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MORPHOGENETIC DIAGNOSTICS AND NOMENCLATURE OF ALLUVIAL-MEADOW SOILS IN THE SUBTROPICAL SEMIARID AREA, FLOODPLAIN OF THE KUR RIVER, AZERBAIJAN

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МОРФОГЕНЕТИЧЕСКАЯ ДИАГНОСТИКА И НОМЕНКЛАТУРА АЛЛЮВИАЛЬНО-ЛУГОВЫХ ПОЧВ СУБТРОПИЧЕСКОЙ ПОЛУАРИДНОЙ ЗОНЫ, ПОЙМЫ Р. КУРЫ, АЗЕРБАЙДЖАН

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Abstract. The aim of this study was to evaluate morphologic features, diagnostic qualifiers and enhance classification of alluvial-meadow soils in the floodplain of the Kur River within Azerbaijan. For this purpose, several soil pits were placed in the representative test areas and multiple soil samples collected within field campaigns (2014–2015). Based on the field and laboratory test data, the detailed soil maps of the test areas were compiled, and diversity of alluvial-meadow soils was classified as suborders (subtypes): alluvial-meadow primitive; alluvial-meadow layered (flaggy); alluvial-meadow dark and alluvial-meadow irrigated. It was found out that in the floodplains, local soil variability was predominantly attributed to not only alluvial sediments, but also water table, mineralization rate and salt content of underground water as well flood water play an important role. The mineralization of ground water is weak (1.40–3.70 g/l) and the concentration of hydro-carbonates (HCO_3^-) varies from 0.56 to 0.92 g/l. No salinization indication found in the profile of alluvial-meadow primitive and alluvial-meadow layered soils, while weak concentration (solid content = 0.40–0.54%) was found at a depth of 80–150 cm in the alluvial-meadow dark soil. Unlike other subtypes, alluvial-meadow dark soil is characterized with the higher biomass (green weight of top = 41.5 cwt/ha and green weight of underground = 142.3 cwt/ha), high mobility of humus substances with predominance of the 1st fraction of humin (20.0–28.1%) and fulvic acids (14.6–22.3%). The ratio of Cha : Cfa reaches 1.18–1.32. For the alluvial-meadow irrigated soil, the second fraction of humin acid (9.3–10.2%) and total content of humin acid ranges from 45.6 to 50.3%. The ratio of Cha : Cfa is larger (1.37–1.50). Depending on the lithology of alluvial sediments, the content of SiO_2 and R_2O_3 varies in the ranges of 53.0–57.2% and 9,6–26,0%, respectively. For the alluvial-meadow dark soil, decomposition of alum silicates in alkaline hydrolysis is typical (8.7–9.0). The content of SiO_2 and R_2O_3 varies between 47.8 and 50.6 %, and 19.7 and 21.6%, respectively. In the topsoil, of the irrigated soils in associated to washing out the content of Ca and CaO content (12.2–13.1%) increases in deeper horizons.

Аннотация. Целью данного исследования была оценка морфологических признаков, диагностических показателей и уточнение классификации аллювиально-луговых почв в пойме реки Куры в пределах Азербайджана. Для этого на репрезентативных полигонах было заложено несколько почвенных разрезов, а в ходе полевых исследований (2014–2015 гг.) было отобрано несколько почвенных проб. По данным полевых и лабораторных исследований составлены детальные почвенные карты опытных площадей, а разнообразие аллювиально-луговых почв классифицировано на уровне подтипа: аллювиально-луговые примитивные; аллювиально-луговые слоистые; аллювиально-луговые темные и аллювиально-луговые орошаемые. Выявлено, что в поймах локальная изменчивость почв преимущественно связана не только с аллювиальными отложениями, но и большую роль играют уровень грунтовых вод, степень минерализации и солености подземных вод, а также паводковые воды. Минерализация подземных вод слабая (1,40–3,70 г/л), концентрация гидрокарбонатов (HCO_3^-) колеблется от 0,56 до 0,92 г/л. В профиле аллювиально-луговых примитивных и аллювиально-луговых слоистых почв признаки засоления не обнаружены, а в аллювиально-луговой темной почве на глубине 80–150 см обнаружена слабая концентрация (содержание твердых веществ = 0,40–0,54%). В отличие от других подтипов, аллювиально-луговые темные почвы характеризуются более высокой биомассой (зеленая масса покрова = 41,5 ц/га и масса подземных частей = 142,3 ц/га), высокой подвижностью гумусовых веществ с преобладанием 1-й фракции гумуса. (20,0–28,%) и фульвокислоты (14,6–22,3%). Соотношение Сгк : Сфк достигает 1,18–1,32. Для аллювиально-луговых орошаемых почв вторая фракция гуминовой кислоты (9,3–10,2%) и общее содержание гуминовой кислоты колеблется от 45,6 до 50,3%. Соотношение Сгк : Сфк больше (1,37–1,50). В зависимости от литологии аллювиальных отложений содержание SiO_2 и R_2O_3 колеблется в пределах 53,0–57,2% и 9,6–26,0% соответственно. Для аллювиально-луговых темных почв характерно разложение алюмосиликатов при щелочном гидролизе (8,7–9,0). Содержание SiO_2 и R_2O_3 варьирует от 47,8 до 50,6% и от 19,7 до 21,6% соответственно. В пахотном слое орошаемых почв в связи с выщелачиванием увеличивается содержание Са и содержание CaO (12,2–13,1%) в более глубоких горизонтах.

