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FERTILITY OF SOILS OF THE OLD DEVELOPED ZONE OF THE HUNGRY STEPPE

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ABSTRACT
Hungry and Jizzak steppes are the largest perspective and urgent regions for irrigation construction in Uzbekistan, where the irrigation, which began 45-50 years ago dramatically changed the hydro-geological conditions of the area. The level of water table has raised up, as well as the progress of secondary salinization. This investigation aims to study the depth of ground water salinization and ground water quality composition, together with studying the geomorphological and hydrogeological properties of the soils. The quality study of the ground water including dissolvable and toxic salts, their genesis, migration and accumulation due to the process of irrigation during many years

Mechanical composition some physical and chemical characteristics of the soil were examined. Soil salinity was widely analyzed concerning, salt quality, quality, dissolvable and toxic salt until the 1 m depth.

For the first time, in condition of new irrigation of the massive the new soil- reclamation conditions are being revised. The depth of layer, mineralization of ground water and structure of soil layer were defined.

KEYWORDS: *Hungry and Jizzak steppe, saline alkaline soils, reclamation.*

INTRODUCTION

The irrigated lands of the Republic of Uzbekistan make about 3-4 million hectares, which really are national wealth and invaluable property of the Uzbek people. Irrigation practices nowadays is a base for modern agriculture. One of the largest perspective and urgent regions for irrigation construction in Uzbekistan is Hungry steppe, where the irrigation, which began 30-35 years ago, dramatically changed the hydro-geological conditions of the area. The water table was raised due to water seepage from canals and poor drainage. This also led to the progressive of the salinity process and land degradation. Soils of Hungry steppes were investigated for the first time by Gorbunov (1942). His results shows the characteristics light, typical and dark sierozem of Zaamin area on depth of 4-5 meters and the question of sierozem development are considered.

Ahmedov (1978) studied the geomorphological, hydrogeological and soil conditions of Hungry and Jizzak steppes. Both structure of water-soluble and toxic salts and accumulation due to irrigation process were also investigated.

Ahmedov (1981) also studied the salt accumulation in soil of meliorating condition under the irrigated soil of the territory.

The large contribution has brought to study of a soil cover of Hungry steppe was carried out by Kamilov (1982). Adilov (1991) studied the changes of soil properties under the influence of irrigation in the central part of hungry steep.

Therefore, this study was carried out for better under standing of the soil characteristics, ground water properties and also to understand the different changes due to the influence of irrigation.

MATERIALS AND METHODS

The area under investigation is located at Hungry and Jizzak steppes, Republic of Uzbekistan. Two soil types were chosen to be represented in this study. First section is alkaline-saline soil (Jizzak steppe) and, second is sierozem-meadow irrigated saline soil (Hungary steppe).

Profile 1: Alkaline-Saline soil:

The Jizzak steppe, The section is typical for the Zaamin-Khavast interconical depression (Obruchev depression)

The Jizzak steppe is a deluvial-proluvial plain at the foothills, which gradually turns northward into a flat plain.

The northern boundary of the steppe passes along the southern Hungry steppe canal named after Sarkisov A.S., the eastern one-along the meridian via Khavast (Ursatyevskaya) railway station; the western and southern boundaries are at the foothills of the Nuratin and Turkestan ranges, Balikli-tau, Koitosh and Malguzar.

Within the boundaries, the Jizzak steppe occupies the territory of 3.14 km^2. Its altitude is between 310 and 500 m above sea level. The general decline is from south to north from 0.01 to 0 03-0.001.

Climatic indicators are given in Table 1.

Research of soil and reclamation in the Jizzak steppe revealed new alkaline semi-hydromorphic soil in sierozem area to be developed in the future.

Table 1
Climatic Indicators, of Ursatyevskaya meteorological station

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean
Temperature of air °C	-0.8	1.8	8.6	16.0	22.2	27.6	20.9	28.2	22.3	14.2	7.7	2.5	15.0
Precipitation, mm	28.0	21.0	44.0	45.0	42.0	24.0	10.0	1.0	4.0	27.0	29.0	37.0	312.0
Evaporation, mm	25.0	31.0	55.0	102.0	173.0	267.0	316.0	293.0	213.0	120.0	63.0	34.0	1692.0
Humidity percent	1.12	0.67	0.79	0.44	0.24	0.09	0.03	0.00	0.02	0.22	0.46	1.09	0.18

Alkaline-saline soil spread in Jizzak Steppe. It is in the upper part of the Zaamin-Khavas interconical depression. Its evolution is due to weakly alkaline sulphate sodium and magnesium water and to the specifics of soil forming rock. The surface of the area where a typical section I was made is characteristically a plain clearly-expressed narrow ravines of a riverbed shape stretching from south-east to north-west (general decline -0.007-0.008) are in the northern and eastern parts as well as in the extreme west. The absolute level of the surface is from 425 to 430m.

