A.3. Soils of the Aral sea basin, their peculiarities and classification

A.3.1. Soils classification, peculiarities and location

The base for soil classification in Central Asia is "Soil classification and diagnosis in USSR" based on genetic principles. Soil is considered as natural-historic body created in result of simultaneous action of 5 factors: time, bedrock, climate, vegetation, antrpogenic impact.

In accordance with such approach soil units change subordinates to belt, latitudinal and vertical zoning which is reflected in peculiarities of soil-forming process of the region. Phenologists use common systems of taxons or levels while classificating soils. There are: soil-climatic belt-soil type- sub-type- genre-kind - veriety-class-sub-class.

On soil map of 1:1000000 contours of types and sub-types are distinguished.

Soil type-big group of soils developing under similar biological, climatic, hydrogeological conditions and characterized by bright manifestation of the main process of soil formation. Soil type - this is basic unit of soil systematization (light grey soils, typical grey soils, dark grey soils, brown, carbonate, brown leached, etc.).

In spite of general principles of classification certain objective and subjective reasons bring difference in soil classification in republics. For example, subjective distinguishing of different soil types.

Climate, vegetation and relief in Kyrgyzstan predetermine formation of chestnut and mountain-chestnut soils which are not met in other republics. within grey soils zone sub-types of light, typical (ordinary) grey soils are distinguished. But in Tadjikistan and Kyrgyzstan they have different indices:

in Kyrgyzstan C_1, C_2, C_3 and Tadjikistan C_e, C_1, C_t. Biggest misunderstanding is caused by high-mountain soil diagnosis. High-mountain, desert, steppe and meadow-steppe soil are distinguished by pedologists of Kyrgyzstan as high mountain -half-peat, in Uzbekistan -as light-brown and meadow-steppe soils.

Genetic soil classification, as described above, considers soils as natural-historical body and integrates them on base of similarity and differences independent from possible utilization by people. However, as in this classification all set of soil properties is taken into account, it has high possibility of interpretation and practical use, that is its advantage against other soil-evaluation researches in different countries which have no immediate links between any groups of soils and their general classification based on genetic principles.

Natural peculiarites (climatic, lithological-geomorphological, hydrogeological define soils of the region and their distribution.

Planes are covered by desert soils of sub-boreal and sub-tropic belts; pre-mountain-mountain desert-steppe soils and sub-tropic desert-semi-savannah. In the mountains soil is characterized by vertical zoning with transition from semi-desert soils to meadow-steppe and mountain meadow and mountains (table A.3.1, fig.A.3.1)

Table A.3.1

Major soil types of Central Asia
(Central Asia, 1968)

Soil type and index	Area (including irrigated m/m ha					
	Uzbekistan	Kyrgyzstan	Tadjikistan	Turkmenistan	Total	%
	Planes					
Meadow, marshy-meadow and flood plane	1.6	-	-	0.9	2.5	3.5

Soil type and index	Area (including irrigated m/m ha					
	Uzbekistan	Kyrgyzstan	Tadjikistan	Turkmenistan	Total	%
Takir type and takir	2.8	-	-	5.4	8.2	12
Grey-broun	11.0	0.2	-	8.5	19.7	27
Sandy-desert	13.3	-	-	24.3	37.6	52
Salts and shors	1.5	-	0.1	2.4	4.0	5.5
Total	**30.3**	**0.2**	**0.1**	**41.5**	**72.0**	**100**
	Pre-mountain planes and hillsides					
Grey soils	4.8	2.1	1,6	5,0	13.5	89.4
meadow, meadow-marshy, flood planes	1.1	0.3	0.2	-	1.6	10.6
Total	**5.9**	**2.4**	**1.8**	**5.0**	**15.1**	**100**
	Mountains					
Mountain grey soils	2.7	0.9	1.2	0.6	5.4	17.0
Mountain chestnut	-	2.5	-	-	2.5	8.0
Mountain black soils	-	0.9	-	-	0.9	2.8
Mountain-forest	1.8	2.0	2.0	0.3	6.1	18.9
Mountain meadow	-	2.7	2.5	-	5.2	15.9
Mountain-meadow-steppe	0.8	5.1	-	-	5.9	18.5
High mountain	-	1.0	5.4	-	6.1	18.9
Total	**5.3**	**15.1**	**11.1**	**0.9**	**32.4**	**100**
Total for region	**41.5**	**17.7**	**13.0**	**47.4**	**119.5**	**100**

Note: Hyphen means information absence

Soil of planes

Within sub-boreal and sub-tropic desert of Turan plateau similar genetic types of soils are formed: arid grey-brown, takir-type and takir, sandy desert as well hydromorphous verities of desert soils, salts and alluvial flood planes soils. Sandy-desert soils cover about 52 %, grey-broun-27 % of area.

Takir soils cover 12 %, meadow soils, meadow-marshy and flood planes cover about 10 %. Automorphous soils cover totally near 80 % of the territory.

Soils of pre-mountain planes and foothills

Soils are formed according to vertical zoning. Altitudinal location of soils is presented in table A.3.2.

Lower part of proluvial-alluvial of sub-tropic belt is cover by light grey soils transferting to typical and dark grey soils. Grey soils of pre-mountain planes have high peculiarity differing from soils of desert morphologically, chemically and by fertility. Automorphous soils prevale in grey soil zone as well as in desert.