Keywords: soil, carbonates, soil profiles, alluvial soils, humus, groundwater, floodplains.

Ключевые слова: почва, карбонаты, почвенный профиль, аллювиальные почвы, гумус, грунтовые воды, заливные равнины.

Introduction

As noted in J. Berhal, the importance of river valleys for the development of agriculture in the ancient East has long been known. Primarily, emergence of agricultural development was limited to areas with favorable soil moisture regime and high fertility where accommodate alluvial soils, particularly in floodplains [1]. However, genetic and diagnostic features, spatial distribution and classification of alluvial soils in floodplain areas were less studied in compared to zonal soils. The main reason for less focusing on alluvial soils among soil scientists, maybe highly dynamic soil formation and complexity of soil cover structure [2, 3].

G. V. Dobrovolsky [3] highly substantiated theoretical importance of studying alluvial soils occurred in floodplain particularly pointing out significant variability's in space and time.

In the floodplains, soil forming processes are newly manifested in the adjacent territories to riverbed (local shallow pools where optimal condition for herbaceous vegetation exists) while territories released from flood regime are characterized mainly zonal indications of soil forming.

Most probably, the soils of the floodplain areas were less studied due to abovementioned characteristic soil formation condition compared to the soils in watersheds where pedogenic processes are more stable as well gradual variability in laterally and vertically.

One of the most outstanding and fundamental studies regarding genesis and evolution of alluvial soils was published by V. R. Kovda [4] named “Soil formation process in floodplains and river deltas of continental zones”. In this study, the author developed genetic-evolution approach that played a key role in studying soils in large areas of alluvial plains where alluvial soil forming predominated in the past. He stated that soil formation in the floodplains and deltas are apparently tend to sod-forming process. In the areas out of floodplain regime prevail apparently zonal indications of soil forming.

The scientific-theoretical ideas of V. A. Kovda and G. V. Dobrovolsky were followed in the long-term comparative-geographical studies we conducted in alluvial soils of the river valleys in the arid and semi-humid subtropics zones of Azerbaijan [5-7].

Materials and Methods

The Kura River is the largest stream in the eastern Transcaucasia. The flood plain of the Kur River is more than 3000 hectares. The width of floodplain including first terrace ranges from 3 to 5 km.

The study area is located in the floodplain of the Kur River across the Kur-Araz lowland. The climate of the study region is arid or partially semi-arid as typical to subtropics. The average annual precipitations and air temperature is 245-310 mm and 14.1-14.5 °C, respectively. The potential evaporation ranges between 950 and 1100mm, humidity factor is <0.4, and the sun of active air temperature is 3800-4000°. The vegetation cover is represented by herb bunchgrass steppe with 120-165 cwt/ha photomasks annually.

The two representative test areas (site-specific) were selected in the study region. More than 10 soil pits were placed to a depth of 1.8-2.0 m and soil samples were collected from the genetic horizons, in 2014-2015.Total area of each test site is more than 10 hectares, and the soil map was compiled at a scale of 1:2000. The soil samples were tested for particle size by using pippete method and trituration with sodium pyrophosphate. Humus content and total nitrogen was determined according to L. V. Tyurin, and Ca^{2+} and Mg^{2+} cations according to D. V. Ivanov, Na according to K. K. Gedroits, pH (water) by pH-meter, CO_2 content of carbonates using the calcimeter, gross soil composition was estimated by the classical method by E. A. Arinushkina and the fractional and group composition of humus according to I. V. Tyurin in the modification of V. V. Ponomareva and T. A. Plotnikova.

