character is explained by the rise of the level of subsoil waters and subjecting to surface evaporation. As previous irrigated lands, although the level of subsoil waters varies between 1,5-2,0 *m*, nevertheless, they influence greatly to salinity of lands. It is connected with that that the level of the mineralization degree of those waters is very high (15-20 *g* in each *l*). From other side, not having collector-drainage net in the territory, these waters can't be taken away of the area and are subjected to surface evaporation causing sharp salinity of the soils. Five-year dynamics of soils indicated that an average value of the DMT coefficient in these soils is 1,32.

Alluvial plain and rivers' bringing cones in the Mil plain cover great areas. The soils in these areas have specific salt regime. The level of subsoil waters locate in the depth very close to the surface. Nevertheless, the influence of these waters to salt regime of soils is different. In fact, as subsoil waters don't have natural flow in alluvial plain, the constantly influence the salinity of soils. Having got natural flow in the areas of rivers' bringing cones, these waters influence salt regime by other way. In order to show it, let's give some information from the analyses of our stationer investigations.

Stationer field characterizes the soils of a saucer-like big hollow area in alluvial plain of lower zone of the bringing cone of the Araz River. Having got approximately 1500 *ha* of area, this massif was used for cotton plant some 8-10 years ago. At present, the field is completely out of use because of severe salinity. The amount of salts in all profile of the soil is much. In this state, their maximum amount accumulated in the upper layer of the soil, being not very thick. Chloride and sulfate salts prevail here (picture 6). Although all of these prevent the increase of agricultural plats, nevertheless, they couldn't influence negatively to the development of wild plants, having spread here, in the contrary, speeding their development. The height of shovitsa alfalfa, having spread in the area, is 50-60 *cm*. The root system of the plant increased well too. The roots of this plant, having got thick mother-root, being vertical, could spread up to subsoil waters (see picture 6).

Picture 6. The root system of shovitsa alfalfa (1), damping (2) and salinity (3) profiles of the soil.

Broom, cane, sircan and other plants, having spread in the territory, have the same root system. The root system of those plants also increased up to subsoil waters.

Salts are very dynamic in these soils. in summer months, salts mainly accumulated in 0,8-1,0 *m* of upper layer. Towards autumn, in the result of atmospheric precipitations, these salts are subjected to definite washing and there is observed their gradual motion towards the upper layers of soils. This process gradually causes the equality of dirt of salts in the soil profile. Nevertheless, the upper layer of the soil, especially its 0-10 *cm* layer got very saline because of the amount of salts. Although salts are more than 3% in this layer, this amount varies among 2-3% in low layers.

Changing of salts in this way in the soil profile is observed annually. All these show that the amount of salts in the soils of the territory is very changeable. This in its turn influences greatly to the salt regime of the soil. Sharply changing of the soil's salt regime is especially typical for its 30 *cm* thick plough layer. Calculations indicated that if the DMT coefficient was 1,35 for 1962, then, this figure diminished to 0,34 in 1963 and increased to 5,37 in 1964-1965.

The same state is also defined for under-plough layer and averagely for one-meter layer of the soil. All these indicate that if from one side there was going the process of seasonal accumulation of salts, from other side, there were subjected to washing. Thus, it can be supposed that it is impossible to define the direction of salt regime of the soil. However, mathematical calculation of seasonal accumulation coefficient of salts gives a chance of elucidating of this direction. According to calculations, there was defined that average seasonal accumulation of salts here is more than unity, in fact, it composes 2,35 for dry remainder and 1,47 for chlorine in under-plough layer and in one-meter layer – correspondingly 1,42 and 1,09. At the same time, it is proved by mathematical calculation of the coefficient of yearly accumulation of salts (DIT). According to dry remainder, the DIT coefficient is 2.32 in plough-layer of the soil, in under-plough layer (30-70 *cm*) – 1,45 and in one-meter layer – 1,84. Thus, it becomes clear that there is going on regular process of accumulation of salts in the having described soils, i.e. these soils have seasonal-unchangeable salinity salt regime.