Hydromorphous soils-grey-meadow, meadow of different salinity and salts are in less amount (table A.3.2). They are formed mainly in zone of ground water seepage.

Pre-mountain planes create contact zone between planes and mountains.

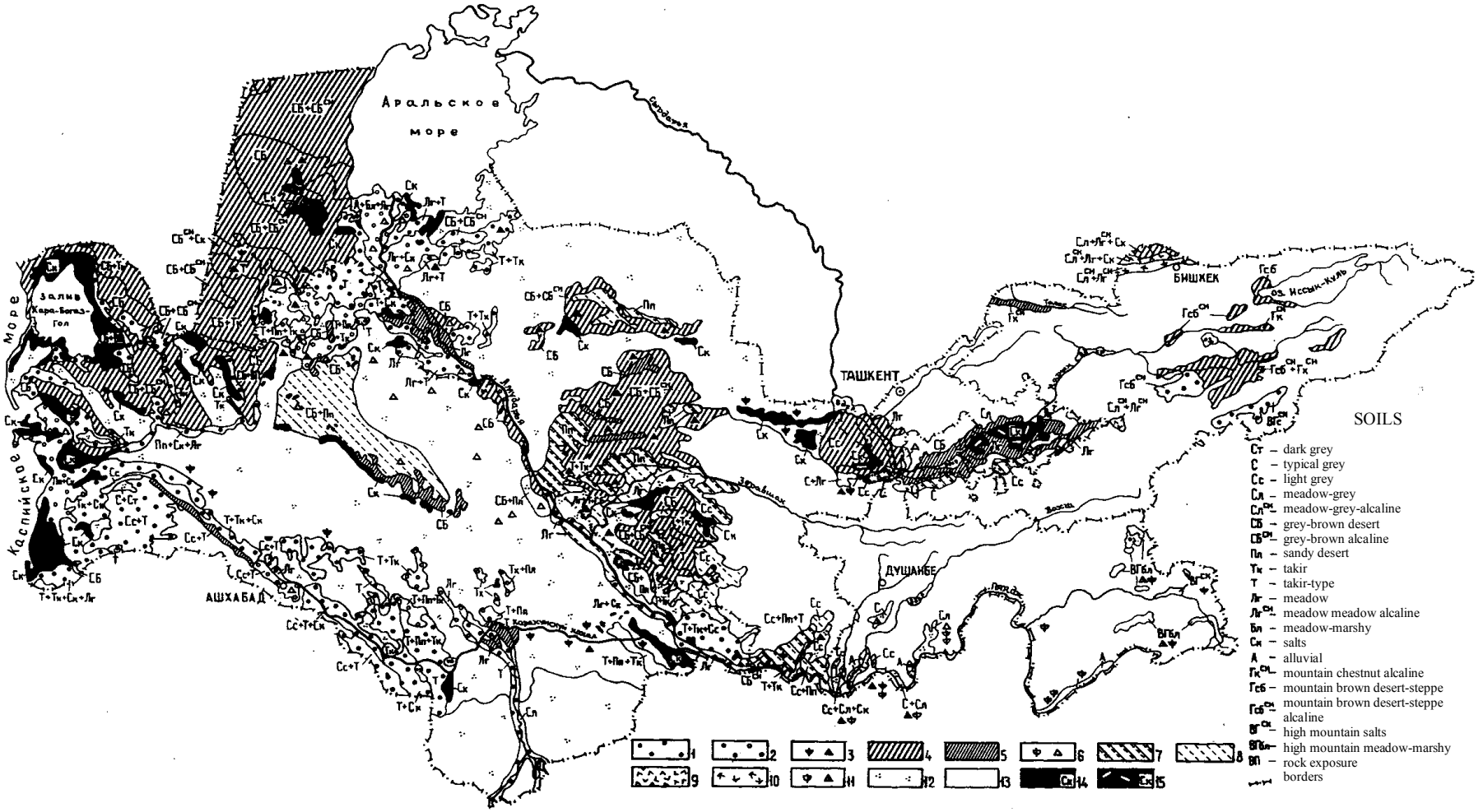

Fig. A.3.1. Soil salinity map for central Asia (band on the map of soil chemical salinization in USSR, 1976).

Soils salinized mostly by chloride. Salinization within layer 0-100 cm the area: 1->50 %; 2-50-20 %; 3-<20 %. *Soils salinized mostly by sulfate.* Salinization within layer 0-1cm on the area: 4-> 5- %; 5-50-20 %; 6-<20 %. Salinization within the layer 100-200 cm on the area: 7->50 %; 8-<50 %. *Soils salinized mostly by soda* (or with participation of soda). Salinization within the layer 0-100 cm on the area: 9->50 %, 10-50-20 %; 11-<20 %. Additional explanations: 12 - potentially salinized; 13 - non-saline; 14 - salt chloride; 15 - salt sulfate.

Table A.3.2.