The phytomass of meadow-herbaceous plant was determined during their maximum development (at the end of May) within two years by cutting green mass from 1 m^2, in fivefold repetition. The cut mass was weighed in wet and dry condition, with subsequent transfer of the crop to cwt/ha. (L. K. Remzov, N. I. Vizilevich). The underground mass-by the method of monolite 25×25 cm on 0-20 and 20-50 cm (N. A. Kachinsky).

Results and Discussion

The lack of systematic studies of the soils in the floodplains and river valleys in Azerbaijan resulted in very less availability of data on diagnostic features and nomenclature of alluvial soils occurred in the Kur floodplain. V. R. Volobuyev [8] was one of the initial studies describing these soils in the Kur-Aras lowland. Significant attention has recently paid to floodplain lands as potential agricultural areas to plant vegetables in the country scale.

The comparative-geographical studies and detailed mapping of alluvial soils gave an opportunity to analyze variations in soil cover, determine classification and nomenclature. In particular, detailed morphogenetic diagnostics of alluvial soils were examined, depending on water table level, development of soil profile and soil-forming processes the following suborders (types) were distinguished:

1. Alluvial-meadow primary; 2. Alluvial-meadow layered; 3. Alluvial-meadow dark. According to the national soil classification, irrigated variant of alluvial-meadow soil is distinguished and that was also divided into ordinary, clay-marly, saline and compacted diversities [9-11].

The base for the described classification and nomenclature of alluvial-meadow soils are based on V. A. Kovda [4], G. V. Dobrovolsky [3] as well "Classification and diagnostics of soils in the USSR" [12], World Reference Base (WRB) [13], "Classification of Russia soils" [14].

Alluvial-meadow primary soils. V. A. Kovda [15] states that soil forming process is in its primary phase on the outcrops of bedrocks in high mountainous regions and newly deposited sediments, alluvial sediments in the floodplains. However, there are significant differences between the soil forming conditions of the two geographic. Unlike high mountainous areas, in the floodplains soil formation is characterized by permanently accumulation of mechanical, chemical and biogenic derivatives containing high organic matter content. Therefore, the author states that herbaceous, scrubs and various tree species can develop in the course of 2-3 years in all landscape zones of the globe.

Alluvial-meadow primitive soils mainly accommodate locally in the flood zone the Kur floodplain. The soil forming process in these areas is in its primary phase and soil moisture regime is formalized by mostly floods and partially water table. Therefore, the development of herbaceous vegetation is limited. The water table is unstable during the year, mainly ranging from 1.5 m to 3.5 m. In related to unstable water table, gel formation cannot obtain its characteristic features (Table 1).

Table 1

BASIC PHYSICOCHEMICAL INDICES OF ALLUVIAL-MEADOW SOILS
OF THE FLOODPLAIN OF THE RIVER KUR

№	*Horizon, depth, cm*	*Humus, %*	*Nitrogen, %*	*$CaCO_3$, %*	*Water suspension pH*	*Absorbed cations mmol/100g soil*				*Granulometric composition, % , mm*	
						Ca^{+2}	*Mg^{+2}*	*Na^{+}*	*∑*	*< 0,001*	*< 0,01*
	Alluvial-meadow primary										
451	AYv 0-6	1.84	0.14	11.3	7.8	14.8	5.4	0.6	20.8	11.8	30.4
	AYz 6-23	1.73	0.13	11.4	7.9	14.0	5.1	0.7	19.6	8.4	26.5
	A/C 23-48	1.15	0.08	12.5	8.0	12.8	3.8	0.7	17.3	9.2	28.3
	CIg 48-89	0.71	to as.	11.4	8.1	8.2	3.2	0.4	11.8	5.9	21.8
	CIIg 89-125	0.64	to as.	10.1	8.2	10.2	3.0	0.7	14.1	7.3	24.7
453	AYv 0-5	2.07	0.17	12.5	7.9	16.9	5.3	0.7	22.9	12.3	34.3
	AYz 5-20	1.54	0.13	12.1	7.9	14.8	6.2	0.3	21.3	10.0	30.2
	A/C 20-53	1.28	0.10	13.4	8.0	13.0	6.3	0.2	19.5	7.6	23.4
	CIg 53-98	0.53	to as.	13.2	8.2	11.7	6.0	0.8	18.5	8.4	27.2
	Alluvial-meadow bedded										
455	AUv 0-10	3.56	0.26	10.2	7.8	19.4	4.3	0.6	24.4	15.0	44.3
	AUz 10-28	2.82	0.20	10.7	8.0	17.9	5.6	0.7	23.1	19.2	46.8
	B/C 28-67	1.26	0.12	11.5	8.1	18.6	5.8	0.5	24.9	6.8	34.9
	CIg 67-103	0.87	to as.	14.9	8.2	10.4	4.6	0.8	15.8	4.2	21.2
	A^h_g 103-128	2.15	to as.	9.8	8.0	15.7	8.2	0.5	24.5	18.6	44.8
	CIIg 128-170	0.74	to as.	14.3	8.3	12.8	5.2	0.7	18.9	7.5	17.4
458	AUv 0-8	4.02	0.29	8.7	7.7	18.6	7.6	0.5	26.7	14.1	40.6
	AUz 8-26	3.24	0.25	11.3	7.9	17.3	7.6	0.6	25.5	15.5	47.0
	B/C 26-58	1.97	0.09	12.8	8.1	16.5	5.6	0.4	22.6	14.0	42.9
	CIg 58-92	0.76	to as.	11.7	8.2	10.0	6.8	0.6	17.3	7.6	19.4

