Features of the Soil of Subboreal Semihumid Landscape Zone within Urbanized Areas

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Abstract

The paper discusses the features of soil in the West Predkamje urbanized areas within a large urban conglomerate. Peculiarities and genesis of soils typical of northern subboreal semihumid landscape zone, deciduous landscape subzones of the studied landscape are derived. Soils formed on the eluvial-diluvial and alluvial deposits, which differ in their morphological properties are characterized. These areas are involved in long-term economic use and need special protection.

Keywords: *urbanized areas, natural and man-made landscapes, soils, soil morphology, soil-forming rocks, soil neoplasms.*

1. Introduction

Under conditions of indigenous landscape changes included into the system of natural and man-made systems in urban areas related to their active residential and technological development, one of the most promising ways to preserve their natural resource potential is the identification and preservation of the least disturbed natural systems. Within urban areas, they may present a natural frame, capable of offsetting the increasing anthropogenic influence.

It is known that the main component of any landscape is the soil cover, which combines all the internal factors of landscape into a single system. Therefore, the study of soil properties, its modern and acquired characteristics present the material to develop a forecast of land cover and, in general, natural and man-made landscapes' changes [4]. Consequence of the rise of anthropogenic load on the natural landscape within large cities, is the change of soil formation conditions and soil functioning conditions, leading to a change in the result of their ecological functions. In this regard, the study of the features of soil landscape complexes of urbanized areas is an up-to-date challenge.

Also at the present stage of development of the global soil science there is a manifestation of interest in geography, genesis and classification of soils associated with the new international project to develop the Global Soil Map (GlobalSoilmap.net) and the Universal Soil Classification (Universal soil classification) [1, 6, 7].

Investigation of soil-landscape features of deciduous northern subzone subboreal semihumid landscape zone as a result of anthropogenic transformation was carried out by laying tracks of soil-geographical profile in the vicinity of the city of Kazan (the largest town, located on the western landscape area), crossing the characteristic elements of the local topography.

Aim of the research was to study morphological and physical soil characteristics, forming within the described landscape region and reflecting ecological state of the territory.

2. Studied Area

The area is located in the region of West Predkamje. The composition of the territory is dominated by rocks and clay-loamy clay-limestone packs of tatar tier of belebeevsky series and Ufa tier Permian and Triassic systems. Quaternary deposits are widespread in sloping terrain types and determine the features of the soil-forming process. They are presented on the genesis of eluvial-diluvial and alluvial deposits, which are present in the composition of heavy loams and sands, sandy loams and light. In geomorphology, the territory of the district is a very weakly dissected accumulative terraced plains. On the watershed and Kazanka and Noksa absolute elevation marks lie within 80-140 m (Fig. 1).

The climate of the area is temperate continental with relatively wet and cool summers and moderately cold, snowy winters. Annual global radiation is 3900 mJ/m2. Radioactive dryness index on average close to 1.0. Sum of active temperatures of 2132 ° C. The annual amount of precipitation is 520-540 mm. Of them during the warm period of the year

the amount of precipitation in the area is 340-360 mm. The main artery in the area of this district is Kazanka river with its numerous tributaries, one of which is Noksa river, which has no permanent drain.

The area has mostly forest podzolic soils. Most of the territory is covered in varying degrees of clay and ashed loam soils. Generally it is a sod-podzolic on talus and Permian eluvial clay and loam. Dark gray loam soils are located on the slopes and loops of deluvial terraces. In floodplains sod-saturated soil on light sandy substrate alluvial origin dominate the area. Described landscaped area is located in the Volga-Kama sublimely flat region of northern deciduous forests with spruce and pine-lowland deciduous and pine herbal forests. Landscape structure of Nizhnemeshinskogo sublime area fully reflects the interdependency of its components and has quite a wide range of soil-forming factors that determines a variety of types and varieties of soils formed.