Salt regime of the soils of 513 and 514 stationer areas, characterizing of the middle zone of the bringing cone of the Araz River is very similar to the salt regime of the above-mentioned soils.

The salt regime of the upper zone of the bringing cone of the river can be characterized according to the results of investigations, carried out in stationer area 512. The depth of subsoil waters here is 110-120 *cm*. The amount of salts in the soil is not much. However, comparatively more salt was accumulated in the upper layers of the soil. There is sodium in the composition of the salts in all of the profile, but 20-*cm* upper layer. Although the amount of CO_3 ion composes 0,002-0,006%, but the amount of HCO_3 ion is 0,066-0,203%. In this state, the amount of HCO_3 in 20-*cm* upper layer is much more. The amount of sodium in the soil is much as well (picture 7). All these indicate that there is salinity and salty nature in the composition with sodium of those soils.

Thus, from the first sight it is defined that the soil condition of these lands is not suitable for the normal growth of plants. Nevertheless, connected with shallow location of subsoil waters, damping of the soil on proper level caused the development of a number of salt-stable, water-loving plants. Licorice, broom, wild rhubarb, alfalfa (shovitsa) etc. are among them. Together with these plants' above ground part's normal growth, their root system is also spread into the land very well. Main and side roots of these plants, being strong, developed up to the subsoil waters see picture 7).

Picture 7. Root system of shovitsa alfalfa (1), humidity (2) and salinity (3) profiles of the soil.

In many cases, accumulation of salts in the upper layers of the soil is typical for these lands. Nevertheless, although being gradual in the soil profile, salts are enough dynamic. Having accumulated much in 40-*cm* upper layer in summer 1962, they were replaced by washing to lower layers on all profile. Beginning since December, salts gradually accumulate not only in the upper layers, even in all profile. This process reached maximum in 60-80-*cm* upper layer of the soil in summer 1963.

With a small change, this regulation was repeated in 1964.

Another typical feature for these soils is having comparatively small and weak changeability of salts in lower layers of one-meter thickness (in the depth below 80 *cm*). Obviously, it is connected with gradually carrying away of those salts of the lower layers of soils in the direction of the flow of those waters because of the natural flow of subsoil waters in the territory.

Together with it, mathematical calculations of salt balance indicates that there exists seasonal-unchangeable salinity salt regime in the soils of the territory. It shows itself in the coefficients of DMT and DIT. According to dry remainder in plough layer the coefficient of DIT was 2,83 and on chlorine – 4,49. Correspondingly, this contains 2,32 and 5,66 in under-plough layer and in one-meter layer averagely 2,33 and 5,18. These indicate that the accumulation of salts in the having described lands is going on very intensively. In this state, chlorine, being very active and easily soluble in water, accumulates especially severely and very much.

Thus, it becomes clear from all having mentioned that the salt regime of the soils of the Mil plain is very different. If in one part of the territory, soils subjected to natural washing process, there is going on a natural accumulation of salts in other parts. This demands different attitude in the use of the soils of the territory. In fact, because of correct agro-technical use of soils, if the territory can be used under the agricultural plants and it is possible to get high harvest from them, then it is demanded to improve thoroughly the use of irrigation measures in the soils of other arrears.

MELIORATION IMPROVING OF THE SOILS OF THE MIL PLAIN

As we've mentioned, in order to irrigate the soils of the foothill zone of the Mil plain, there was built a big arterial canal in 1930. According to the information of S.A.Zakharov and L.L.Nozhin, the melioration character of the soils of this zone had been useful for cropping until the time of the canal building. In fact, if the use of irrigation could be carried out rightly, there could not occur repeated salinity on 50-*m* above the horizontal. There was advised that a collector-drainage net could be used in the areas, having located below that horizontal. Before using the lands of this area, having heavy mechanical composition and high salinity, there was intended to wash them and to free from salts. Nevertheless, those lands had been used without collector-drainage net. The canal, formerly named after Orjonikidze, caused of using of the foothill part of the Mil plain soils intensively during short of time. Cotton, grain and other agricultural plants gave high harvest in these lands. However, the productivity of plants began gradually diminishing in five-six years. There was felt some definite apathy in the growth of plants in some more years after it.

