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Short Note

Soils of the Prinevskaya Lowland and Prospects for Their Use

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Abstract: The paper presents the results of soil research in the Prinevskaya lowland within the boundaries of St. Petersburg. The study of the direction and rate of change in the properties of fallow lands, aimed at understanding the process of post-agrogenic transformation of soils, as well as the development of a monitoring system for changes in the parameters and properties of fallow soils will contribute to the optimization of the soil-ecological state of soils excluded from agricultural turnover in St. Petersburg and the Leningrad region.

Keywords: prinevskaya lowland; fallow soils; agriculture

Soils are one of the main environmental objects, a difficult-to-renewable natural resource, which is characterized by fertility. They are also the central link of the biosphere, the main source of food, life support and human activity, the habitat and source of existence of the flora and fauna.

Urban soils are one of the most important components of the urban environment, an integral part of humans, plants and animals habitat, as well as the basis for economic and other activities. Soils state is of utmost importance in assessing the ecological state of a particular territory, since soils are of interest in at least three directions: as the initial link in the food chain, as a source of secondary pollution of the atmosphere and water, and as a consolidated indicator of the ecological state of the environment. Often a city expands its territory to adjacent lands developed and used in agriculture, on which various agronatural soils and agrozems with a specific agrogenic horizon have formed.

A large area of the St. Petersburg city is occupied by the Prinevskaya lowland plain. It is a terraced lacustrine-glacial plain composed of the glaciolimmium of the Baltic glacial lake.

The Prinevskaya lowland is a flat area lying between the Gulf of Finland and Lake Ladoga. The history of its formation is associated with the abrasion-accumulative activity of late- and post-glacial basins, which determined the diversity of soil-forming rocks found here. An important feature of the Prinevskaya lowland plain is that most of its area is occupied by St. Petersburg city and the industrial and agricultural enterprises working for it. It determines the significant role of the anthropogenic factor in the genesis of lowland soils for the past three centuries.

The Prinevskiy landscape develops on sandy hills or loamy moraine deposits as well as on banded clays that form the Prinevskaya lowland plain. It is characterized by middle taiga forests, high and lowland swamps, and overgrown lakes. The Prinevskaya lowland plain was formed in pre-glacial times. The formation of the modern landscape began with the retreat of the last Valdai glaciation. It occupied the smallest area, with the most severe climatic conditions.

Currently, the Prinevskaya lowland plain is the main area of suburban agriculture, providing the city with potatoes and vegetables, as well as the territory for animal feed. The fields were drained, limed, and high doses of organic and mineral fertilizers were applied.

Unfortunately, the economic downturn in the country in the 1990s and early 2000s was accompanied by contradictions in land use, which led to the reduction of arable land. Due to the new economic situation, a significant share of arable land in St. Petersburg has become fallow. The fallow and natural overgrowing of agricultural lands is not only characteristic of the last 15-20 years. The majority of territories of the southern taiga subzone have been subjected to anthropogenic impact to

a greater or lesser extent during the historical period, and as a result, many sod-podzol soils are the result of evolution of old ploughed areas into forest lands.

In addition, in 2022, the Russian Government announced the program of "Second Development" of virgin lands. More than 750 billion rubles will be allocated to reclaim virgin and fallow soils in Russia in the coming years. The inventory of fallow lands of different regions and natural zones of Russia is becoming extremely urgent. The North-West region of Russia is a unique museum of fallow land diversity. The quality of lands, their biological parameters and fertility level have a decisive influence on the quality of agricultural products, including seed and grain products. The study of sanitary-hygienic and soil-ecological condition and diversity of Prinevskaya lowland soils and fertility is necessary to increase crop yields and regulate crop quality, as well as to increase its competitiveness in the world market.

The peculiarities of the soils of this territory were covered in the works of R.V. Rispolozhensky (1908), L.I. Prasolov (1922), N.L. Blagovidov (1946), M.N. Vladimirova (1973), "Soils of the Leningrad Region" (1973), N.G. Orejskaya (1974), A.V. Kozlov (1975), A.V. Litvinovich (1985), E.I. Gagarina, N.N. Matinyan et al. (1995) and a number of others. The above mentioned works were written in the last century, their actualization is required. At the same time, the diversity of soils and their chemical state are studied very poorly. There are problems in characterizing the study of the sanitary and hygienic state of soils, there are gaps in information on the dynamics of soil development in agrolandscapes, as well as in information on the sources of polychemical pollution of soils and soil cover. The current level of knowledge accumulated in the study of geochemistry of natural and anthropogenic landscapes of St. Petersburg and the Leningrad region does not allow to close all the issues related to the ecological and geochemical state of soils of the Prinevskaya lowland.