№	Horizon, depth, cm	Humus, %	Nitrogen, %	$CaCO_3$, %	Water suspension pH	Absorbed cations mmol/100g soil				Granulometric composition, % , mm	
						Ca^{+2}	Mg^{+2}	Na^{+}	∑	< 0,001	< 0,01
	$A^h{}_g$ 92-125	1.94	to as.	10.8	8.0	21.6	4.4	0.5	26.5	19.5	51.3
	CIIg 125-165	0.57	to as.	11.5	8.3	15.2	5.1	0.5	20.8	10.4	28.9
	Alluvial-meadow dark										
463	AUv 0-12	5.67	0.32	20.8	8.2	24.3	5.4	1.5	31.2	21.4	51.4
	AUz 12-33	3.79	0.26	22.6	8.4	26.7	6.9	1.3	34.9	26.7	62.7
	A/B 33-50	1.93	0.18	21.2	8.7	21.3	8.4	1.7	31.4	23.0	62.2
	Bg 50-84	1.24	to as.	25.0	8.8	16.8	7.4	1.7	25.9	20.7	59.3
	B/Cg 84-120	1.09	to as.	24.3	8.8	15.7	7.9	1.5	25.1	20.1	51.2
	Cg 120-175	0.76	to as.	23.9	9.0	12.0	8.9	1.6	21.5	12.8	33.5
470	AUv 0-10	5.08	0.35	17.8	7.2	28.1	6.7	1.2	35.3	18.4	58.7
	AUz 10-30	2.93	0.27	18.4	8.0	25.9	7.5	1.5	34.8	22.6	64.1
	A/B 30-48	1.79	0.14	21.8	8.4	20.1	6.5	1.4	28.0	27.2	69.7
	Bg 48-89	1.40	to as.	24.3	8.5	23.6	8.0	1.6	33.2	26.4	64.6
	B/Cg 89-112	0.96	to as.	23.4	8.7	16.2	8.3	1.5	26.0	17.5	56.3
	Cg 112-160	0.57	to as.	24.0	8.8	10.5	5.5	1.4	17.4	14.3	35.1
	Alluvial-meadow irrigative										
468	AU'a 0-25	3.75	0.26	10.1	8.1	23.3	5.6	1.3	30.2	21.0	61.2
	AU"a 25-48	2.85	0.21	10.5	8.1	19.2	5.3	1.5	26.0	25.3	70.8
	A/B 48-63	2.05	0.18	14.3	8.2	18.1	9.9	1.5	28.5	28.1	73.4
	Bg 63-92	1.61	to as.	17.0	8.3	20.4	8.9	1.4	30.7	22.4	68.3
	B/Cg 92-135	1.20	to as.	18.8	8.4	16.0	5.0	1.6	22.6	15.0	41.8
	Cg 135-170	0.48	to as.	15.4	8.5	14.3	5.1	1.2	20.6	12.3	33.9
470	AU'a 0-22	3.16	0.22	12.6	8.0	18.8	4.6	1.7	25.1	24.9	65.1
	AU"a 22-45	2.53	0.18	13.4	8.1	16.4	5.8	1.2	23.4	30.7	71.6
	A/B 45-68	1.82	0.13	15.7	8.2	14.3	7.1	1.2	22.6	24.3	67.8
	Bg 68-96	1.25	to as.	18.4	8.2	17.3	6.2	1.5	25.0	27.8	66.7
	B/Cg 96-128	0.94	to as.	19.2	8.4	13.2	7.1	1.4	21.7	22.0	53.4
	Cg 128-165	0.67	to as.	16.8	8.5	12.5	6.7	0.9	20.1	20.3	48.5