Seeds of plants, having planted after 1940, spoiled not giving sprouts. There can arise a question, how these lands, having been fertile and given high harvest, could fall down to such state during ten years' time? The answer of this question is not so difficult. This happened because of the influence of the intensive use of irrigation cropping without having of collector-drainage net in the soils of the territory and the rise of the level of subsoil waters in the result of irrigation. In addition, having been very saline the low layers of the soils, during the rise of the level of subsoil waters, the salts easily dissolved in those waters and rose to the surface of the earth, accumulating in the upper layers because of the influence of high evaporation.

This state became even worth up to 1946-1947 and caused destroy of the main part of irrigation soils. That's why, they urgently began the building of a collector-drainage net and the works of washing of soils. In the result of these measures, carried out since 1951, there was built a collector-drainage net with general length of 830 *km* in the foothill zone of the Mil plain and begun washing of soils from salts. This net serves to 30 thousand hectare soil area in the plain. Thus, averagely 20-25 collector-drainage net comes to each hectare soil field.

All of these created great changes in the soils of the foothill zone of the Mil plain. In order to bring to the light of all these changes, we have carried out a number of investigation works.

Let's give a short analysis of the changes, having happened in the soils of the territory as the results of our investigations and other works.

The level of subsoil waters and dynamics of mineralization degree

It becomes clear from the generalizing of perennial materials that there appeared great changes in the degree of mineralization and level of subsoil waters during the passed period of irrigation in the foothill zone of the Mil plain. If before the irrigation of the soils of the territory, i.e. in the years of 1926-1929, the level of subsoil waters hesitated between 9,8-13,4 *m*, then, in 15-20 years after the irrigation, i.e. in 1946-1949, the level of these waters rose sharply, averagely locating in 2,1 *m* of depth. Building of a drainage-collector net in the territory in 1951-1952 caused the fall of subsoil waters relatively down. Connected with it, the level of subsoil waters fell to 2,3-2,7 *m* of depth from the earth surface in 1953.

According to the map, having composed by us in the result of investigations, the level of subsoil waters deepened more up to the years of 1960-1963. According to that map, subsoil waters, having located in relatively shallow mainly cover the areas, surrounding water-distributing points. Moving away of water-distributing points, i.e. towards the center of the massif, the level of subsoil waters becomes deeper. In the areas of water-distributing points, subsoil waters locate deep. The analysis of the depth of subsoil waters in about 200 cuts, having dug in our investigation area indicated that the average depth of these waters is more than 3 *m*. This shows that the collector-drainage net, having built in the territory positively influenced the fall of the level of subsoil waters.

This state also influenced to the degree of mineralization of subsoil waters. On the grounds of the having composed map, in the canal surroundings area of the south of the territory, subsoil waters have very weak degree of mineralization. It is explained by the influence of sweet waters from the canal to the dirt of subsoil waters. The mineralization degree of subsoil waters sharply increases (up to 20-30 in each liter of water) in the middle part of irrigation massif. Together with it, the mineralization degree of subsoil waters sharply falls down in the area of the surroundings of the main collector – low part of the massif. The mineralization degree of subsoil waters here is mainly less than 10 *g* in each liter here. Sometimes it contains 5 *g* and even less in each liter. Weak mineralization of subsoil waters on this kind of degree is connected by the influence of the collector, running through this territory. The exactness of this thought once again shows itself in the analysis of the dynamics of the mineralization degree of subsoil waters. Here it is, if the maximal amount of the mineralization degree (15 *g* in each liter) was observed in the middle part of the massif in 1940, then, in the upper part of the territory this was 5,6 *g* in each liter and 11,3 *g* – in the low part. The mineralization degree of subsoil waters in the middle and low parts of the territory mainly contained the same amount (13,2-13,7 *g*).