Profile 2: Sierozem-meadow irrigated saline soil

This Section specifies a lower part of the sierozem belt. The region of the section was opened up for irrigated farming after the Southern hungry canal was put into operation in 1961. The area had been used until that for dry farming and as a pastureland. This area is part of a proluvial plain at the foothills. Decline is very small. The altitude level marks are from 260 to 280 m above sea level.

Climatic indicators are given in Table 2.

Proluvial loess loam is underplayed at a small depth by stratified proluvial deposits of sand, sandy loam, loam and clay with small lenses of pebble and small stones no more then 4-5 m thick. The depth of pebble and small stone interlayer is 90-153 m. Their formation is due to the material brought from the slopes of the Turkestan range.

Infiltration of ground water before the irrigation was below 10 m; but the level raised sharply and it is nowadays 4-5 m down. Insufficient drainage of the region is mainly due to a weak slope of the area and due to clayish interlayer containing gypsum, which are water-resistant. Among the weeds there are some rare species (*Phragmites, Cynodon dactylon, Atriplex tatarica*).

The soil profiles were carefully examined, described and classified according to Umarov (1975). Physical determinations of soil were measured according to Tursunov (1988). Chemical characteristics of soil and water were evaluated according to Arunushkina 1970).

Table 2
Climatic data of Mirzachul meteorological station

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean
Temperature of air °C	-2.3	1.0	8.1	15.3	21.2	25.9	27.2	24.9	19.0	12.6	5.8	1.0	13.3
Precipitation, mm	32	24	50	39	32	14	6	1	4	19	33	41	205
Evaporation, mm	19	25	55	98	169	205	269	240	171	104	54	26	1435
Humidity percent	1.7	1.0	0.9	0.4	0.2	0.07	0	0	0	0.18	0.6	1.5	0.2

Morphological description of Profile 1:

0-3 cm. It is dry, gray, scaly-layered crust.

3-30 cm. It is dry, brownish-gray, clay loam (close to clay), coherent, cleaved; lumps 30 cm in diameter break off.

30-50 cm. Fresh, traces of salt along the clefts appear after drying; it is lumpy clay loam (close to clay), very dense; transition is gradual.

60-90 cm. It is fresh, pale brown-brownish clay ioam of prismlike small lumpy structure, dense, cleaved, with bright dots of salt. Salt crystals appear after drying.

90-100 cm. Weakly damp, less dense, pale brown with rusty dots, medium loam of friable not-shaped structure, with traces of salt. Transition is gradual.

130-200 cm. More damp, loamy, weakly pebbled. Salt appears after drying. Location of the section is in the interconical depression determines a composition of the deposits of this area. These are bedded deluvial-proluvial weakly decomposed deposits, which are represented by clay loam interlaid with light sandy and medium dusty loam.

Changes of flows caused accumulation of stratified deposits, burial of organic horizons, which are excavated 1-1.5 m deep.

Ground water is more than 4 m down the soil, its mineralization is from 1 to 5g/l, which indicates to a good infiltration.

Water has a sulphate, sodium and magnesium composition with an increased level of alkalinity (HCO_3 4-9 meq). It has a small content of normal carbonates (0,6-1,6 mg-equ), but no sodium (HCO_3<Ca+Mg).

The morphological properties of the soil profile are in accordance with analytical data. A heavy mechanical composition and a very dense structure (especially in 3-60 cm layer) determine a high unit weihgt (1,6-1,7 g/cm³), a low porosity (39-35%) and a low rate of absorption (<6-7 mm/h).

The humic content is low (1,1-1,3 in upper horizons). The humic profile is extended. C:N ratio is about 7 which is typical for sierozemic area. The content of carbonates is high -13-15%.Calcium salt prevails in their composition $MgCO_3$ content makes up 10-13% of the sum which is typical for the soil of sierozemic area (Table 3).

pH values of water suspension are within the alkaline interval of the whole profile (up to 9,1-9,3 in alkaline horizon). Gypsum content in soil is low (it makes up 0,4-5% $CaS0_4\times2H_2O$ in 0-50 cm layer); it grows up to 2-2,5% in separate horizons down the profile but <1% comes to aqueous extract, i.e. its solubility in this case is lower than the threshold of gypsum solubility in water.

