Modern characteristics of the properties of meadow-boggy soils of rice agrocenosis in the republic of Adygeya

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Abstract. In this work, changes in the composition and properties of alluvial meadow-boggy soils are considered, with prolonged use in rice crop rotation and not involved in agricultural production - a virgin plot. The morphological differences of meadow-boggy soils of a rice field from a virgin area were revealed, which subsequently determine the properties of the soil cover of the Kuban River delta. The regularities of the interdependence of the granulometric composition of the soil, which lie in the mineralogical composition of alluvial soils and rocks, have been revealed. The tendency of an increase in soil density with an increase in the content of physical clay and silt, as well as an increase in the density of the solid phase of soils, has been established. No significant differences were found in the indices of the agrophysical properties of the subsurface horizons of soils and underlying sediments. The assessment of fertility indicators of meadow-boggy soil of a rice field and virgin analogue is given. Hydromorphic soil-forming processes have led to a significant change in the properties of alluvial deposits and soils involved in the rice crop rotation.

1 Introduction

This work is the result of studies of the composition and properties of soils in rice crop rotations. At present, it is not known how far the transformation of the properties of the former rainfed soils, now used in rice crop rotations, has gone. This raises questions of developing methods for restoring the properties and fertility of soils in rice fields [1, 3].

In this region, the characteristics of soil-forming rocks and soil cover of rice systems are primarily dependent on geomorphology and relief. The main elements of the relief of the Kuban River delta are mane-like rises along active or extinct eriks, flat spaces and closed vast flat depressions, which were flooded for a long time during flood periods. The absolute marks of the terrain vary from 2–4 m to zero and even negative marks [6, 7].

The parent rocks are represented by modern alluvial deposits of various granulometric composition, with a predominance of heavy and medium clays. Groundwater in the region

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under consideration lies in the range of 1–3 m, with a range of mineralization from 0.5 g / liter to 20–40 g / liter and more [8].

Natural vegetation is represented on the rises by meadow, mainly grasses, and in the depressions by sedges and reeds. Under the prevailing natural conditions, hydromorphic soils of the alluvial types were formed, in this case - alluvial meadow-boggy soils [5, 9, 11].

2 Materials and methods

The prevailing area of soils involved in the rice crop rotation is located in the delta of the Kuban River, Takhtamukaysky district of the Republic of Adygea, and studies of soil properties were carried out in this geomorphological region.

When studying the composition and properties of meadow-boggy soils, a meter thickness was investigated, taking into account the small thickness of the humus horizons of soils of 30–40 cm, the studies covered a significant thickness of the humus layer and parent rocks. At the same time, it was revealed that there are no significant differences in the parameters of the properties of the humus layer of the soil and underlying sediments. It follows from this that hydromorphic soil-forming processes did not lead to a significant change in the properties of alluvial deposits; this is due to the youthfulness of the soils under consideration. In this region, the duration of the soil formation process, repeatedly interrupted by the burial of the formed soils with fresh alluvial deposits, does not exceed 2-4 thousand years [2].

Studies on the characterization of the properties of alluvial meadow-boggy soils were carried out in this region in 2020.According to a unified technique in field and laboratory conditions, four soil sections were laid to characterize morphological characteristics and determine the properties of soils, which made it possible to apply statistical methods of data processing and evaluate their reliability. A morphological description of the genetic horizons of soils was carried out, from which soil samples were taken, in which the following types of analyzes were performed:

- organic matter - GOST 26213-91, item 1;
- exchangeable sodium - GOST 26950-86;
- granulometric composition - GOST 12536-2014, clause 4.4;
- pH of the aqueous extract - GOST 26423-85;
- pH of the salt extract - GOST 26483-85.

Based on the field soil survey and the obtained analytical results, an assessment of the structure of the soil cover of the territory, the composition and properties of soils was given, and the parameters of the fertility of alluvial meadow-bog soils were determined.

3 Results and discussion

In geomorphological terms, the study area is located in the delta of the Kuban river. During the formation of the soil cover on the described territory, geomorphological and relief conditions are decisive for such factors of soil formation as parent rocks and moisture conditions. The first studies of soils in the delta of the Kuban (S.I. Tyuremnov, L.I. Iozefovich, S.A. Zakharov, E.S. Blazhniy and others) revealed the main patterns of the evolution of soils in this region [1, 4].