3. Objects and Methods

Objects of the study were the soil and watershed of Kazanka and Noksa rivers, located in the west district of the Western landscape of Nizhnemeshinskogo Predkamje within the city of Kazan (Fig. 1). Soil survey of the area was conducted in 2010-2013 by laying the track of complex geomorphologic soil profile (Fig. 2).

Fig. 1. Soil cuts along the track of the complex profile in the vicinage of Kazan

Programmed profile crossed the characteristic elements of the local landscape and passed through the watershed slopes and terraces to the river valleys of Kazanka and Noksa rivers. These watershed areas and slope complexes have small deviations (up to 20), indicating that a weakly distinguished nature of the territory.

Direct objects of research were integrated exams of soil profiles (Fig. 1). First incision was laid on top of the watershed (lined part) of Kazanka river and Noksa river. Incision 2 was laid in the middle of the slope toward the floodplain of the Noksa river. Incision 3 was laid in the vicinity of the first terrace above the floodplain terrace of Kazanka river composed of ancient alluvial folded sediments. On the slope in a line toward the floodplain of Noksa river dark gray forest loam soil on diluvial loam was found, in incision 4. The central part of the floodplain of Noksa river actual turf rich alluvial soil was discovered, incision 5.

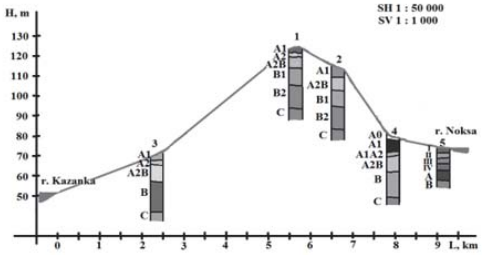

Fig. 2. Diagram of soil geomorphic watershed profile of Kazanka and Noksa rivers (1.Sod-podzolic, with mild clay

content, loamy soil 2. Gray forest soil with mild clay content 3. Sod-podzolic sandy soil poorly differentiated 4. Dark gray forest loamy soil; 5.Actual alluvial sod saturated soil)

Physical characteristics of some soil samples studied are presented in Table 1.

Table 1. Physical characteristics of soils

Horizon	Hygroscopic moisture, %	Density of soil in the hard phase g/cm^3	Particles content, %		
			>0,01 mm	<0,01 mm	<0,001 mm
Grey-forest loamy					
A1	0,84	2,47	66,11	33,89	6,15
A2B	1,13	2,54	81,80	18,20	10,88
B1	1,38	2,58	74,24	25,76	18,34
B2	2,41	2,64	72,60	27,40	17,87
Sod-podzolic sandy					
A1	0,05	2,57	95,72	4,28	0,72
A2	0,72	2,63	97,24	2,76	0,64
A2B	1,63	2,61	97,72	2,28	0,79
B	0,40	2,64	95,77	4,23	3,67

As the main method of study of soil landscape area comparative geography was used. The structure of natural-territorial complexes with a predominance of different components on different elements of the relief, different breeds, with different plant groups were compared. At each point geographical coordinates were defined using GPS - receiver and cuts were laid with full morphological description by conventional methods and sampled for subsequent physical and chemical analysis. In the study of soil profiles standard geo-botanical descriptions were performed using Atlases determinants of meadow plants and forest plants.

4. Results

Description of the soils studied. Incision 1. Soil - sod-podzolic loamy on carbonate-free eluvial-diluvial loam. Most sublime profile area lined surface watershed rivers of Kazanks and Noksa (Fig. 1). Secondary vegetation - apple orchard, herb cover is represented by sedge-forb association. The species composition of herbaceous vegetation following: sedge, dandelion, buttercup creeping cinquefoil erect, red clover, bluegrass.