Sodium prevails in the composition of absorbed cations. The share of magnesium is high, it is increasing in depth. Calcium content in the absorbing complex is not big (Table 4).

Water-soluble salt in the soil of the Obruchev depression is contained in very big quantities, especially in the upper 2-m layer (Table 5). Maximum of salt is concentrated in the middle part of the profile (50-150 cm). Salt content below 3-4 goes down to a level of average and weak salinization. Salt composition is sharply sulphate. Chlorine content is very low in comparison with that of sulphates.

The upper soil horizons have a higher alkalinity (HCO_3 total 1-2 mg-equ., per 100 g, in some sections - up to 3 mg-equ.); sodium traces are registered at this (HCO_3>Ca+Mg). Sodium and magnesium ions prevail in the composition of cations; in some horizons the amount of magnesium salt is higher than that of sodium once.

Table 3

Content of organic matter, carbonates and gypsum in salinealkaline soil of the Obruchev depression

Depth, cm	C:N	Humus, %	Total nitrogen, %	$CaSO_4\times2H_2O$ without wat. sol	Sum of carbonates $CaCO_3\times MgCO_3$	$CaCO_3$	$MgCO_3$	Water, pH
						% of sum of carbonates		
0-3	8,2	2,09	0,148	0,50	13,41	90,7	9,3	8,5
3-10	7,6	1,29	0,099	0,46	13,94	86,5	13,5	9,1
10-30	5,6	0,68	0,071	0,57	14,59	87,1	12,9	8,3
30-60	6,1	0,72	0,069	2,74	15,01	86,6	13,4	8,7
60-90	5,7	0,64	0,065	1,88	14,11	95,3	4,7	8,9
90-110	5,7	0,59	0,062	1,65	13,67	91,1	8,9	9,1
110-130	5,5	Not found		1,06	14,63	88,6	11,4	8,8
130-150	Not found			2,44	15,21	89,0	11,0	8,9
150-200	Not found			2,60	13,72	86,3	13,7	8,8

Table 4
Composition of absorbed bases, taking into account correction for solubility of magnesium and natrium sulphates and natrium chloride

Depth, cm	mg-equ. per 100 g of soil					% of sum			
	Ca ʺ	Mg ʺ	Na ʹ	K ʹ	Sum	Ca ʺ	Mg ʺ	Na ʹ	K ʹ
0-3	1,8	0,2	13,2	1,4	16,6	10,8	1,2	79,5	8,4
3-10	1,3	1,9	7,8	1,7	12,7	10,2	15,0	61,4	13,4
10-30	1,8	1,6	7,2	1,7	12,3	14,6	13,0	58,5	13,8
30-60	1,1	2,5	9,1	1,9	14,6	7,5	17,1	62,3	13,0
60-90	1,4	4,2	5,4	1,6	12,6	11,1	33,3	42,9	12,7
90-110	1,2	3,5	5,2	1,4	11,3	10,6	31,0	46,0	12,4
110-130	1,0	4,0	5,0	1,4	11,4	8,8	35,0	43,9	12,3

Table 5
Chemical composition of water extract of meadow sierozem saline-alkaline soil (mg-equ. per 100 g)

Deapth, cm	Sum of salts, %	HCO_3ʹ	Cl ʹ	SO_4 ʹ	Ca ʺ	Mg ʺ	Na ʹ	K ʹ
0-3	2,48	1,59	1,32	31,41	1,13	0,08	33,15	0,76
3-10	0,93	1,93	0,14	11,24	0,44	0,04	12,50	0,67
10-30	0,85	1,27	0,19	9,92	0,24	0,16	11,45	0,49
30-60	2,17	0,25	0,71	20,62	4,74	2,21	23,51	1,01
60-90	2,30	0,20	2,20	30,95	5,95	4,14	23,26	1,12
90-110	2,74	0,25	6,49	34,68	7,96	11,17	20,81	1,12
110-130	2,24	0,23	8,21	26,48	5,30	10,69	17,55	1,01
130-150	3,03	0,25	12,96	34,96	8,88	15,23	21,34	1,11
150-200	2,84	0,22	14,79	29,07	7,88	10,55	24,59	1,03

Basic kind of salt in entire profile sodium sulphate, magnesium sulphate appears only from 30 cm. Calcium carbonates are available in entire profile, and magnesium and sodium carbonates - up to 30cm (Table 6).