Altitudinal location of major types of soils in Uzbekistan (Uzgiprozem data)

Soils	Altitude above sea level, m
Planes	
Grey-brown	150-250
Desert, steppe	120-150
Takir type and takir	120-180
Meadow-takir	120-150
Meadow and meadow-marshy	80-100
Salts	80-100
Unfixed sands	120-150
Pre-mountain and mountain zone	
Light grey soils	250-500
Typical grey soils	500-750
Dark grey soils	750-1200
Brown	1200-2800
Light brown high-mountain	2800-3500
Meadow-grey soils	250-500
Meadow, marshy-meadow	250-500

Soils of middle mountain (1200-1500 up to 2000 m) are covered by meadow-steppe and forests. They are brown (typical and leached), mountain black soils, dark forest soils. High mountain are covered by meadow, mountain-meadow and mountain steppe soils.

Two types of landscape are distinguished within Turan planes: ancient salinization and modern salt accumulation. First soils prevale in the region, the second occupy only 10 % of area. The first soils are automorphous, the second hydromorphous (fig.A.3.2)

A.3.2. Natural salinization of the basin soils

a) Automorphous soils salinization

In desert grey-brown sandy desert and takir type soils are located. All of them are characterized by sad absence, porous, low humus (0,3-1,0 %), low absorption ability (6-10 mg/ekv/100 g soil), high carbonate content and salt horizons availability at different depth depending on hydro-thermic regime, hydrogeological and geochemical conditions.

Grey-brown arid soils are underlain by pebble, eluvium of compacted rocks, sometime by sandy-loam sediments. These soils contain certain amount of water-soluble salts and gypsum. Gypsum content can very from 0,1-0,3 up to 40-70 % in gypsum bearing horizon. Water- soluble salts are chloride-sulfate due to high gypsum content.

Second genetic type of desert soils-takir type soils within which crust (2-6 sm), fluky brown horizon (20-30 cm) and fluky sediments with humus and salt interlayers are distinguished. Soils are carbonate, gypsum content is low (1-2 %). Soil salinization is ancient with high content of chlorine and low content of gypsum.

Desert sandy soils are formed on ancient alluvial planes of Kzylkum and Karakum on littoral plane (subaeral delta). These soils mainly are non-saline or slightly saline within the upper 1 m layer, that is caused by soil leaching by precipitation. On depth of 1,5-3,1 m these soils are underlain frequently by salt sediments of strata and, thus, there is danger even for sandy-desert soils to be salinized. Salinization is chloride, sometimes with gypsum.

Typical salt profiles on irrigated lands of Central Asia (20-25 m depth)		Salt conservation and distribution with depth			Ground-water salinity, g/l	Typical lithology	
major types	sub-types	0-1м	0-3м	0-20м		zone of active water and salt exchange (up to 100 m);	20 m upper thickness
1	2	3	4	5	6	7	8
I тип		0.1-0.3 30-60	0.1-0.3 100-250	0.1-0.3 150-600	до 2.0		
II тип		1.5-3.5 150-450 до 16 600-750	1.1-3.0 до 550 16-0.3 700-750	3.5-0.3 550-1500 16-0.1 1750	5-14 и более 50-100		
III тип		0.1-0.3 30-150 1.5-2.0 450-600	0.1-2.0 300-1600 1.5-2.5 до 1100	1.1-0.3 до 2000 1.5-0.1 2500	5-20 5-10 и более		
IV тип		0.8-1.5 350-500	0.8-2.0 600-700	0.8-1.1 1500	2.5-7.0 в понижениях > 10		
V тип		0.1-0.2 30-50	0.1-1.5 90-150	0.1-1.8 3000	15-35		
VI тип		2.5-2.0 500 3.5-1.0 450	2.5-2.0 1150 1-2.2 950	1 2500-4000 1-2.1 5000	10-15 и до 40 40-60 и более		

Dr. 2.19. Types of salt profiles on irrigated lands of Central Asia.

Automorphous soils of pre-mountain planes of Central Asia are characterized by grey soil-prevalence. They border mountain massive at the altitude of 250-1200 m (table A.3.2). Soil is made of loess loam and loess-strongly silt, porous micro-aggregated carbonate sediments. They are frequently saline and gypsum bearing. Grey soils are formated under grass vegetation with participation of ephemers.

In difference of automorphous desert soils grey soils have clearly distincted humus profile with humus content 1-1,5 % in light soils, 1,5-2 % in ordinary soils and 3-4 % in lower sub-types. Gypsum and salt horizons in light grey soils are in the lower part of layer 0-100 cm, in ordinary soils - within the layer 100-200 cm, within the dark soils on depth of 2-3 m i.e. in soil-forming rocks.

Usually sulfate-sodium salt and gypsum are available in grey soils. Salt content is low (1-2 %). Gypsum strata can contain up to 20 % gypsum, but this is ancient gypsum bound with hydromorphous stage of soil formation

Thus, major types of automorphous soils of desert and semi-desert are salinized at different degree or are potentially dangerous for salinization. Their salinity is mainly links with ancient soil-forming rocks salinization.

b) Semi-automorphous soils salinization

In natural conditions semi-automorphous type of soil-formation could be distinguished which occupies intermediate position between automorhousand hydromorphous type. Semi-automorphous soils are located on pre-mountain planes of lacated on pre-mountain planes of sub-boreal and sub-tropic semi-deserts. Light grey soils are located on ancient alluvial planes (Golodnaya steppe), pre-mountain planes and low mountains. They are salinized by water - soluble salts. Ordinary (typical) grey soils are located in upper parts of pre-mountain planes and foothills. They are distinguished by dark humus horizon and deeper position of salt and gypsum horizons; salinized typical grey soils under automorhousconditions are met seldom.