Morphological description of the profile: A1,0 - 18 cm - fresh, dark gray, with desiccation gray, compact, loamy, dusty lumpy, moves worms and roots of plants, 10% HCl no effervescence; A1A2 - 18-24 cm, fresh, gray, with desiccation light gray, compact, loosely-fine lumpy-powdery, the roots of plants, 10% HCl no effervescence; A2, 24 - 40 cm, fresh, light gray, with whitish desiccation, compact, dusty, flat border, a sharp transition from 10% HCl no effervescence; A2B, 40 - 65 cm, fresh, whitish-brown, compact, loamy, nutty, abundant skeletans, humus streaks boundary linguiform, noticeable transition from 10% HCl no effervescence; B1, 65 - 99 cm, fresh, reddish-brown, dense, loamy, nutty, humus streaks, skeletans in a small amount (there are streaks of silica powder), wavy border, 10% HCl no effervescence; BC, 99 - 150cm, moist, brown, dense, prismatic, loamy, single skeletans, humus streaks on the faces of the structural units (humus Kuta), the remains of roots, root voids, 10% HCl no effervescence; C - below 150 cm, brown, loamy, 10% HCl no effervescence, carbonate-free. Depending on the diagnostic features of this soil in WRB classification it can be attributed to soil group Albeluvisoils [2, 3, 5, 9].

Incision 2. Soil - Grey forest moderately mildly alluvial underlain by ancient alluvial deposits. The middle part of the slope is directed towards the floodplain of Noksa river. Vegetation - planting birch with a predominance in the grass cover of sedge, reed land, dandelion, plantain average mouse peas, clover, campanula rotundifolia, daisy.

Morphological description of the profile: A1, 0 - 20 cm, fresh, dark gray, gray with desiccation, medium compact, powdery-fine lumpy lumpy, sandy loam, penetrated by plant roots, worms moves, the boundary is smooth, gradual transition, no effervescence of 10% HCl; A1A2, 20 - 28 cm, fresh, gray, with desiccation light gray, fine-lumpy platy, compact, sandy loam, skeletans, noticeable transition, plant roots; A2B, 28-63 cm, fresh, whitish-brown-brown, compact, loamy, abundant skeletans, humus cutan, some plant roots, transition is conspicuous, 10% HCl no effervescence; B1, 63-97 cm, fresh, reddish-brown, compact, nutty, light loamy, skeletans, humus cutan, the boundary is smooth, gradual transition, no effervescence with 10% HCl; BC, 97-150 cm, fresh, brown, dense, prismatic, medium, single skeletans, humus cutan, border smooth, gradual transition, from 10% HCl no effervescence; C below 150 cm, fresh, brown, dense,

loamy, carbonate-free, 10% HCl no effervescence. This soil type according to WRB classification can be attributed to soil group Luvisoils.

Incision 3. Sod-podzolic sandy soil poorly differentiated on ancient sediments. District of the first terrace above the floodplain of Kazanka river. Secondary vegetation is represented by sagebrush sedge grass association. Soil profile poorly differentiated.

Morphological description of the profile: A1, 0-12 cm, fresh, light gray, friable, loosely-fine lumpy-dusty, sandy, plant roots, moves worms border wavy gradual transition, from 10% HCl no effervescence; A2, 12-21 cm, fresh, whitish, loose, fine lumpy-dusty, sandy, 10% HCl no effervescence; A2B, 21-65 cm, fresh, light - yellow, friable, sandy, notably the formation of thin layers of compacted reddish brown pseudofiber (ortsand), 10% HCl no effervescence; B (65-140 cm), fresh, reddish-brown-brown, compact, nutty-dusty, sandy, there are powerful pseduofiber interlayers, 10% HCl no effervescence; C, below 140 cm, brownish sand, fresh, loose, from 10% HCl no effervescence.

Incision 4. Soil - dark gray forest moderately loamy soil on diluvial loams. Opened in a line of slope toward the floodplain of Noksa river. Tree landscape consists mainly of broad-leaved trees, there are English oak, linden, Tara, hazel. Herbage is presented by sedges, dandelion, plantain.