Parametrization of soil formation processes is the most important task of fundamental and applied soil science throughout the entire development of this science. Parameterization of processes is necessary for their quantitative and qualitative assessment, which can be further used for management of processes and agroecological potential of agroecosystems, as well as for practical implementation of practical aspects of environmental management. This task is solved in several ways: (1) parameterization of components of soil-forming potential of the environment, (2) soil appraisal, (3) assessment of ecosystem services (services), including functional, depository, spatial, supporting and resource services. The last point is relatively new and not well developed. Thus, monetization of ecosystem services should be preceded by their identification and parameterization. This process should be verified and based on standardized databases for each region. At the same time, retrospective analysis of soil condition [4] is the most important tool of modern soil science and can be used in chronologies of fallow soil progradation/degradation to qualitatively identify and quantify the implementation of their ecosystem functions.

According to official sources, currently in Russia 30 to 40 million hectares of arable land is out of turnover and not used, which is converted into fallow land and transformed under the influence of natural and anthropogenic processes of soil formation, soil self-development, forest overgrowth, sodding, siltation, swamping, waterlogging, etc. [1,2]. In the North-West Federal District (NWFD) of the Russian Federation, according to the data of Rosreestr as of 01.01.2017, the area of agricultural land was equal to 31418.4 thousand hectares, which amounted to 18.6% of the total land area in the NWFD and 8.2% of the area of agricultural land in Russia. According to the most approximate estimates, more than half of these lands went into fallow state. Some of them immediately after the radical change of the economic and agricultural paradigm at the end of the twentieth century, some of them - later, already in the twenty-first century.

In the conditions of the Leningrad region, where arable land contours with the area of 3-15 ha, surrounded mostly by forests and swamps, are dominant, it is enough to put the land into pasture land without proper care for 3-4 years to start the process of overgrowing. After 5-7 years from the beginning of arable land removal, cultural plowing on them without agro-reclamation measures becomes practically impossible.

The process of postagrogenic evolution of former agricultural lands follows classical succession patterns towards the formation of zonal types of ecosystems. In parallel with the restoration of zonal

vegetation, there is also a natural change in the morphogenetic characteristics of soils, their physical, chemical and biological properties during postagrogenic evolution. Secondary forest ecosystems with mixed coniferous and small-leaved trees are formed on fallow lands after 20-30 years. Processes of the eluvial-illuvial series are initiated in sandy and loamy-clayey soils. Intensive accumulation of litter occurs.

As for peatlands (drained and deeply ameliorated soils of upland and lowland bogs), spread on the vast areas of the eastern part of the Leningrad region, there is no restoration of natural ecosystems and even no tendency to move in this direction. Peat bogs ameliorated by closed drains remain in the state of uncertain quasi-equilibrium postagrogenic stage of ontogenesis for years. A separate problem is presented by fallow sod-carbonate soils of Izhorskaya Upland, which are used not for their direct purpose, because poultry farm wastes are often placed on them.

Transition to fallow lands and overgrowing of agricultural lands with forests — a consequence of socio-economic conditions characteristic not only for the last two decades. In order to involve fallow lands in agricultural turnover and development of reclamation measures in May 2021, the RF Government Decree No. 731 dated 14.05.2021 "On the State Program of effective involvement of agricultural lands in turnover and development of reclamation complex of the Russian Federation" was issued [3]. Ref. [3], according to which for the period from 2022 to 2031 it is necessary to ensure the involvement in turnover of 13.2 million hectares of unused land and preservation of reclaimed soils in agricultural turnover on the area of at least 3.6 million hectares. The document also formulates the tasks of collecting information on the current state of agricultural land. Therefore, the issue of inventory of fallow lands, virgin lands and lands already used in agriculture remains important.

Active and fallow agroecosystems are a unique object, which is represented by models of development, degradation, progradation and, in general, the evolution of biogeocenoses components in time and space in connection with the positive and negative dynamics of agrogenic impact during the 20th century on the territory of the Russian Federation. The North-Western region in this sense is of particular interest, since there has been both large-scale development of land and uncontrolled transfer of land into fallow state and their removal from fallow state recently. There were also processes of drainage and irrigation, intensive land reclamation. All this led to the formation of chronosequences of soils with varying degrees of influence of agrogenic factors.