The topsoil (AY) is characterized by slightly humic, layered and contained much more coarse particles and its thickness reaches up to 15-20 cm where humus content is between 1.5-2.0%. The complexity of alluvial sediments plays an important role in humus formation. That is reflected in productivity of phytomass on surface (15-20c/ha) and subsurface (115.5 c/ha) horizons. The soil texture is mainly loamy and sandy-loam according to the national texture classification. The content of particle sizes <0.01 mm in the topsoil reaches 26.0-30.4% while its content significantly decreases up to 11.8% in the middle horizons.

The soil profile is distinguished by monotonous carbonate ($CaCO_3$=10.0-13.4%) and the reduced absorption capacity (14.1-22.9 mmol-eq/100 g soil). These soils aren't salinized, as they are connected with weak mineralization (1.4-1.8 g/l) of underground waters. The sequence of genetic horizons is typical: AYv-AY-Clg-CII gca.

Alluvial-meadow layered soils characteristically occur in the central part of the floodplain, and expose to short-term periodic floods. The organic matter accumulation is attributed by the relatively well-developed herbaceous vegetation. Productivity of phytomass is 33.0 cwt/ha, but the root mass is 130.6 cwt/ha. The topography is mainly flat, and the level of water table varies from 1.0 to 2.5 m depending on the seasons. The main difference between alluvial-meadow layered and alluvial-meadow primitive soils are commonly more developed soil profile, grass-covered ground, thicker topsoil (AU = 25-30 cm), spread of humic substances to mid-horizons (40-50 cm), well-marked gley signs in the middle and deep horizons.

Noticeable stratification of soil profile and frequently occurred buried humus horizon at a depth of $A^h{}_g$=0.8-1.3 m are characteristic morphological features of the described soils that is attributed to the divagation of the Kur River. The topsoil is heavy loamy in texture (<0,01mm = 44.3-47.0%; <0,001 mm = 14.1-19.2%) while deep horizons are lighter in texture, the content of particles <0.01mm and <0.001 mm reaches to a 17.4-19.4% and 4.2-7.6 %, respectively.

The humus content in the upper horizon's changes between 2.8 and 4.0% and decreases up to 0.8% in depth. However, in the buried horizon its content again increases, 1.9-2.2% ($A^h{}_g$ = 0.8-1.3m) which is considered as the main diagnostic feature for the studied soils. The amount of total nitrogen in the AU horizon is 0.20-0.29%. The profile of alluvial-meadow layered soils contains carbonates to some extend ($CaCO_3$ = 8.7-12.8%) but without visible carbonate depositions. The sum of the exchange bases is relatively high, and its content reaches to 23-26 mmol/100 g soil in the A horizon and decreases up to 15-18 mmol/100 g in depth toward B and C horizons. The soil reaction is slightly alkaline in A horizon (pH=7.8-7.9), and moderately alkaline in the B and C (pH=8.0-8.3%) horizons.

In most cases, the soils are non-saline and total solid content cannot exceed 0.2-0.3% which is attributed to weakly mineralization of ground water (2.1-2.5 g/l). The following sequence of genetic horizons is typical: AUv-AUz-B/Cig-Agh-CIIg.

Table 2

Group and fractional composition of humus of alluvial-meadow soils (%) of total C