Dark grey soils are close to typical ones but are distinguished by higher humus conditions (up to 4,5 %), higher thickness of humus horizon (60-120 cm) and deep (2-3 m) gypsum horizons.

Under semi-automorphous conditions main salt stock is concentrated above ground water level. Depending on ground water level and salinity salt amount could be 1,0-1,5 %; chemical composition -from sulfate to chloride.

All grey soils are widely used in agriculture. Their irrigation offers secondary salinization (Golodnaya steppe, etc.). Under irrigation these soils relatively fast are transformed into semi-hydromorphous conditions and, thus, danger of salinization is high.

c) Hydromorphous soils of Turan plateou salinization

These soils occupy less area to compare with automorhous ones cover only near 7 % of area (excluding irrigated lands). Hydromorphous soils are foemed in river valleys and deltas on pre-mountain planes, in depressions and on littoral zones under shallow ground water or surface water inflow. Among hydromorphous soils of Central Asia meadow soils of different degree of salinity, salts, desert-meadow and grey-meadow soils are distinguished as well as alluvial soils of flood planes and deltas.

Easily soluble salt in hydromorphous soils are accumulated under ground water evaporation and their composition is determined by composition of ground water.

Lithology and hydrogeological conditions diversity, irregularity of surface water inflow predetermine soil salinization motley. Salt accumulation is one of main natural processes for low alluvial and deluvial-alluvial planes under hydromorphous water regime.

Peculiarity of salt accumulation is typical for hydromorphous soils of pre-mountain planes connected with ground water seepage zone. These soils are called saz soils. They are constantly fed by ground water, leaching by high flow is not applied

Saz soils are located on pre-mountain planes of grey soil zone.

Under ground water seepage within the cones of withdrawal and between cones saline soils of sulfate-sodium type are formed.

Often these soils contain high concentration of gypsum (southen zone of Hungry steppe).

The least drained areas of saz zone-depressions are covered by strongly saline chloride sometimes sulfate type soil.

Gypsum bearing is another peculiarity of these soils, sometimes gypsum strata is located along all profile.

Regions of alkaline salt accumulation are located within southern valleys of Tadjikistan and northern regions of Kyrgyzstan. These soils share in Sentral Asia is low.

Saz meadow-grey-brown soils as well as saz meadow-grey often are characterized by high gypsum content. Salinity type is sulfate or chloride. Amount of salt usually equal to 1 % on depth of 20-30 cm.

Hydromorphous soils of depressions and bowls have limited location but play important role in regional salt accumulation processes. Depressions could be located in different lithological geomorphological regions: low planes and high plateau, lake bowls, other depressions.

Salt prevail among soils of "alive" depressions. They are formed under conditions of hot arid climate and absence of outflow. In desert zone in upper salt horizon 5-10 cm 15-30 % of water soluble salts can be contained.

Maximum ground water salinity is 200-250 g/l and in salt lakes-450 g/l. Ground water feeding salts have salinity 20-30 g/l. Maximum salt content is within upper horizons but their high content is fixed along all profile up to groundwater table. Salts can be sulfate as well as chloride.

A.3.3. General regularities of salt accumulation within upper thickness of quaternary deposits and its distribution.

This question is important from the point of view of soil secondary salinization under irrigation, new land development and cropping pattern. Selection of reclamation measures, irrigation regions and technique, drainage design, soil leaching, reclamation period, predetermining expediency of these lands development. By SANIIRI investigations in 1965-1980 was found, that geomorphological peculiarities (pre-mountain, river valleys, alluvial planes, comes of withdrawal, depressions, river deltas and terraces) in combination with the conditions of ground water formation, thermic soil regions, balance of surface and ground water predetermine differences in soil salt stock and profile.

There are 6 types of salt profile to depth of 20-30 m which determine intensity of drainage salt outflow under land irrigation and reclamation (fig.A.3.2)

I type. Non-saline profile on all depth of quanternary sediments. This type of profile is typical for upper part of cones of withdrawal, mountain and pre-mountain planes, upper and

middle river terraces. Fine-grain deposits with intekness up to 1,0 m undrelain by gravel-pebble deposits. This is zone of transit with deep water table. There is intensive water exchange between surface and ground water due to intensive water infiltration from canals and irrigated lands. Salt exchange is absent.

II type. Strong salinization of upper (up to 2-25,5 m) soil layer beneath with soil is non-saline. In Khorezm oasis, Zerafshan valley, Kzylkum massif only 1 m layer is salinized. This type of superficial salt accumulation is often met in lower river terraces, cones of withdrawal inter-mountain planes, alluvial deltas with fine-grained deposits with thickness of 3-2 m underlaid by sandy-gravel sediments. Territory is weakly drainable with shallow ground water (3-5 m).

Ground water are mostly artesian (Central Fergana, old zone of Golodnaya steppe) or sub-artesian (Khorezm oasis, Tashaus province). Non-artesian aquifers (Zerafshan oasis-middle reaches of Zerafshan river, north and south zones of Karakalpakstan, Kzylkum and Toguz-Chiili massif, etc.