On the surveyed territory, a clear dependence of the formation of soil types depending on relief conditions was revealed. Alluvial meadow-boggy soils are confined to the modern delta plain and formed on a lower part of it, sections No. 1, 2. The parent rocks are alluvial deposits of a heavy granulometric composition.

Alluvial meadow-boggy soils develop under conditions of constant moistening with groundwater, which lie at a depth of 1.5-2.5 m and periodic moistening of atmospheric

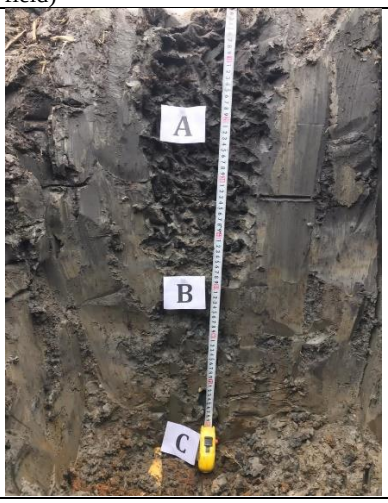
precipitation with surface water. Their soil profile is steadily located in the zone of capillary-film uplift of ground moisture, but most of these soils do not experience excessive ground moisture. The exception is short-term waterlogged meadow-boggy soils, confined to the most pronounced depressions in the relief, where there is a high level of groundwater and a more increased accumulation of moisture in atmospheric precipitation. These soils are characterized by a sharp seasonal variability of moisture conditions, expressed in abundant short-term waterlogging in winter and early spring periods and the subsequent dominance of rising moisture currents from groundwater in summer and autumn.

Alluvial meadow-boggy soils have a gray or dark gray color of the upper humus horizons, which acquires a brown hue in horizon "B". At the same time, the entire profile of alluvial meadow-boggy soils is characterized by the presence of hydromorphic features in the form of rusty-ocher spots and patches of iron oxide. Ferrous forms of iron (signs of gleying) in the form of bluish-gray spots and streaks are found in the middle part of the profile, horizon "B", and the parent rocks, as a rule, are significantly gleyed [10, 12].

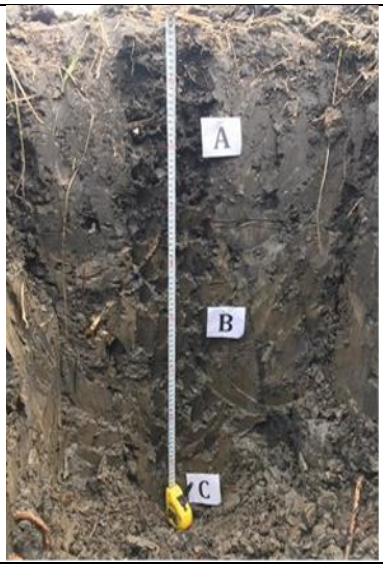
In terms of the thickness of the humus layer, the described alluvial meadow-boggy soils are not very thick.

The morphological structure of alluvial meadow-boggy soils is presented in more detail in Table 1.

Table 1. Morphological composition of alluvial meadow-boggy soils

Horizon, depth, cm	Characteristic of morphological traits of soil	
Section № 1 (Rice field)		
A 0–32	moist, dark gray almost black, lumpy structure, clayey, compacted, plant roots, gradual transition is noticeable in color	
B 32–82	moist, gray-brown with olive, lumpy-blocky, finely porous, viscous, compacted, roots, gradual transition	
C 82–90	raw, brown with a grayish tinge, structureless, finely porous, gleying, ocher	

Section № 2 (Virgin land)		
A 0–38	moist, dark gray, lumpy-nuciform structure, clayey, slightly compacted, plant roots, gradual transition is noticeable in color	
B 38–86	moist, gray-brown with olive, lumpy-cottony, viscous, compacted, roots, gradual transition	

C 86–95	moist, olive brown, structureless, finely porous, gleyed	

The granulometric composition of alluvial meadow-boggy soils is medium and heavy clay. The properties of the soil are determined by the chemical composition of primary minerals, their crystalline structure and the amount of secondary minerals formed from rocks in the process of weathering. Of the stable primary minerals, feldspars, micas, and quartz are of the greatest interest.

The content of physical clay in the humus horizon of clay varieties is 81.9–85.3%. The grain size distribution along the profile is predominantly homogeneous (Table 2).