Morphological description of the profile: A0, 0-3 cm, forest cover; A1, 3-34 cm, fresh, dark gray, lumpy-grained, compact, loamy, the roots of plants, from 10% HCl no effervescence; A1A2, 34 - 40 cm, fresh, whitish-gray, compact, fine-lumpy, loamy, whitish powder, plant roots, the boundary is smooth, distinct transition, from 10% HCl no effervescence; A2B, 40 - 78 cm, fresh, whitish -brown, compact, heavy skeletons, numerous humus streaks, boundary tongued, noticeable transition, from 10% HCl no effervescence; B, 78-130 cm, fresh, reddish brown, nuciform, compact, loamy, skeletans, humus streaks, 10% HCl no effervescence. According to WRB classification given soil can be attributed to soil group Phaeozems.

Incision 5. Soil is actually alluvial rich and sod. The central part of the floodplain of Noksa river. In the upper part of the profile mildly distinguished bedding soil-forming alluvium is observed, profile consists of humus horizon A capacity of 25 cm, dark gray, with a lumpy-granular structure, fresh, compact, 10% HCl no effervescence, transitional horizon B, which has brown color, with nuciform structure, fresh, compact, contains no indication gley soil, maternal breed is distinguished with weak residual humus. According to WRB classification given soil refers to soil group Fluvisoils

5. Discussion

Morphological characteristics of sod-podzolic loamy, gray forest and dark gray forest soils should include abundant skeletans which are presented with streaks of siliceous powder (in the middle part of the profile in the form of a whitish mass, covering the structural units) and humus cutan in the form of chocolate film faces structural separately. Their presence is related to soil formation under mixed and deciduous forests. Morphological characteristics of sod-podzolic sandy soil can be attributed to glandular clusters as ortsand, penetrating the lower part of the profile and leading to its compaction. These formations are most common for soils taiga forest zone developed on alluvial deposits.

In the studied dark gray and gray forest soils morphologically observed lightening of the bottom of the humus horizon, highlighting transitional horizon (A1A2), which is typical for gray forest soils. Maximum lightening manifested in sod-podzolic loamy soil, where independent podzolic horizon stands apart with capacity of16 cm, which is probably due to the location of this soil type on the smoothed surface elevation watershed. Power and color of the humus horizon in loamy soils studied corresponds to natural analogues [8, 10].

Illuvial horizons in the upper parts of the profiles, both gray forest and sod-podzolic soils are heterogeneous grayish-brown in color due to a lot of humus and skeletan cutan. Structure of A2B horizon is predominantly flat and nuciform, grain size slightly heavier than the upper horizons. In the central part of the illuvial horizon coloring almost homogeneous, usually brown-brown, although some marked differences in the abundance of silica powder covering the faces of the structural units. At the bottom of the illuvial horizon appears prismatic structure, coloring becomes more intense brown color [11].

Sod-podzolic sandy soil developed on ancient sediments, characterized by poor differentiation profile of genetic horizons, the presence of a low-power humus light gray horizon, changing towards sandy podzolic horizon of white color. A characteristic feature is the presence of ocher-yellow sandy illuvial horizon, in the bottom of which there is the development of compacted and winding horizontally against pseudofiber. The layers deeper than 100 cm of ortsand achieve greater thickness and arranged much thicker, almost blending into a solid reddish-brown illuvial horizon.

Granulometric composition of sod-podzolic loam, dark gray and gray forest soils has a pronounced differentiation of the profile, which is typical for eluvial-illuvial soil type. Profile of the studied sod-podzolic sandy soil is characterized by not pronounced differentiation of granulometric composition, probably due to the peculiarities of ancient alluvial deposits,

which are parent rocks for this type.