Thus, if during the passed period the mineralization degree of subsoil waters fell down considerably, then, it increased very much in the low part. The mineralization degree of subsoil waters increased even more in the direction of inclination of the territory in 1953. In fact, if the mineralization degree of subsoil waters in the middle part of the territory diminished and contained 10 *g* in each liter, then, in the low part, increasing, it reached 17 *g*.

All these indicate the motion of mineralized subsoil waters in the direction of inclination and gradually going away of the massif.

This regulation, having defined in the mineralization degree of subsoil waters, at the same time shows itself in the results of our recent investigations.

The mineralization degree of subsoil waters in the upper part of the territory in 1964 averagely was 3,3 *g* in each liter, which is two times less according to the information of 1953. Diminishing of mineralization degree of subsoil waters shows itself more openly in the low part of the territory. The present mineralization degree of subsoil waters composes 8,4 *g* in each liter of water (table 4), i.e. diminished approximately more than half during the recent 10 years.

The dynamics of saline lands

In order to make clear the results of influence of the melioration measures, carried out in the Mil plain, there were put into practice investigation works, sharply differing from each other two fields (having more than 6 thousand *ha* of general area) in the region of previous irrigation system named after Orjenikidze.

Up to the time of building of a collector-drainage net in the Mil plain, A.S.Preobrazhenski (1951) had composed the map of distribution of salts on the massif in the soils of the territory. According to this map, the soils of the investigation area had got saline up to the period of building of the drainage-collector net, i.e. had got very saline until 1951. The average amount of salts in one-meter layer of the soil composes 1-2% in the area of the main collector. The amount of salts is more a little in some fields. Soils are averagely saline in many parts of the territory. Spreading of soils in the forms of separate spots and weakly saline soils are typical for these fields. There are severely and averagely saline soils in the forms of separate spots here as well.

Table 4

The depth and mineralization degree of subsoil waters in the soils, having used in the background of the collector-drainage of the Mil plain
(*gram m/equiv. in 1 liter water*)

The upper part of the massif

The middle part of the massif

The low part of the massif

Thus, it becomes clear that there had not been un-saline soils in the characterized massif up to the period of beginning of melioration works. Towards the north from the south of the territory, i.e. towards the low part of the territory from the high part, the amount of salts increases in the soils. It is connected with the presence of the flow of subsoil waters in that direction.

Repeated mapping works, indicating define the degree of salinity of salts after building of the collector-drainage net in the territory, were carried out by the Azerbaijan Melioration and Water Economy Ministry.

It becomes clear from the comparative analysis of these materials that there occurred great changes in the degree of salinity of the soils of having characterized territory since the time after 1951. The comparison of information of 1951 and 1954-1955 of the Azerbaijan Melioration and Water Economy ministry on repeated mapping shows that the soils got considerably un-saline during five years. Relatively high salinity remained in the middle part of the territory. It is typical that in all cases free from salts lands have spread in drainage, water-accumulating and arterial canal surrounding areas. It indicates the positive influence of those fields to getting un-saline of soils. However, in some cases there are observed highly saline soils as separate spots in the areas of drainage and irrigation canal surrounding places. It indicates that one can’t be satisfied only by building of collector-drainage nets when freeing having got saline soils and improving them. No doubt, that, collector-drainage nets are important in improving of soils, but they can’t secure fundamental melioration of soils in private. Together with the building of a collector-drainage net, there must be carried out the complex of melioration measures jointly. Saying *complex melioration measures*, we consider the smoothing of lands fundamentally where the soils would be normalized, the use of them under assimilating and agricultural plants, carrying out of correct irrigation regulations and high civilized cropping. In this case, the washing of soils according to having defined norms is considered one of the decisive measures. Here, when comparing of the results of the works of repeated mapping, carried out after the washing of soils in the area of 213 *ha* of the territory in 1958 with the information of 1955, it becomes clear that the soils here got completely free of salts and became useful for agricultural plants. Weakly saline soils remained here only in very little area, which are considered practically useful for agricultural plants.