The edaphic diversity and polychemical status of soils in the Prinevskaya Lowland were studied on the example of following objects (Figure 1):

1. agricultural and fallow soils of agrolandscapes on the territory of former state farms;
2. soils of forest lands;
3. urbanized soils under residential areas;
4. soils of industrial areas.



a



b

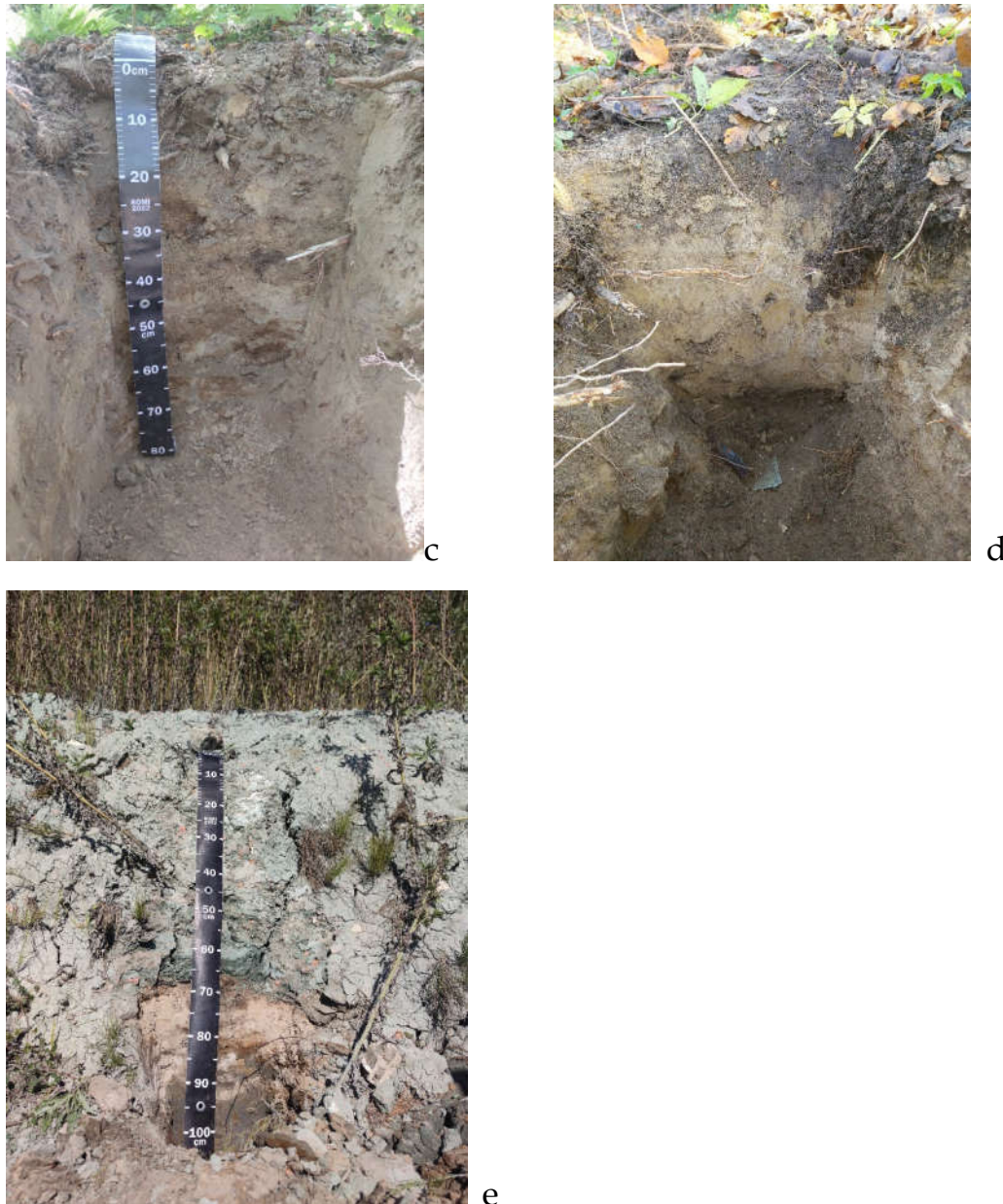


Figure 1. Studied soils: a) agrozem texture-differentiated subeluvial loamy loam on Cambrian clays on the territory of an agricultural field, north-west of the New Kolpino Cemetery. b) agrosoil ameliorative deep-turbid redoximorphic sandy loam on overwashed fluvioglacial deposits of the Prikoltushskaya part of the Prinevskaya Lowland in an agricultural field at the forest border near the village of Manushkino. c) soddy podbur redoxymorphic sandy loam on Kamov sandy loam (Nevsky forest park). d) agrodernovo-podzol sandy loam with buried gray humus horizon near the Almazov National Medical Center of the Ministry of Health of Russia. e) lithostratite on Cambrian clay on the territory of the Cambrian clay quarry, west of the Krasny Bor landfill site.

The high degree of agricultural soils development of the Prinevskaya lowland plain and the significant role of the lithological factor in the formation of the soil cover of studied territory explain the need for further research: the study of the sanitary-hygienic and soil-ecological state and diversity of the soils of the Nevsky lowland to optimize soil monitoring methods and green management systems.

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