This way, the soil under consideration has several specific properties; lumpy and prism-shaped structure high density, cleat, heavy mechanical composition, low water permeability, increased alkalinity, prevailing absorbed sodium in composition of cations, high sulphate magnesium-sodium salinizations, low content of gypsum and organic matter.

This material and its comparison with the data on saline soil of seirozem area published earlier provide to refer the soil of the Obruchev depression to alkaline-saline kind of soil with a high level of salinization and alkalinity.

As concerns dealkalinization of the soil described, it undergoes a process of self-dealkanization during melioration of this land as a result of a large calcium potential of this region’s irrigation water. This is verified by the existing scientific and production activities. But dealkalinization of the soil is quite a problem, because due to heavy mechanical composition, it has a low water-permeability which greatly hampers leaching operations and natural drainage.

Table 6
Salt contents in alkaline-saline soil of the Obruchev depression (mg-equ.)

Depth, cm	Dry residue, %	$Ca(HCO_3)_2$	$CaSO_4$	$Mg(HCO_3)_2$	$MgSO_4$	$NaHCO_3$	Na_2SO_4	NaCl	KCl
0-3	2,48	1,13	No	0,08	No	0,38	31,41	1,32	0,76
3-10	0,93	0,44	No	0,04	No	1,45	11,05	0,14	0,67
10-30	0,85	0,24	No	0,16	No	1,11	9,92	0,19	0,49
30-60	2,17	0,25	4,49	No	2,21	No	23,63	0,71	1,01
60-90	2,30	0,20	5,75	No	4,14	No	21,06	2,20	1,12
90-110	2,74	0,25	7,71	No	11,17	No	15,8	5,37	1,12
110-130	2,24	0,23	5,07	No	10,69	No	10,7	7,20	1,01

Profile 2: Sierozem-Meadow irrigated saline soil.

Morphological and Micromorpholigical description of profile 2.

0-30 cm. It is arable, light gray, friable, medium loamy, friable lumpy. There are encounted weakly decomposed remains of plants. Transition is clear by colour and composition. It is of greyish-light brown colour, aggregated. First order aggregates prevail, some are represented by coprolites, second order aggregates are also encounted. Coprolites are from 0,2 to 0,6 mm in size that, some of them are a part of larger aggregates; there is non-aggregated material as well. It is dusty-plasmic; plasma has a high birefringence; skeletal grains are corroded; there are a lot of strongly weathered grains with the flakes of ferrous hydroxide; grains of angular shape prevail. There are single semi-round grains. Organic substance is represented by coaly particles and rarely - by fibrous semi-decomposed tissues. Mineralogical composition of the skeleton is diverse: quartz, feldspar, mica, zirconium, or minerals and carbonates (dolomite).

30-50 cm. It lies below arable one, grayish-pale

accumulations of gypsum in spices; gypsum crystals are mainly of irregular shape, some of them have a rhombohedral shape.

102-139 cm. It is brownish-yellow, more damp, puddled, medium loamy, with small gypsum crystals.

139-176 cm. It is brownish-pale brown, very damp, sand loamy. It is granular: it consists of skeletal grains and rare plasmic aggregates. The size of grains is less homogeneous (0,02-0,06 mm). No gypsum was found.

Micromorphological characteristics indicate to a high aggregation level of the entire profile, which is due to a high carbonization and to the activities of mezofauna. High-horizon aggregates were apparently slightly ruined by ploughing: their best expression and complicated structure are observed in 66-102 and 102-139 cm horizons. Maximum of carbonates is in the first horizon. A high level of profile aggregation is indicated to by a complete absence of cracks; all the pores are

brown, damp, puddled, medium loamy, small lumpy. There are few roots, sometimes ways of insects; there is a lot of carbonate concretions. It is less compact due to plenty of corprogenic aggregates 0,2-0,5 mm in diameter and due to plenty of nonaggregated material. Plasma is carbonate and clayish, it is lower than in an upper horizon. Sometimes there are uncounted coaly particles and fragments of carbonate concretions. Skeletal composition is also diverse. Most grains are seritisized, there are a lot of hydroxide flakes.