From the results of our investigations, carried out by us in the years of 1960 and 1963, it becomes clear that there went on the freeing of soil from salts in the characterized area (table 5). During the period passed since 1951, in the 6th field of the massif, where we carried out our investigation, the soils had considerably freed from salts. In this case, the soils in the upper part of the massif, located in inter-canals area mainly became free of salts. The amount of salts is less than 0,1% in one-meter layer of the soil here.

Sharply increase of soils, having got free of salts and diminishing of soils, being severely saline occurred in other areas of the territory of investigations.

Table 5

The dynamics of saline fields in the region of irrigation system named after Orjonikidze in the Mil plain (by %/*ha*)

From the information of repeated mapping of salts, having carried by us in 1963 is seen that the soils in the upper part of the 5th field have been complete un-saline. Here is also observed the increase of the amount of salts in the direction towards the lower part of the territory. Nevertheless, the difference of amount of salts is met in this direction as well.

It can be said that, there don't remain salty and severely saline soils in the investigated fields at present. Such soils compose only 5% of general area.

Thus, it comes forth from the having mentioned that during the period after the building of the collector-drainage net, the soils of the territory became considerably free of salts and soils, fit for growth of agricultural plants increased very much. At present, useful for the growth of agricultural plants soils contain 70% of general territory. Having got salinity soil area fell down to 30% from 1951's 74%.

If an average amount of salts on the massif of the territory contained 0,95% in 1951, then, later on this amount diminished more than two times (see table 6).

During the period since 1951 up to 1963, the salt stock of soils in the investigated 6120 *ha* of area fell from 820 thousand tons down to 348 thousand tons, i.e. 472 thousand tons of salt removed away from the territory. In this case, the soils of the 6th field of the massif subjected more un-salinity. Although the influence of melioration measures was relatively little (since 1951 until 1960), nevertheless, general amount of washed salts (300 thousand tons) was more than in the 5th field (173 thousand tons) – during longer melioration period (since 1961 up to 1963) (Table 6).

Table 6

The dynamics of salts of the soils in the region of irrigation system named after Orjonikidze in the Mil plain

Melioration improving of soils more clearly indicates itself in amount of chlorine. According to this indicator, two-thirds of the territory had become un-saline in the mentioned soils. Amount of chlorine here varies between 0,.004-0,009% here. This amount reaches 0,012-0,017% very rarely.

It is seen from the described map that being un-saline because of chlorine soils spread in the upper and middle parts of the territory, in the 5th area of the investigated massif. Saline lands cover the low part of the area. The soils, in the composition of which there is S1 less than 0,02% in the 6th field, spread both in the upper and low parts. Amount of chlorine in the soils of the middle part of the area is relatively more. This regulation indicates the motion of salts, especially their easily soluble in water kinds from the upper part of the territory

