

# Urban soils classification for Russian cities of the taiga zone

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## Abstract

Urban soils are formed under the combined influence of natural and anthropogenic factors. The latter are determined by specific land use practices in the urban environment. The first Russia classification of soils and soil-like bodies within a town was proposed by Stroganova et. al. (1997-1999). In this paper we distinguish and describe two new groups of urban soils "urbanozems" which are opened urban soils and "ekranozems" which are urban soils sealed by road surfaces). Soils of towns comprise natural (undisturbed) and human-transformed soils, which are further subdivided into surface-transformed, and deeply transformed soils. There are also human-made, or technogenic, soil-like bodies-technozems. The urbic diagnostic horizon is an individual horizon with individual features and to be characterized by the pedogenetic agents responsible for its properties, as well as by the processes inherent to this horizon. The Urbic horizon is considered as a diagnostic one for the majority of urban soils and a criterion to differentiate urban soils from natural soils.

**Keywords:** Human-transformed soils, urban soils classification, urbanozem, urbic diagnostic horizon.

## Introduction.

Human activities are intensive and diverse in towns. The impact of man transforms the major pedogenetic agents and soil itself. The main factor of soil formation in towns is the land use type (industrial zones, settlement areas, natural gardens, etc.)

Soils of a city are described for the first time as specific natural-anthropogenic phenomena contrary to their former perception as non-soils. The thousand-year-old urban civilization produced specific groups of soils. It is a good reason for the investigation of urban soils.

Urban soils are essentially distinguished from natural soils by:

- parent material: filled, washed or mixed sediments, or cultural layers;
- occurrence of fragments of construction and household waste in the topsoil;
- new acid-alkaline balance with a tendency for alkalization;
- high pollution with heavy metals and oil products;
- different physical-mechanical properties (lower water retention capacity, strong compaction, stoniness, etc.);
- upward growth of the soil profile due to intensive aerial deposition.
- ( Each of the above features may be inherent to natural soils (volcanic, alluvial, rendzina), while their combination may be unique and "incompatible" with the natural environment.)

The content of nutrients varies considerably in urban soils but on average it is high.

## Materials and Methods

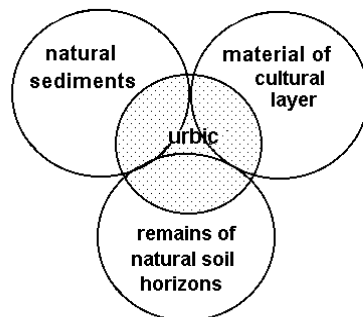
We investigated town soils in the nonchernozem zone of the European part of Russia. These are located in Moscow, Saint-Petersburg, Smolensk and Nizhny-Novgorod.

This classification of soils and soil-like bodies within a town was firstly proposed by Professor Stroganova et. al. (1997). We've distinguished and described in detail two new groups of soils 3"urbanozems" (These are opened urban soils) and "ekranozems" (These are urban soils sealed by road surfaces).

To characterize the **urbic** (urbs, urbanus-town, city) **diagnostic horizon** it is necessary to base its definition on the individual features while taking into account the pedogenetic agents responsible for its properties. In the Revised Legend of Soil map of the World (FAO, 1988) and in WRB (FAO, 1998) where "*urbic material*" is defined as "*anthropogeomorphic soil material*" containing more than 35 % (by volume) earthy material mixed with building rubble and artifacts

The Urbic horizon is defined here as a surface organo-mineral horizon resulting from mixing, filling, burial or pollution, or it is the upper part of the cultivated layer contaminated by industrial or town-produced wastes (more than 5%). It is thicker than 5 cm. The urbic horizon may be: soddy, humus-enriched, gleyed, carbonate-enriched, contaminated with petroleum etc.

Urbic diagnostic horizon consist of remains of natural soils, different artifacts and other matter of urban cultivated layer (Figure 1). Urbic includes also natural sediments contaminated by human activity.



**Figure 1. Composition of Urbic horizon.**

Urbic horizon have some characteristic features. They are brown in color; contain weakly decomposed organic matter; have mostly a weak structure, are dominated by clods, platy blocks and crumbs; are characterized by general heterogeneity and abundance of artifacts. Thin section studies revealed the presence of active carbonates, micro fragments of natural soil horizons, neoformed minerals.

The Urbic horizon is regarded as a diagnostic one for the majority of urban soils and a criterion to discriminate them with the natural soils. It might be formed in towns during centuries, or be "constructed" in a few days in the course of landscape designing, forming lawns or gardens.

## Results and Discussion

There are soils, soil-like bodies and different sediments in town. Soils of towns comprise *natural* (undisturbed) and *human-transformed* soils, which are further subdivided into surface-transformed, and deeply transformed. There are also *human-made*, or technogenic, soil-like bodies-technozems (Table 1a).

The *natural* undisturbed soils preserve the normal profiles and occur under urban forests and forest-parks located within the town. Their properties may be weakly transformed. Chemical analyses may reveal elevated concentrations of heavy metals, higher pH values than in similar soils outside the town. They may also contain some artifacts.

The *surface-transformed soils* comprise soils with transformations not penetrating deeper than 50 cm. Their topsoil is characterized by set of urbic horizons less than 50-cm thick; the subsoil is undisturbed and presented by undisturbed natural soil horizons. These are remains of natural profiles. These soils are named urbo-soils.

The nomenclature for these soil classes follows the rules used in the new Russian Taxonomy for agricultural soils. Thus, the surface-transformed soils are termed "urbo-soils" like "agro-soils", f.i., agro-chnozems, agro-podzolic soils, etc; so we have urbo-podzolic, urbo-alluvial, urbo-peaty soils in Moscow.