№	*Horizon, depth, cm*	*C, %*	*Bitumen*	*Decalcinate*	*C, % humus carbon*								*humin*	$C_{h.a}$:$C_{f.a}$
					humic acids				*fulvic acids*					
					fractions									
					1	*2*	*3*	*sum*	*1*	*2*	*3*	*sum*		
	Alluvial-meadow primitive and bedded soils													
453	AYv 0-6	1.20	5.08	6.24	12.13	4.32	1.83	18.28	10.24	2.82	1.25	14.81	26.43	1.23
	AUz 6-20	0.89	4.54	5.32	13.21	5.15	2.65	21.01	12.26	3.43	2.19	17.88	28.35	1.18
455	AU'v 0-10	2.33	3.75	4.73	20.03	5.07	2.18	25.28	12.85	3.62	2.78	22.25	31.12	1.31
	AUz 10-28	1.88	2.96	4.18	20.10	4.07	3.28	28.50	14.63	4.84	3.25	20.54	37.28	1.25
	B/Cg 28-67	0.73	2.15	2.35	10.04	3.12	1.16	14.32	8.93	1.06	1.82	11.51	43.43	1.23
	$A^h{}_g$ 103-128	1.25	3.18	4.21	22.46	6.18	5.42	34.06	18.91	4.18	3.03	26.12	38.56	1.18
	Alluvial-meadow dark soils													
463	AUv 0-12	3.29	4.05	3.54	23.32	5.04	3.86	32.22	18.46	3.14	3.41	25.01	40.38	1.29
	AUz 12-33	2.20	3.86	2.75	25.18	6.25	4.04	35.47	22.34	4.06	3.62	28.02	42.15	1.26
	A/B 33-56	1.12	3.53	1.86	28.14	7.03	3.15	40.32	22.08	4.12	4.34	30.54	43.72	1.32
	Alluvial-meadow irrigative soils													
468	AU'g 0-25	2.18	3.27	2.32	20.05	10.2	5.35	34.56	14.93	3.18	2.95	23.08	48.05	1.50
	AU"a 25-48	1.65	4.94	2.18	21.56	9.27	6.02	36.65	18.08	5.42	3.08	26.58	50.34	1.39
	A/B 48-63	1.19	3.18	1.85	13.22	7.65	5.56	25.43	12.73	4.05	1.76	18.54	45.56	1.37

Alluvial-meadow dark soils are mainly occurred in association with alluvial-meadow-boggy soils and correspond concave topographic elements, depressions. The soil profile is periodically exposed to changes in water table that contributes to the development of herbaceous vegetation. Therefore, dense grass-covered ground (AUv = 10-12 cm) with rich surface (41.5 cwt/ha) and subsurface (142 cwt/ha) phytomass is typical. For this reason, the thickness of organic matter accumulation horizon (AUv+AU = 40-50 cm) varies between 70 and 80 cm. The topsoil contains more humus (5.1-5.7%), hence that is dark in color (black in moist state) and considerably aggregated(crumbling-textured). The total nitrogen content varies between 0.26 and 0.35%, C:N ratio is largely variable (9.8-13.9) that shows weak decomposition of organic matter. Furthermore, for the surface horizon (AU=30-35 cm) of the soils is characterized by the high content of absorbed bases reaching to 31.2-35.3 mmol-eq/100g. The Ca predominates in the absorbed bases. The soil profile is highly calcareous, the maximum content of $CaCO_3$ (24-25%) occur at a depth of 150-170 cm that is considered typical genetic feature. The carbonate accumulation horizon is greenish-bluish in color when soil is moist, but yellowish-whiten dry state. It was determined that marl formation in this layer is attributed to the ground water which is rich in hydrocarbonates (HCO_3^- =0.56-0.92g/l) playing an important role as source of carbonates. The sign of carbonates in soil profile is invisible when soil is wet because of saturation.

V. R. Volobuyev [8] noted that the evolution of these soils passed though. boggy and meadow-boggy regime and called them “stingy-meadow” soils. In relatively high-mineralized underground water (2.7-3.5 g/l), the concentration of CO_3^{2-} and HCO_3^- was found 0.02-0.04 g/l and 0.90-1.22 g/l, respectively. The content of SO_4^{2-} in ground water is highly variable (0.44-1.00%) while the content of chloride is less variable (0.10-0.29%). The high mineralization of ground water and particularly hydrocarbonates is related to lateral stream of ground water.

Note that the particle size distribution in the studies soils is significantly affected by surface streams. Fine particles is leached from topsoil (AU=25-30 cm) to middle horizons (<0.01 mm=64.6-73.4%; <0.001 mm = 23.0-27.2%) due to long-term stay of bog water on soil surface and swampy-meadow regime.

Unlike primitive and bedded varieties dark alluvial-meadow soil have signs of poor salinity at depth of 50-150 cm, the dense residue content is 0.40-0.56%. They are characterized by the following system of genetic horizons: AUv-AU-AB-Bmlg-B/Cmlg-Cmlg.