towards to low part of the massif. This shows the existence of the flow of subsoil waters in that direction and taking the salts of the territory, they cause un-salinity of lands.
It comes forth from the description of salts in the second-meter layer of the soil that the amount of salts in this layer is more than in one-meter layer of the soil. Majority part of the massif's being saline is typical for this layer of the soil. There are severely saline soils in the form of separate spots here as well.
Not having a map, characterizing salinity of soils for previous times in the deep layers of the soil, we'll compare the degree of salinity the soils of separate areas according to the information of our map on different times.
In different times L.L.Nozhin, A.S.Preobrajensky and V.S.Muratova carried out analyses of salts, making deep soil cuts and digging wells in the massif of our investigations. These cuts and wells were made in 8 and 9h irrigation canals on the 5th field and in the 1-1, 3-4, 6-7th inter-irrigation canals on the 6th field.
Average amount of salts in the 1st meter of soils was 0,71% and in the 2nd meter – 2,04% in the 5th field of the massif in 1929 (L.L.Nozhin's information). The amount of salts in the 3 and 4 meters layers was relatively more and in the layers under that – very little. Investigations, carried out by V.S.Muratova in 1953 indicated that there had been great changes in salinity of this area during the passed time. There was defined that although there was not a change of the general stock of salts in the upper four-meter layer, nevertheless, they, i.e. salts had accumulated to the first-meter layer from 2-4 meters layers. 0,7% of amount of salts in this layer in 1929 reached 1,9% in 1953. Not depending on micro-relief condition of the territory, in all cases this layer of the soil got highly saline. In fact, the soils were observed in the same micro-height with much amount of salts (32nd well), in micro-plates (34th well), in micro—hollows (27th well) and in the even part of the territory.
However, majority of salts in deep hollows (29th well) accumulated in the second-meter layer of the soils (see table 6). Investigations, having carried by us approximately 10 years later indicated completely other result. It became clear that the role of micro-relief is very big in the distribution of salts on the territory. In this case, maximum amount of salts (nearly 2%) accumulated in the upper layer of the soil, especially in its one-meter layer in the soils of micro-height (529th cut) and minimum (0,15%) – in hollow soils (532nd cut). The soils of even fields (528, 530 and 531st cuts) got averagely saline, having equal salt stock (table 7). Nevertheless, there was observed considerably diminishing of the amount of salts in these soils. There was noticed the washing of the amount of salts in one-meter layer of the soil in 1953 more than two times in 1963 and relatively less washing in the second-meter layer. Amount of chlorine diminished for 3,5 times in one-meter layer and about 2 times in the second-meter layer during ten years. Such kinds of changes were observed in the soils of the 6th field of the massif as well. The only difference was only in that the soils of the 6th field were washed more severely than the soils of the 5th field. So, on dry remainder the amount of salts in the first and second-meter layers up to the year of 1960 diminished more than 2-4 times and on chlorine – even more than those figures. Differing from the information of 1953, maximum amount of salts in the soils of this field is not in the first meter layer, but accumulated in the second meter layer, which indicates intensive washing of the soils of this field during 10 years.

Table 7

Salinity regime of the soils, having used in the conditions of the collector-drainage net of the Mil plain
(dry remainder, chlorine by %)

Intensive washing of soils in this scale is explained that the soils of the massif were being used in irrigation cropping very intensively during the last 10 years. The accumulation of salts in the first one-meter layer is connected with not using of those lands in irrigation cropping. Such kinds of parts of the territory played the role of "dry drainage" for the irrigated surrounding fields and caused the accumulation of salts in them.
Thus, it becomes clear that the role of smoothing of fields is great in the melioration and irrigation of soils. Nevertheless, not in all states there is paid attention to the carrying out of this important measure.
Although special roads had built along all drainage and irrigation canals, nevertheless, irrigation regulations are roughly disordered in the territory. In fact, because of surplus water lost, it is impossible to pass to a field by machinery in vegetation period. In many cases, irrigation waters are floated to drainage and water-accumulating places. Drainages are not kept in good condition. They are completely under canes, other water-

liking plants and silt and even roads run on the drainages. This state laid obstacles to the flow of saline waters and to improvement of melioration of soils.

Nevertheless, the collector-drainage net, existing in the territory and melioration measures, having carried out in the territory caused the normalization of the having described area and thus, the sharp increase of cropping fields, being useful for agricultural plants.

For the effective influence of melioration measures, the main condition is to keep the collector-drainage net in necessary level, their periodical cleaning and to finish the incomplete buildings. Making the fields smooth thoroughly, washing of saline lands, their use under relatively solid to salts agricultural plants after the washing is one of the main conditions. One must not forget correct carrying out of irrigation and agro-technical rules as well. All of these are the most handful factors for improving of the soils of the Mil plain rapidly, increase of cropping fields and productivity of agricultural plants.