In these regions ground water table is 1,5-2,5 m, salinity is 3-5 g/l (on irrigated lauds) and 40-50 g/l on non-irrigated lands. Deep ground water salinity is low (1,5-3,0 g/l). In Khorezm oasis ground water salinity up to depth 25-30 m is low (3-4 g/l), downword it increases up to 15 g/l.

Salt profile second type belongs to the regions with high category of water exchange. Water exchange between unsaturated zone and ground water is defined by water supply volume losses from irrigation canals. Drainage outflow is formed at expense of ground water overflow and head. Intensity of salt exchange and drainage outflow depends on salt content within top fine-grained deposits and overflow volume from unsaturated and top fine-grained deposits

III type. Non-saline profile of limited depth (up to 1-1,5 m) with sharp increase of salt content up to 5-8 m and then its decrease in lower layers-deeply salty soils. This salt profile is typical for deluvial-alluvial planes, inter-cone depressions, proluvial alluvial planes before irrigation. Salt stock within 1 m layer is lower than permitted and varies within 30-150 t/ha, within 3 m layer up to 1600 t/ha and within 20 m layer up to 2000 t/ha. Lithology is represented by one-layer made of low permeable sediments with sand inter-layer

Region of III profile is weakly drained or non-drained. Ground water table is 5-10 m, salinity is 10-15 up to 25-40 g/l, under irrigation secondary salinization occures mainly due to saline ground water level rise. As example could be Golodnaya steppe, Fergana valley, Djizak-Lomakino trains. These regions are main provider of salt outflow under irrigation.

IV type. High salt content within upper layers with increment to the depth of 12-15 m. Salt stock within 1 m layer is 350-550 t/ha, within 3 m layer 600-700 t/ha, within 20 m layer-up to 1500 t/ha. This type of salt profile is formed usually in tail part of cones of removal, deposits of SyrDarya and AmyDarya river delta. One-layer of fine-grained sediment with sand interlayers is typical for geological cross-section. Region is not drainable, ground water level is 2-3 m and salinity is 10-15 up to 50 g/l. Soils are semi-hydromorphous and semi-automorhous

V type. Non-saline from surface to depth 1,5-2,0 m with gradual increment of salt content downward, Salt stock along the profile up to depth of 20 m within 1 m layer is 30-50 t/ha, 3 m layer-90-150 t/ha, within 20 m layer-3000 t/ha. This type of profile is typical for irrigated massives in central and peripheric parts of alluvial planes and inter-mountain depressions (Golodnaya steppe), inter-channel sediments in river deltas (Karakalpakstan). One-layer and two-layer quaternary deposits prevail in this profile. Region is not drained. Before irriga-

tion ground water table was 5-10 m, salinity-5-15 g/l. Under irrigation saline ground water level rise and secondary salinization take place.

VI type. Proportionally high salt contents in all layers: salt stock within 1 m layer is 500 t/ha, 0-3 m-1150 t/ha, 0-20-4000 t/ha. This type of profile is typical for peripheric parts of cones of withdrawal, inter-cone depressions, large bowls within inter-mountain depressions of Fergana valley, south-east- and south-west parts of Golodnaya steppe, central parts of Sardoba-Karakaray depression in Golodnaya steppe, lake deposits in northern part of Karakalpakstan. Geological cross-section is constituted by one-layer and two-layer complex. Territory is practically without outflow. Ground water is shallow (up to 3 m), its salinity is 10-70 g/l.

From 6 profiles II type is the easiest one with minimum salt stock, which is mainly located within 0-1, 0-2,5 m, downward salt content is negligible.

III, IV, V, VI types of profile with huge salt stock are the main sources of salt provision and salt flow formation.

Among saline soils are distinguished:

saline (maximum salt content within 0-100 cm layer), deeply saline (salt are in underlaying layers or ground water). The first group is divided into: superficially saline (salt are within 0-50 cm layer) and average-profile saline (50-100 cm). Soil salinity was described quantitatively according to water abstracts (1:5) analysis (table A.3.3).

As to degree of salinity the soils are divided into 5 categories: non-saline, slightly saline, medium saline, strongly saline, very strongly saline. As to chemical composition the soils are with neutral salts (chloride and sulfate) and with alkaline salts, mainly soda.

Areas of saline soils in Central Asia, presented in table A.3.4, relate to lands of meliorative fund, i.e. lands which are being reclaimed at present time and could be used in prospective.

Lands with hard soil-meliorative indicators, strongly saline (shor) and lands with shallow neogenic (or paleogenic) impermeable layer, desagregated stony soils requiring earth work (more than 500 m^3/ha); soils with very low permeability (except rice check soils).

Lands with gradients more than 0,2 and non-fixed and slightly fixed sands are not included in meliorative fund.

Meliorative fund of the republics of Central Asia (Soyuzvodproekt, 1988) is about 28 mln ha. Irrigated area in Uzbekistan constitutes 39 % of this fund, in Turkmenistan -11 %; in Kyrgyzstan and Tadjikistan about 31 %. During last desades area of irrigated lands incresed on about 1-2 %.

Table A.3.3.

Soil classification on salinization degree and dependence of salt chemical composition (above line-sum of salts, under line-toxic salt, * %).