6. Conclusion

Soil-geographical studies of the West Predkamje within Nizhnemeshinsky sublime district were conducted. For the studied landscapes (territory of Kazan) peculiarities and genesis of soils typical of northern Subboreal semihumid landscape zone, deciduous landscape subzones based on the mortgaged botanical soil-geomorphological profile crossing watershed areas of urbanized territories. Within the profile genetic groups of soil were highlighted, which differ in terms of formation conditions, especially in altitude, composition and age of the parent rocks, geomorphic surfaces, the mesotopography, vegetation. Basic soils are the following: sod-podzolic, gray forest, dark gray forest, alluvial. Studied soil differences in morphological context fully comply with the conditions and factors of soil formation of the geographical location.

It should be noted that under anthropogenic landscape change, as a result of man-made and residential development in the urban environment, directed processes occurring in soils, are expressed significantly weaker morphologically than the changes in the vegetation, because the soil is the most conservative element of the landscape. Which allows the soil cover to enforce its biosphere and ecological functions under conditions of natural-anthropogenic landscapes.

7. Findings

1. Landscape structure of the investigated area and burial grounds directly integrated profile is characterized by a fairly wide range of environmental and soil-forming conditions, which lead to high nature and soil diversity.
2. Soil cover consists of combination and complexes of automorphic and hydromorphic soils, usual for subboreal semihumid northern landscape zone.
3. Variety of natural conditions, dynamics and activity of soil-forming processes, differences in particle size and chemical composition of quaternary sediments have determined the soil variety of the area.

References

Golden M., Micheli E., Ditzler C., Eswaran H., Owens P., Zhang G., McBratney A., Hempel J., Montanarella L. , Schad P. Time for a Universal soil classification system // Proceedings of the 19th World Congress of Soil Science, Soil Solutions for a Changing World. ISBN 978-0-646-53783-2, published on DVD, http://www.iuss.org, Symposium 1.4.1. Classification and information demand. Brisbane, Australia: IUSS, 2010. P. 48-51.

Guidelines for soil descriptions. 4th edition.- Rome: FAO.- 2006. – 97 p.

IUSS Working Group WRB. World Reference Base for Soil Resources. World Soil Resources Reports No. 103. FAO, Rome. 2006/ 128 p.

Klimentyev A.I., Pavleichik V.M.m Chibilev A.A., Groshev I.V., Lozhkin I.V., Nesterenko U.M. Soils and landscapes of Kzyldyr Karst Field in the South Ural // Eurasian Soil Science, 2007. #1. P.7-17.

Lecture notes on the major soils of the world (with CD-ROM) // World Soil Resourcer Report No 94 / Ed. By P. Drirssen, J. Deckers, O. Spaargaren, F. Nachergaele. – Rome: FAO. 2001. – 334 p.

Sanchez P.A., Ahamed S.F., Carre A.E., Hartemink J., Hempel J., Huising P., Lagacherie A.B., McBratney A., McKenzie M.L. de Mendonca-Santos et al. Digital soil map of the World // Science. 2009. V. 325. No 5941. P.680-681.

Semikolennyh A.A., Bovkunov A.D., Aleinkikov A.A. Soils and soil cover of the taiga belt of the North Ural (upper reaches of Pechora river)// Eurasian Soil Science. 2013. #8. P. 821-832.

Ulanova N/G/ The effects of windthrow on forests at different spatial scales: a review // For. Ecol. Manage. 2000. V. 135. P. 155-167.

World reference base for soil resources 2006. A framework for international classification, correlation and communication. 206 edition // World Soil Resources Reports No. 103/ - Rome: FAO, 2006. - 132 p.

Zaidelman F.R., Nikoforova A.S. et al. Dark-grey soils of the Tambov plain: agroecology, characteristics and diagnostics // Eurasian Soil Science, 2012, #5. P. 459-471.

Zaidelman F.R., Rydkin UY. I. Soils of Opol'e Regions in the forest zone: genesis, hydrology, reclamation, and use // Eurasian Soil Science, 2003, # 3. P. 241-252.