Table 2. Granulometric composition of alluvial meadow-boggy soils

Horizon	Fractions content in % from absolutely dry soils							Granulometric composition of soil
	1-10 mm	1-0,05 mm	0,05-0,01 mm	0,01-0,002 mm	0,002-0,001 mm	less than 0,001 mm	sum of fractions less than 0,01 mm	
Section №1(rice field)								
A 0–32	–	6,26	8,46	11,49	28,79	45,00	85,28	heavy clay
B 32–82	–	4,78	6,76	9,01	32,69	46,76	88,46	heavy clay
C 82–90	–	3,11	9,95	9,23	32,29	45,42	86,94	heavy clay
Section №2(rice field)								
A 0–38	–	2,62	13,99	8,93	29,52	44,94	83,39	medium clay
B 38–60	–	5,55	12,39	9,58	26,98	45,50	82,06	medium clay
C 64–90	–	2,98	10,98	6,33	32,30	47,41	86,04	heavy clay
Section №3(rice field)								
A 0–32	–	3,21	13,02	8,65	28,48	46,64	83,77	medium clay
B 32–75	–	6,17	5,81	6,20	33,25	48,57	88,02	heavy clay
C 75–90	–	4,27	11,31	11,26	28,99	44,17	84,42	medium clay
Section №4(virgin land)								
A 0–38	–	4,63	13,43	7,97	27,55	46,42	81,94	medium clay
B 38–86	–	2,59	14,86	9,81	26,50	46,24	82,55	medium clay
C 86–95	–	7,23	19,00	6,94	23,30	43,53	73,77	light clay

Alluvial meadow-boggy soils of medium and heavy clay granulometric composition are characterized by a compacted and dense soil profile. With an increase in the granulometric composition, an increase in the bulk density and an enlargement of the structural composition are observed (large-nuciform-blocky aggregates prevail). The described soils are characterized by an unsatisfactory structural composition of the humus layer.

By the amount of soil organic matter in the humus horizon, alluvial meadow-boggy shallow soils are classified as low-humus (4.4%) and weakly-humus (3.2-3.8%) species. The distribution of humus along the horizons is uniform with a gradual decrease in its content down the profile (Table 3).

Table 3. The main chemical results of analyzes of alluvial meadow-boggy shallow soil

Horizon, depth, cm	Humus, %	Reaction of soil environment		Exchangeable sodium, mmol/100g	Sum of toxic salts, %
		water pH	salt pH		
Section № 1 (rice field)					
A 0–32	3,7	7,3	6,1	0,76	< 0,15
B 32–82	1,9	7,9	6,4	0,84	< 0,15
C 82–90	1,1	7,8	6,7	0,89	< 0,15
Section № 2 (rice field)					
A 0–38	3,8	8,0	6,6	0,78	< 0,15
B 38–60	1,6	7,9	6,4	0,90	< 0,15
C 64–90	1,3	8,0	6,7	1,00	< 0,15
Section № 3 (rice field)					
A 0–32	3,2	7,9	6,7	1,21	< 0,15
B 32–75	1,4	8,2	6,8	1,72	< 0,15
C 75–90	1,9	7,9	6,8	1,30	< 0,15
Section № 4 (virgin land)					
A 0–38	4,4	7,8	6,3	0,91	< 0,15
B 38–86	2,5	7,7	6,3	1,10	< 0,15
C 86–95	1,3	7,7	6,8	2,30	< 0,15

Alluvial meadow-boggy soils are characterized by a low amount of absorbed bases. The reaction of the soil environment is predominantly slightly alkaline pH from 7.3-8.0 in the upper horizons, to 7.7-8.2 in the horizons "B" and "C". The described soils are not saline. The content of toxic salts is <0.15%. Alluvial meadow-boggy soils are not solonetzic (the content of absorbed sodium is 0.76–1.21 mmol / 100 g in the humus horizon).

4 Conclusions

The main indicators of the properties and granulometric composition of the alluvial meadow-boggy soils of the rice agrocenosis differ from the virgin area, this difference depends on the anthropogenic impact. The introduction of rice crop rotations after the construction of rice irrigation systems paved the border between the processes of soil formation in rice agrocenoses and rainfed analogs. Chemical analysis of soil samples, field morphological examination of soil profiles shows that the territory is represented by alluvial meadow-boggy low-humus and weakly-humus varieties, with the organic matter content in the virgin area higher by 16.0% than in the rice crop rotation. The mass fraction of soil particles less than 0.01 mm is 73.77-81.94% on virgin soil and 82.06-88.46% in rice paddies. The soil layer of low thickness is not saline.

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