Soil salinization degree	Salt chemical composition (ratio of ions, mg-ekv/100 g of soil)					
	Neutral salinization (pH < 8.5)			Alkali salinization (pH > 8.5)		
	Chloride, sulfate-chloride $Cl:SO_4$ >1	Chloride-sulfate $Cl:SO_4$ =1-0.2	Sulfate $Cl:SO_4$ < 0.2	Chloride-soda**** and soda chloride $Cl:SO_4$ >1 HCO_3 > Ca+Mg HCO_3 > Cl	Sulfate- soda and soda- sulfate $Cl:SO_4$ < 1 HCO_3 > Ca+Mg HCO_3 > Cl	sulfate-chloride-carbonate HCO_3 > Cl HCO_3 SO_4 HCO_3< Ca+Mg
Threshold of foxi city (non-saline soils)	< 0.1 < 0.05	< 0.2 < 0.1	< 0.3(1.0)*** < 0.15	< 0.1 < 0.1	< 0.15 < 0.15	< 0.2 < 0.15
Slight	0.1 – 0.2 0.05-0.12	0.2 – 0.4(0.6)*** 0.1-0.25	0.3(1.0)-0.6(1.2)*** 0.15-0.3	0.1-0.2 0.1-0.15	0.15-0.25 0.15-0.25	0.2-0.4 0.15-0.3
Medium	0.2-0.4 0.12-0.35	0.4(0.6) – 0.6(0.9)*** 0.25-0.5	0.6(1.2)-0.8(1.5)*** 0.3-0.6	0.2-0.3 0.15-0.3	0.25-0.4 0.25-0.4	0.4-0.5 0.3-0.5
Strong	0.4-0.8 0.35-0.7	0.6(0.9)-1.0(1.4)*** 0.5-1.0**	0.8(1.5)-1.5(2.0)*** 0.6-1.5	0.3-0.5 0.3-0.5	0.4-0.6 0.4-0.6	Не встречается
Very strong	≥ 0.8 > 0.7	> 1.0(1.4)*** > 1.0	> 1.5(2.0)*** > 1.5	≥ 0.5 > 0.5	≥ 0.6 > 0.6	-«-

*Sum of toxic salts equals to sum of toxic ions in %. Stox. salt % = $(Cl+Na+Mg+SO_{4тох}+HCO_{3тох})$%
Ions Cl, Na, Mg relate to the category of toxic ions as a whole; $HCO_{3тох}$total – $(Ca – HCO_3)$.
Calculation of the sum of toxic ions is performed in mg-ekv, then these ions are transformed in % and made sum.
** Indicators of toxic salts sum under chloride-sulfate type of salinization for category of strongly and very strongly saline are rounded up to 1.0-1.5 % against 0.9-1.4 in the table of Classification (1997).
*** Numbers in brackets correspond to gypsum bearing soil salinity degree which contain sore than 1% $CaSO_4 * 2H_2O$; according to anlysis of water abstracts these soils usually contain 10-12 mg/ekv Ca и SO_4 (non-toxic).
****Soda salinization degree is assessed on chloride-soda indicators.

Table A.3.4

Areas of saline* soils of meliorative fund of the Central Asia region, th. ha

Republic	Total area	Arable land area	Meliorative fund**				
			Total	Non-saline	Saline	Including strongly saline	Irrigated lands, total
Uzbekistan	32889	26085	10710	2684,3	8025,7	1532,0	4164,2
Kyrgyzstan	15994	10057	3021	2267,5	753,5	63,0	1034,2
Tadjikistan	9479	4158	1964	1595,5	368,5	73,9	689,7
Turkmenistan	32968	30325	12198	1423,2	10774,8	4253,5	1317,0
Total	91330	70625	27893	7970,5	19922,5	5922,4	7205,1

* Soils containing salts within the first meter of soil profile.
** Scheme of reclamation development in USSR for period 2005, Soyuzvodproekt, 1989.
*** Program of complex reconstruction of reclamation systems, Soyuzvodproekt, 1988.

A.3.4. Irrigated lands secondary salinization under irrigation development

Intensive development of irrigation in 1900-1913 was started with reconstruction of new irrigation system within old irrigated oasises (Tashkent, Bukhara, Khorezm) and development of Golodnaya steppe.

During this period irrigated areas increased from 2 to 3,2 ml/ha. Further irrigation development in 1925-1940 was connected with past-war water sector rehabilitation, irrigation and development of new lands in all regions of the Aral sea basin: Fergana and Vakhsh valleys. Dalverzin steppe, etc. Irrigated area increased up to 4,3 mln ha.

It is worth to note, that mentioned areas comprised all irrigated lands including so called conditionally irrigated which irrigation was performed only in humid years.

Such lands in pre-mountain zones and river deltas at that period occupied up to 50 % of irrigated lands (basins of Kashkadarya, Fergana valley, Bukhara, Khorezm, etc.).

Up to 1965 irrigation was developed through broadening and reconstruction of existing systems, construction of water reservoirs, AmuDarya and SyrDarya rivers flow regulation as wel as construction of new large reclamation systems Ferganavalley, Bukhara oasis, Golodnaya steppe, Djizak, Kashkadarya and Yavan steppes.

Until 1990 Nurek, Tuyamuyun, Khauskhan water reservoirs were constructed on AmuDarya river; Toktogul, Andijan, Chardara reservoirs on SyrDarya and Naryn rivers; Karshi and Amubykhara canals were put in operation; large reclamation system in Karshi steppe, AmuDarya and SyrDarya lower reaches, etc.