50-66 cm. It is brownish, damp, poreous, weakly puddled, medium loamy with single small carbonic concretions. It is of dirty brown colour, very well aggregated and carbonized. There are second-and third-order aggregates and some coprolites. The amount of plasma on the whole goes up; some aggregates are entirely plasmic. There are packing and rare roundish pores. There are uncounted coaly particles and single plant remains; hydroxide flakes are visible on mineral grains.

66-102 cm. It is brownish and pale brown, damp, puddled, clay loamy, with a great amount of small gypsum crystals. It resembles a previous one by its high level of aggregates, microstructure of components, but the skeletal grains are uncounted more rarely. It is distinguished by multiple compact

those of packing, it also has a high level of weathering of primary minerals, sharply falling at the depth of about 1 m.

Irrigation resulted in destroyed aggregates in the upper part and in a deep spreading of clayey particles.

Double value of hydroscopicity was produced for humidity of wilting, water permeability is 102.0 mm/h.

The data of mechanical analysis of soil show that the differentiation of soils as mainly due to sandy and large dusty fractions. Clay and silt increase down the profile. Soil 250 cm in depth is bedded on clay, which worsens filtration properties and prompts resalinization of ground. Irrigated sierozem-meadow soil has a small amount of O.M.%, which gradually decreases down the profile (Table 7). Horizon with more than 13% content of gypsum is singled out 70-80 cm deep. In absorbed complex prevails calcium, which makes above 60% of exchanging cations. Down the profile increases a share of magnesium and decreases a share of calcium.

Table 7

Content of organic matter, carbonates, gypsum, exchanged cations and mobile forms of phosphorus and potassium in irrigated sierozem-medow soil

Depth cm	O.M. %	$CaCO_3$ %	Gypsum %	Exchangeable cations mg equ./100 g soil					P_2O_5	K_2O
				Ca	Mg	K	Na	Sum	mg per 100 g of soil	
0-30	0.60	7.21	0.91	4.69	1.48	0.51	0.14	6.82	2.38	31.33
40-50	0.44	7.63	0.35	4.24	2.22	0.36	0.18	7.00	0.62	19.27
50-60	0.40	8.23	0.36	4.14	2.80	0.31	0.04	7.29	0.40	13.97
70-80	0.30	5.91	13.53	-	Did not find				0.40	13.98
110-120	0.20	7.32	1.72						0.30	9.64

There are somewhat increased content in the 70-80 cm horizon is apparently due to water-soluble gypsum in water extract.

Profile of irrigated sierozem-meadow soil is homogenous by its mineralogical composition. It is composed of the minerals of hydromica group, kaolinite, chlorite, montmorillonite, minerals of ferrous oxides, high- dispersion quartz and amorphous substances (Table 8). In initial period of land development when the ground has not the reason that, the soil is cultivated without any reclamation. Plants are provided with Phosphorous and potassium in relatively sufficient quantities but an application of mineral fertilizer is very efficient.

Table 8
Mineralogical composition of irrigated sierozem-meadow soil

Depth, cm	Hydromica	Chlorite	Kaolinite	Montmor.	Hydrous ferrum oxides	Amorphous substances
0-30	+++	++	+	-	+	-
40-50	+++	++	+	+	+	+
190-200	+++	++	+	-	+	+

CONCLUSION

1. In this investigated area there are differences in geomorphological structure and difficult hydrological condition in the district. The ground water has a weak flowing and watermainly evaporated and this causes salinity.
2. Intensive irrigation during 35-40 years changed the hydrogeological conditions of the area and resulted water seepage from canals, and irrigation water in fields raised the level of ground water.
3. In weak irrigated fields the use of drainage water raised the salinity from 2-7 till 30 g/L
4. The increase of use of irrigation speed the transformation autmorphous soil to polyhydromorphous during 5 and 8 years and hydromorphous during 12 and 16 years. The main soil types are meadow sierozem, sierozem- meadow and meadow soils. There are many different melioration conditions of the soil.
5. Polyhudromorphous new irrigated soils in the territory it is about 58.56 thousand hectares. There are weak, middle and strong mineralization of the ground water in the depth of 2-5m. There are mainly gypsum salts in 1.0-1.5m deep.
6. Hydromorphological new irrigated soil is about 24.19 thousand hectares (28.39%). Here is strong and very strong mineralizationals (10.1- 30.3g/L) middle mineralized (5-10g/L).
7. Due to irrigation the salts increased by 42% in 1971 and by 70% in 1998 where the ground water is about 3 m deep.

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