For *deeply transformed soils* the term "urbanozem" is proposed. Soil group of Urbanozems includes soils with the set of urbic horizons (U1, U2, etc.) thicker than 50cm, sometimes followed by impermeable layers (asphalt, concrete plates, pipelines), no other genetic horizons may be recognized to the depth of 50 cm and even lower.

*Urbanozem* is the central concept for soils in towns and cities. There are three major ways for these soils to be formed: 1) development on loose artificial deposits; 2) evolution of the cultivated layer - anthropic material; 3) transformations of natural soils.

**Table 1. Categories of surface bodies occurring in urban areas**

a)

Open unsealed areas					
Soils			Soil-like bodies	Sediments	
Natural	Human-transformed		Human-made		
	Surface transformed	Deeply transformed			
with urbic features	Urbo-soil	Urbanozem	Technozem	Sediments: natural (fills, dredged, mixed, etc.)	Sediments: technogenic (industrial wastes, ash, slag, etc.)
<ul style="list-style-type: none"> <li>• podzolic</li> <li>• alluvial</li> <li>• peaty</li> <li>• etc</li> </ul>	<ul style="list-style-type: none"> <li>• urbo-podzolic</li> <li>• urbo-podzolic-gley</li> <li>• urbo-alluvial</li> <li>• etc.</li> </ul>	<ul style="list-style-type: none"> <li>• urbanozem</li> <li>• agrourbanozem</li> <li>• nekrozem</li> <li>• industrizem</li> <li>• intruzem</li> </ul>	<ul style="list-style-type: none"> <li>• replantozem</li> <li>• construtozem</li> </ul>	<ul style="list-style-type: none"> <li>• naturfabrilites</li> <li>• abralites</li> <li>• petrolites</li> <li>• stratolites</li> <li>• rudelites</li> </ul>	<ul style="list-style-type: none"> <li>• artifabrilites</li> </ul>

b)

Sealed areas		
Soils and soil-like bodies	Sediments: natural and human-made	Builtup areas
Under asphalt, concrete or any other hard impermeable coverage		Under basements of buildings
<b>Ekranozem</b>	<b>Sealed sediments</b>	
over/on: <ul style="list-style-type: none"> <li>• natural soil,</li> <li>• urbo-soil,</li> <li>• urbanozem</li> <li>• technozem</li> </ul>	Sealed: <ul style="list-style-type: none"> <li>• abralites,</li> <li>• petrolites,</li> <li>• stratolites,</li> <li>• rudelites</li> <li>• etc.</li> </ul>	

Urbanozems comprise some specific type of soils, which are termed in accordance with the agent of their mechanical pedoturbation: *culturozem*, *nekrozem* and chemically altered soils *-industrizems* and *intruzems*. Along with these soils, soil-like *human-made* superficial bodies occur in towns. There are *technozems*. These artificial soils made by application to parent rock of fertile soil material, peat and/or composts or by constructed of difficult soil-like profiles. In modern towns, up to 70-90% of the area is sealed by asphalt-concrete and other road coverings, or is under buildings. Natural soils, soil-like bodies and grounds may occur under the asphalt concrete. *Sealed soils* and ground are common ingredients of town. They should be studied and mapped, since their properties affect the ecological situation in towns.

We specify a separate group of soils sealed by asphalt-concrete and stony road coverings - *Ekranozems*. This term originated from the Russian word "ekran" it means "screen" or "barrier" (Table.1b).

Further subdivision of urban soils into genera, species, varieties and phases follows the traditional rules of the Russian Soil Classification. The criteria to further subdivide human-affected soils are based on soil properties indicating a weak development of either natural or human-induced processes.

Following the traditional approach, the extent of development of any phenomena in the soil or the abundance of any other qualitative parameter is referred to at the species level. Thus, there are several soil properties characterized at the species level:

- profile thickness: weakly developed soils <10 cm; shallow soils 10-50 cm; moderately deep soils 50-100 cm; deep soils >100 cm.
- type of artifacts: construction and municipal waste, industrial waste, peat-mucky inclusions and fragments of soil horizons.
- abundance of artifacts, percentage of the soil volume; few <25; common 25-50; many >50.
- depth of humus-enriched layer: shallow <15cm; moderate 15-30 cm; deep >30 cm.
- manifestations of gley: superficially and deeply gleyed.

Examples of full names of soils are rather long and intricate: urbo-podzolic deeply gleyed lead-polluted loamy soil on loamy till; shallow carbonate low-humus stony loamy sandy replantozem on construction waste, etc.

## Conclusions

Attempts were made to correlate between Urbanozems in the Russian classification and soils described in WRB.

Gleyic, stagnic, strongly humic diagnostic properties and secondary carbonates were described in different profiles of urban soils. All kinds of anthropogeomorphic soil material and calcaric soil material as defined in WRB may be present in Urbo-soils, Urbanozems and Ecranozems.

The major part of urban soils is classified in WRB as Urbic Anthropic Regosols. Some urban soils may be classified as Hortic or Terric Anthrosols (old cultivated soils). But in cities all cultivated soils affected by special urban anthropogenic activity (air pollution, addition of construction rubbles and others). So, soils of botanic gardens, city gardens, parks and agricultural areas that are polluted by heavy metals, hazardous substances, domestic wastes, construction rubbles and others anthropogenic materials should use the qualifier "toxic". One may have a problem to distinguish Urbic Anthropic Regosols and Hortic Anthrosol in cities, because they have similar morphological and chemical properties.

In the WRB classification system to classify soils with buried natural horizons and whole buried natural soil profiles may be shown by the "Thapto" formative element.

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