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CONSIDERATION ON SOME PROPERTIES OF LINIC AND EKRANIC TECHNOSOLS FROM URBAN AREAS

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Abstract: In recent periods, urban soils have been extensively studied. These studies contribute to better understanding of the soil cover diversity in the urban area, identification of changes and threats resulting from expansion of urbanization and industrialization. The aim of our study is to identify to define correctly some urban soils, such as "technogenic soils", that are recently introduced in the soil classification and are constantly updated and completed. The studied sites are located in the urban areas from northeastern part of Romania. In our studies we made several soil profiles. The studied soils have been diagnosed according to the Romanian System of Soil Taxonomy and World Reference Base for Soil Resource. Characterization of soil profiles was done following the instructions from guidelines for soil and land descriptions. The urban soils are characterized by a strong spatial heterogeneity resulting from various input of exogenous materials and mixing of material from different soil horizons. Case studies conducted in several locations of urban areas showed that Ekranic and Linic Technosols keeps some undisturbed soil properties such as particle size, mineralogical composition and allows some plants roots to develop their roots. We believe that the results obtained during our investigations will facilitate easier identification in the field of urban soils such as Linic and Ekranic Technosols and the establishment of appropriate management.

Keywords: *residential area, soil cover diversity, spatial heterogeneity, technogenic soils*

INTRODUCTION

Soils in urban and suburban areas are strongly modified by human activities.
Urban soils are also characterized by a strong spatial heterogeneity due to various inputs of exogenous materials such as bricks, pottery, glass, crushed or dressed stone, wooden boards, industrial waste, garbage, processed oil products, bitumen, mine spoil and crude oil. These exogenous materials are called artefacts and usually are mixed with original soil material or original soil material or lithological layers [1 – 3].
In urban areas, soils provide support for buildings, roads, parking lots, shelter for cables and pipes of various size and composition (drinking water, wastewater, gas), and substrate for plants [4].
According to Stroganova et al. (1998), the soil surface can be covered or isolated from the impact of the atmosphere by buildings, permeable and impermeable road surfaces such as pavement, gravel, road surfaces asphalt, concrete [5]. One of the main problems in urban ecology is the covering of huge areas with impermeable surfaces of asphalt or concrete plates [6]. For a long time, surfaces covered with continuous, impermeable or poorly permeable constructed geomembrane have been regarded as non-soil areas.
It was also believed that survey, describing, classification and mapping soils in urban areas would be very difficult and even impossible due to the very large spatial vertical and horizontal variability of soils on small areas resulting from the occurrence of various exogenous material (artefacts) mixing with remnants of natural soils, the young age of urban deposits [7 – 9]. The artefacts found in urban soils are represented by pieces of bricks, concrete, pottery, glass, crushed or dressed stone, wooden boards, metal wires, slag, industrial waste, garbage, processed oil products, bitumen, mine spoil and crude oil [10]. In the first edition of the World reference base for soil resources [11] the technogenic soils were allocated to the Regosols.
Starting with 2006, these soils belong to the Technosols reference group. It was an important step forward in soil classification 10. After World Reference Base for Soil Resources Technosols can be ekranic, linic, urbic spolic garbic cryic isolatic leptic subaquatic tidalic reductic and hyperskeletic [1].
„Linic" qualifier is used with Technosols that have a continuous, very slowly permeable to impermeable constructed geomembrane of any thickness starting ≤ 100 cm from the soil surface. This geomembrane separates completely separates the soil material into two soils isolated from each other.
Soils with very slowly permeable or impermeable geomembranes were included for the first time in the Romanian Soil Taxonomy System (SRTS-2003) in the class "Protisoluri" under the name "Entiantrosol litoplacic" [12].
In the Romanian Soil Taxonomy System (SRTS-2012 and SRTS 2012+), "Linic Technosols" is named as" Tehnosol antroplacic" and it is defined as a soil with a compact, artificial layer (hardened, paved, concreted, asphalted, etc.), continuous which start from different depths. It is usually impermeable [2, 3, 13].
„Ekranic" qualifier is provided for technosols that have technic hard material like asphalt or concrete starting with depth of 0-5 cm from the soil surface, often exactly at the soil surface [1, 14].
„Ekranic tehnosol" was first introduced in the Romanian Soil Taxonomy System in 2012 [2]. It is defined by an artificial compact layer (through anthropogenic processes) starting from the first 4 cm and covering over 90 % of the land surface. Some urban

soils such as technosols, have strongly modified properties and perform only part of the specific functions that allow only low biological activity and root growth of plant species [15].