Period of intensive irrigation development in the Aral sea basin was completed by 1989 due to basins water reservoir exhaustion and ecological situation aggravation. Since 1990 wide scale development of irrigated lands in the basin was stopped.

It is well known, that irrigation essentially changes soil formation processes.

In first turn, soil water and thermal regimes are changed that impacts all soil processes and properties.

Sufficient moistening, systematic soil tillage and fertilizers application facilitate soil biological and physical-chemical activity increase and soil processes intensity, irrigation promotes creation of more powerful humus horizon (compared with non-irrigated soils) clayey soil profile, destruction of carbonate substance, etc.

On old irrigated lands new type of irrigated soils is formed: cultural-irrigation oasis soils which are distinguished by high fertility and are "gold fund" of Central Asia. Nevertheless, analysis shows that irrigation not always leads to soil fertility and properties improvement. At present time is obvious that over irrigation and irrigation by saline water under insufficient artificial and natural drainability leads to development of degradation and fertility reduction.

In Central Asia the following degradation processes are very active:

1. Soil secondary salinization - most spread process which is inevitable under hydromorphous conditions and ground water table rise up critical depth (2,5-3,0 m under salinity 3-5 g/l).

Among irrigated lands certain regions should be distinguished, which saline lands area expansion is connected with high initial salinity of mother rocks and exposure of salt horizons as a result of land leveling. These lands occupy vast areas among new developed lands. Saline water application for irrigation, especially in recent years, activates land salinization of old and new developed lands.

Thus, salinization could be caused by different reasons, but always negatively impacts plants development and growth as well as properties of soil itself.

It destroys soil structure, aggravates water physical and physical-chemical properties, impacts microbiological activity and, thus, causes soil degradation.

2.Over-moistening (water logging) is the second process widely spread over Central Asia. This process usually (ground water table 2-1,5 m) is combined with salinization process. It actively runs on pre-mountain planes, where irrigation leads to lower areas water logging.

3.Other degradation processes caused by irrigation are the following:

- Desertification process linked with over drying and soil water regime aggravation due to moisture deficit;
- Irrigationerosion on irrigated lands is especially dangerous for adirs;
- Wind erosion which is especially dangerous for sandy desert soils and salt spreading;
- Processes of agrogenic and technogenic pollution which require separate analysis.

It should underlined that among all degradation processes soil salinization is the most important and dangerous. Reclamation cadastre shows scale of soil salinization, ground water table position and land meliorative state. This cadastre was started since 1980 and is under progress until now (table A.3.5).

As is obvious from this table, irrigated lands with ground water level up to 3 m occupy more than 60 % (except Kyrgyzstan). Saline soils mostly are located in Uzbekistan and Turkmenistan (table A.3.6). By 1994 in Uzbekistan of total area of salt survey 4198,42 th. ha 2222,9 th. ha are subjected to salinization or 53 5. In Turkmenistan of total area 1744,1 th. ha 1674,9 th. ha are subjected to salinization (93,4 %).

Land reclamation state in the Aral sea basin is irregular, depends on natural conditions and changes significantly from upstream to downstream.

For AmuDarya and SyrDarya upper reaches saline soil area is small (medium and strongly saline are only 10 %).

In Kyrgyzstan saline lands are met in Osh and Naryn oblast, in Tadjikistan - in Lininabad and Khatlon obalasts, in Uzbekistan - in Andijan, Namangan, Fergana, Samarkand and Tashkent oblasts.

Saline lands mostly are located in inter-cone depressions with artesian water recharge and low outflow and low outflow.

Constructed drainage systems due to their insufficient workability cannot fully desali nize lands.

Within the middle reaches of the rivers (Kashkadarya, Bukhara, Mary, Labap, Akhal, South-Kazakhstan, SyrDarya oblasts) saline lands areas achieve 80-90 %, among them medium and strongly saline-25-30 %, areas with ground water table up to 3 m - more than 70 %.

In the lower reaches of SyrDarya and AmuDarya lands are mostly salinized. In Tashauz, Khorezm oblasts, Karakalpakstan, Kzyl Orda obalst 83-95 % of lands are saline. Ground water table is about 1-3 m. These soils are mostly hardly reclaimed.

According to Cadastre within the period of 1990-1994 big changes in saline lands and ground water table distribution were not observed. Areas with unsatisfactory meliorative conditions varied in 1990-1994 within 1320-1350 th. ha over the basin, 350-400 and 654-653 th. ha for Uzbekistan and Turkmenistan, respectfully (table A.3.7).

In spite of drainage construction and other measures, directed to irrigated lands meliorative state improvement, land ratio with satisfactory and unsatisfactory state almost did not change during 1990-1994. All above mentioned witnesses that lands in Central Asia are subjected to degradation processes aggravating their meliorative state.