Alluvial-meadow irrigated soils significantly differ from its natural variants in terms of soil forming condition and morphological and diagnostic features. The main diagnostic indications occur subsurface and middle horizons. In the subsurface horizon (AUa=25-65 cm) compactness and blocky-lamp structure is attributed to ploughing, and in the middle horizon gel formation is weakly manifested. Further analyses results showed that irrigation significantly affect general structure of soil profile, stratification is weakly visible, and carbonates moves downward across the profile. Its maximum concentration ($CaCO_3$=14.3-18.4%) was found in the middle horizons. Generally, typical morphological indication of alluvial-meadow irrigated soils includes clay-formation in the middle part of the profile, hence the total content of particle size <0.01 mm reaches67.8-73.3%, and the sharp increase is typical for the particle sizes <0,001 mm (25.3-30.7%). In subsurface horizon, the soil density varies from 1.42 to 1.45 g/cm^3. The humus and total nitrogen content in the subsurface horizon ranges from 3.2 to 3.7% and 0.22 to 0.26 %, respectively. In related to agro-irrigative sediment load and successive agricultural measures have resulted in slowly increasing organic matter accumulation (196-235 cwt/ha). In the cultivated horizon, total exchangeable bases are 25.1-30.2 mmol-eq, and from 50 to 150 cm depth its content remains low and stable (20.1-22.7 mmol-eq) downward. In compared to other suborders, topsoil of alluvial-meadow irrigated soil (AUaz=0-25 cm) is moderately alkaline (pH=8.0-8.1).

The structure of genetic horizons include: AU’a-AU”a-A/B-Bg-B/Cg-Cg.

In the fraction-group content of humus, the 1st fractions predominate, humin acid (12.6-28.5%) and fulvic acid (10.2-20.3%). Contrarily, the content of 3rd fractions, humic (2.8-5.4%) and especiallyfulvic acid (1.3-3.4%) decreases. Specifically, in alluvial-meadow dark soils the content of the second fraction noticeably increases (5.0-6.3%). Among the fractions, humin acid was found more mobile.

Furthermore, the content of humin acid increases across soil profile, the sum of fractions of humin acid reaches to 32.3-40.7% in surface horizon. Such mobility of humic acids, the low content of the fraction extracted from decalcified (1.8-3.5%) soil by a single processing 0.1n. NaOH is related to its very high calcareous, in alluvial-meadow soils ratio $C_{g.k}$:$C_{f.k}$ is 1.18-2.32. High mobile of humic acids in the investigated soils is also confirmed by low content of humin (26.4-43.0%) and weak development and youth of accumulative humorous mountains AU and total genetic profile in alluvial-meadow soils. The noticeable increase of humin acid content (34.5-36.9%) is observed in irrigated soils and the ratio $C_{g.k}$:$C_{f.k}$ rises till 1.37-1.50 in humus composition, Here, the noticeable increase of humin content is also noted, (45.6-50.3%).

Table 3

GROSS CHEMICAL COMPOSITION OF ALLUVIAL-MEADOW SOILS, % FROM CALCINED SUBSTANCE

Horizon, depth, cm	*PPP*	*SiO_2*	*Al_2O_3*	*Fe_2O_3*	*P_2O_5*	*CaO*	*MgO*	*SO_3*	*Na_2O*	*K_2O*	*$\frac{SiO_2}{Al_2O_3}$*	*$\frac{SiO_2}{Fe_2O_3}$*	*$\frac{SiO_2}{R_2O_3}$*
Alluvial-meadow bedded soils (455)													
AU'v 0-10	7.51	55.58	16.66	9.34	0.08	6.75	3.07	1.76	1.20	1.03	5.68	15.17	4.14
AU10-28	6.87	57.15	13.73	8.45	0.08	7.88	4.93	1.92	1.08	0.74	5.59	15.83	4.13
CI 67-103	4.71	52.96	13.21	7.74	0.06	6.95	2.88	1.24	0.91	0.70	6.71	18.80	4.94
A^h_g 103-125	7.62	56.74	15.27	9.48	0.08	9.57	3.81	1.79	1.27	0.47	5.42	15.83	4.00
Alluvial-meadow dark soils (463)													
AUv 0-12	13.84	47.80	13.89	7.69	0.12	13.83	9.77	1.84	1.42	2.71	6.05	17.89	4.52
AU 12-30	12.65	48.68	14.68	7.83	0.12	15.45	8.34	1.58	1.34	1.48	5.72	17.04	4.28
Bg 48-89	10.47	50.63	12.71	6.95	0.08	16.84	6.53	1.25	1.54	1.73	6.23	16.35	4.53
Cg 112-160	13.72	48.66	14.82	8.89	0.10	14.05	7.96	1.34	1.72	1.34	6.10	18.86	4.61
Alluvial-meadow irrigative soils (468)													
AU'a 0-25	7.53	52.85	17.78	8.43	0.10	8.05	6.79	1.47	1.20	1.63	5.86	19.41	4.50
AU"a 25-48	6.89	52.82	18.26	8.67	0.08	9.73	7.08	1.44	1.08	1.79	5.57	19.60	4.33
Bg 63-92	8.92	53.25	16.02	9.42	0.06	13.08	8.16	1.25	1.21	1.55	5.66	17.39	4.26
Cg 135-170	7.54	55.32	18.82	7.24	0.09	12.21	6.48	1.08	0.92	1.53	6.01	19.38	4.59