The difficulty of rendering the great heterogeneity of the soil cover in urban spaces is also due to the multitude of complex changes in the properties of these soils and which often do not reflect a spatial dependence and do not respect a certain correlation with natural environmental factors [16 – 18].

If urban soils are used to achieve a pleasant ornamental landscapes, the main goal is to obtain quality, aesthetically pleasing plants. Hardiness, resistance to pest, color and abundance of blooms are more important than yield of obtained biomass. Labor costs and convenience are generally of more concern than fertilizers costs. Expensive, slow release fertilizers are also widely used [19].

We mention that these soils are recently introduced in the soil classification and are constantly updated and completed. We believe that the results obtained during our investigations will facilitate easier identification in the field of urban soils such as Linic and Ekranic Technosols and the establishment of appropriate management.

We also consider that the characteristics of the Ekranic and Linic Technosols presented in this paper will facilitate an easier field recognition of these soils, the more precise correlation of the taxa within the Romanian Soil Taxonomy System with international soil classification World Reference Base for Soil Resources (WRB 2014).

The use of existing information on Technosols and extrapolation of the results obtained in the field of sustainable use of urban soils is facilitated by the appropriate correlation of the terms used in different national soil classifications with the latest international classifications. The results obtained in the soil studies will be taken into account when completing and updating the taxa at different levels within the national and international soil classification systems.

MATERIALS AND METHODS

Investigations were conducted in urban and periurban area of Iasi. It is located in the central eastern part of Romania, at 47˚10' northern latitude and 27˚35' eastern longitude.

Have been studied sidewalks, asphalt alleys and paved paths, in the immediate vicinity of roads, in parks or near the historical monument, technosols separated by geomembranes from dump depots and in different stages of construction.

The representative soil from agricultural area is Haplic Chernozems.

Degradation of asphalted alleys and sidewalks in the immediate proximity of roads after infestation with different plant species has been also studied.

In the studied locations were identified the plant species that developed and samples of biological material were taken. Biological collected material was used in order to establish genus and species of plants. The binomial nomenclature of plant species was done on behalf of the rules of the International Code for Botanic Nomenclature reviewed in the latest taxonomy works [20, 21].

In the studied urban area have been taken many pictures with digital camera. The obtained images in the field were stored, analyzed and processed on the computer.

In some places, soil profiles have been made and characterized. The characteristics of some soil covered by asphalt or pavers were estimated based on the properties of soil from around studied area.
Characterization of soils was done following the instructions of guidelines for soil and land descriptions [22, 23]. Soil samples were taken from each soil horizon in order to conduct laboratory analyses: according to the current methodology [24, 25]. Following the processing and analysis of the data obtained in the field and laboratory, we diagnosed studied soils according to the World Reference Base for Soil Resource [1].

RESULTS AND DISCUSSIONS

After criteria of the World Reference Base for Soil Resources [1] three subtypes of Technosols are recognised: with artefacts (i), with a geomembrane (ii) and with technic hard material (iii).
Depending on the type of artefacts, technosols can be urbic (1) spolic (2) and garbic (3).
Technosols with a geomembrane within 100 cm from the soil surface, which completely separates the soil material into two soils isolated from each other are defined as "Linic Technosols".
In our investigations we identified several soils that were separated by impermeable or permeable membranes. The soil above the separation membrane has all the characteristics of technosol.
Linic Technosols separated by continuous concrete membrane from Haplic Chernozems was identified near the industrial area (Figure 1).