Table A.3.5

Distribution of irrigated lands in respect of ground water table position, th./ha/ %

№№ п/п	Republic	Years	Irrigated land, th. ha	Ground water level, m					
				‹ 1.0	1.0-1.5	1.5-2.0	2.0-3.0	3.0-5.0	› 5
1	2	3	4	5	6	7	8	9	10
1	KAZAKHSTAN	1990	781.0 100	- -	22,7 2.9	75.6 9.8	338.8 42.7	315.1 40.3	38.6 4.3
		1994	786,2 100	73.9 9.4	77.83 9.9	142.3 18.1	189.47 24.1	209.92 26.7	92.78 11.8
2	KYRGYZSTAN	1990	423,8 100	0,9 0,2	2,0 0,6	8,3 2,1	7,9 1,7	7,0 1,6	397,7 93,8
		1994	429,5 100	1,7 0,4	4,3 1,0	7,7 1,8	9,4 2,2	9,1 2,1	397,3 92,5
3	UZBEKISTAN	1990	3151,35* 100	67,04 1,6	323,91 7,8	739,22 17,8	404,05 33.8	649,83 15,6	967,3 23,4
		1994	4202,92* 100		416,05 9,9	851,95 20,3	1380,43 32,8	659,59 16,7	802,61 19,1
4	TADJIKISTAN	1990	706,1* 100	7,8 1,1	29,6 4,2	55,8 7,9	112,3 15,9	180,8 25,6	319,8 45,3
		1994	719,2 100	17,3 2,4	36,7 5,1	59,0 8,2	131,6 18,3	165,4 23,0	309,2 43,0
5	TURKMENISTAN	1990	1317,2* 100	52,4 4,0	477,2 36,2		591,4 44,9	120,2 9,1	76,0 5,8
		1994	1744,1 100	42,4 2,4	649,2 37,2		673,7 38,7	179,5 10,3	199,3 11,4
	TOTAL	1990	6380,25 100	128,14 2,1	1735,28 26,1		1449,45 32,6	1272,93 17,2	1794,4 22,0
		1994	7430,00 100	217,8 2,9	2109,83 29,5		2234,47 30,1	1152.92 15,5	1714.98 23.1

* areas under control.

Table A.3.6

Distribution of irrigated lands under observation in respect of salinization degree, th. ha/%

№№ п/п	Republic	Years	Irrigated land, th. ha	Non-saline	Slightly saline	Medium saline	Strongly and very strongly saline
1	KAZAKHSTAN	1990	781,8 100	222,0 28,4	383,1 49,0	121,9 15,6	54,8 7,0
		1994	788,2 100	209,9 28,7	309,5 47,0	142,3 18,1	64,5 6,2
2	KYRGYZSTAN	1990	423,8 100	402,1 25.0	13,4 3.1	4,5 1,0	3,8 0.9
		1994	429,9 100	408,7 95.0	12,7 3.0	4,7 1.1	3,8 0.9
3	UZBEKISTAN	1990	4127,21 100	2033,32 49,3	1267,72 30,7	615,77 14,9	210,4 5,1
		1994	4198,42 100	1975,49 47.0	1432,99 34.2	621,98 14.8	167,96 4.0
4	TADJIKISTAN	1990	641,65 100	526,95 82.1	75,5 11.8	30,7 4.8	8,5 1.3
		1994	653,14 100	536,43 82.0	76,86 11.7	31,2 5.0	8,65 1.3
5	TURKMENISTAN	1990	1229,2 100	134,9 11,0	457,7 37,2	477,7 38,9	158,9 12,9
		1994	1744,1 100	79,2 4,6	487,4 27,9	961,1 55,1	216,4 12,4
	TOTAL	1990	7203,66 100	3319,27 46,1	2197,42 30,5	1250,57 17,4	436,4 6,0
		1994	7811,76 100	3209,72 41,1	2379,45 30,4	1761,28 22,5	461,31 6,0

Notes:
* 1) - not all area is under observation; on slightly saline lands observations are not conducted;
* 2) - assessment of land salinization degree is done according to criteria established in"Methodological recommendations on irrigated lands meliorative state control", Moskow, 1982.

Table A.3.7

Assessment of irrigated lands meliorative state, th. ha/%

№№ п/п	Republic	Years	Irrigated land, th. ha	Land meliorative stste					
				good	satisfactory	unsatisfactory	Including due to reasons		
							non-permissible ground water level	saline soils	non-permissible ground water level and saline soils
1	KAZAKHSTAN	1990	781,8 100	308,8 39,5	291,6 37,3	181,4 23,2			
		1994	786,2 100	302,7 38,5	262,6 33,4	220,9 28,1			
2	KYRGYZSTAN	1990	423,8 100	391,1 92,3	16,4 3,9	16,3 3,8			
		1994	429,5 100	397,0 92,5	13,9 3,2	18,6 4,3			
3	UZBEKISTAN	1990	4154,76* 100	1536,41 37,0	2217,63 53,4	400,72 9,6	172,14 4,1	59,62 1,4	168,96 4,1
		1994	4202,48* 100	1658,29 39,4	2189,63 52,1	354,56 8,5	196,77 4,7	50,25 1,2	107,54 2,6
4	TADJIKISTAN	1990	704,9 100*	470,3 66,7	167,9 23,8	66,7 9,5	31,84 4,5	27,8 4,0	7,8 1,0
		1994**							
5	TURKMENISTAN	1990	1317,3 100	171,3 13,0	486,8 37,0	659,2 50,0			
		1994	1744,1 100	271,3 15,6	819,8 47,0	653,0 37,4			
	TOTAL	1990	7382,56 100	2877,91 39,0	3180,33 43,1	1324,32 17,9			
		1994	-	-	-	-			

* areas under observation
** data is not available