The investigated subtypes of alluvial- meadow soils significantly differ from each other on gross chemical composition of soils. The distribution of silicates and sesquioxide dioxides in the profile of alluvial-meadow stratification soils is mainly due to the lithological composition of alluvial deposits and their humus content, Thus, in the clay heavy-loamy humus-accumulative (AU=0-30 cm) and buried humors horizons (A^h_g=10.3-12.5 cm), the content of R_2O_3 is 24.9-26.0% in loamy sandy-loamy horizons (Cg=67-103 cm) it is reduced to 20,8%. The noticeable enrichment in upper horizons SiO_2 (55.6-57.2%) can be clarified by intensive biological accumulations that is confirmed by high ash content (5.1-7.0%) of products of the meadow grassy vegetation.

The given gross chemical analyses of alluvial-meadow dark soils indicate noticeable decay of alumina silicates as a result of alkaline hydrolysis in anaerobic conditions and content of SiO_2 is only

47.8-50.6%, but a quantity of R_2O_3 doesn't increase 19.7-21.6%. In ir*ri*gated soils the noticeable decrease of SiO_2 (3.5-4.2%) is observed on upper horizons in comparison with virgin soils. Apparently, this difference is determined by leaching impact of irrigation water on the one hand, by a different composition of irrigation sediments of forming soils on the other hand. The union of CaO is revealed in connection with enlacing of silicate Ca on upper parts of soils, u increase of CaO on underling horizons that can be explained by enrichment of soil forming alluvial deposits of calcium. Low molecular ratio SiO_2: R_2O_3 in virgin and irrigated alluvial-meadow soils (4.0-4.6) indicates to assign them to silicate-type of weathering.

Alluvial-meadow irrigated soils of the investigated object are characterized by a great capacity of humus layer and enough high supply of humus (120-200 t/ha) in layer of 0-50 cm, and nitrogen (8-12 t/ha), and also important quantity of the nutrient. They are distinguished with good aerations of upper horizons, alkalescent reactions, favorable water-physical properties. These soils are engaged with highly productive pastures, hayfields and bushes, at present. The important areas are used under irrigated vegetable, cereal crops and perennial gardens.

Conclusions

Based on the field and laboratory test data, the detailed soil maps of the test areas were compiled, and diversity of alluvial-meadow soils was classified as suborders (subtypes): alluvial-meadow primitive; alluvial-meadow layered (flaggy); alluvial-meadow dark and alluvial-meadow irrigated.

In the floodplains, local soil variability was predominantly attributed to not only alluvial sediments, but also water table, mineralization rate and salt content of underground water as well floods play an important role. The mineralization of ground water is weak (1.40-3.70 g/l) and the concentration of hydrocarbonates (HCO_3^-) varies from 0.56 to 0.92 g/l. No salinization indication found in the profile of alluvial-meadow primitive and alluvial-meadow layered soils, while weak concentration (solid content = 0.40-0.54%) was found at a depth of 80-150 cm in the alluvial-meadow dark soil. Unlike other subtypes, alluvial-meadow dark soil is characterized with the higher biomass (green weight of top = 41.5 cwt/ha and green weight of underground = 142.3 cwt/ha), high mobility of humus substances with predominance of the 1^{st} fraction of humin (20.0-28.1%) and fulvic acids (14.6-22.3%). The ratio of $C_{h.a}$:$C_{f.a}$ reaches 1.18-1.32. For the alluvial-meadow irrigated soil, the second fraction of humin acid (9,3-10,2%) and total content of humin acid ranges from 45.6 to 50.3%. The ratio of $C_{h.a}$:$C_{f.a}$ is larger (1.37-1.50). Depending on the lithology of alluvial sediments, the content of SiO_2 and R_2O_3 varies in the ranges of 53.0-57.2% and 9.6-26.0%, respectively. For the alluvial-meadow dark soil, decomposition of alum silicates in alkaline hydrolysis is typical (8.7-9.0). The content of SiO_2 and R_2O_3 varies between 47.8 and 50.6%, and 19.7 and 21.6%, respectively. In the topsoil, of the irrigated soils in associated to washing out the content of Ca and CaO content (12.2-13.1%) increases in deeper horizons.

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