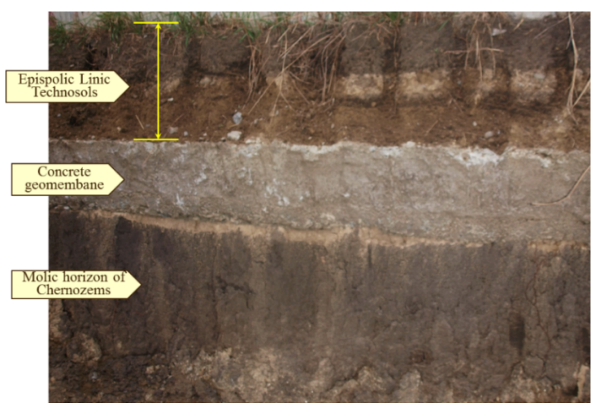

Figure 1. *Concrete membrane that separates Epispolic Linic Thehnosols from Haplic Chernozems*

Above the concrete membrane is the soil consisting of humic horizon followed by a layer of spolic material containing soil from the cambic horizon, loessoid deposit and some concrete artefacts.
The presence of the concrete membrane prevents the infiltration of water and the penetration of plant roots. The analytical data from Table 1 show clear differences between the humic horizon with slight acide reaction and well supplied with humus and the underlying layer containing artifacts and calcium carbonate which a slight alkaline reaction.

Table 1. *Some properties of Epispolic Linic Technosols and humic horizon of Haplic Chernozems*

Depth [cm]	**Size particle [mm]**				*p*H	$CaCO_3$ [%]	Humus [%]
	0.2÷2	0.02÷0.2	0.002÷0.02	<0.002			
0-35	1.1	40.6	28.1	30.2	6.5	-	3.4
35-78	3.4	36.7	24.8	35.1	7.8	5.8	-
78-115	Concrete membrane						
115-158	-	43.3	29.3	27.4	6.7	-	3.7

Epispolic Linic Technosols has moderate restrictions for plants due to the presence of concrete artefacts, the continuous concrete membrane that prevents the penetration of roots and reduces the soil's ability to retain water.
Another studied Linic Spolic Technools have been constructed intentionally in order to ensure good conditions for growing plants to ensure drainage through the gravel layer and prevent soil contamination with gaseous compounds resulting from the decomposition of garbage materials from deposit (Figure 2).

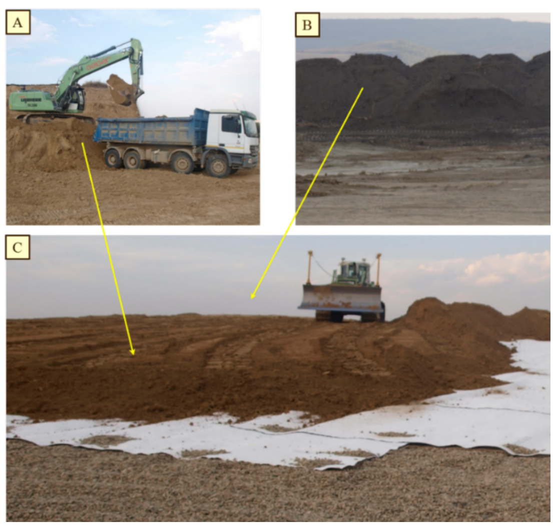

Figure 2. *Source of lithogenic and humic soil material for Linic Spolic Technosols under construction*

Linic Spolic Technosols under construction will consist of a layer of medium-textured material from the lithological layer (Figure 2A) and a humic layer resulting from the top of the soil that covers the loess-like deposit (Figure 2B). The total thickness of the soil will be 100 cm, and that of the humus trawl will be 15 cm.
The lithological deposit from which the material for covering the deposit is taken is made up of layers with relatively homogeneous texture (Figure 2C). This layer from depth of 15 - 100 cm has a medium and homogeneous texture (Table 2).

Table 2. *Some properties of constructed Linic Technosols and humic horizon*

Depth [cm]	**Size particle [mm]**			*p*H	$CaCO_3$ [%]	Humus	Plasticity number
	0.02÷0.2	0.002÷0.02	<0.002				
0-15	50.4	31.7	17.9	6.4	-	3.7	17.2
15-100	45.7	29.5	24.8	8.3	9.2	-	15.6

New constructed soil has favorable physical and chemical properties for plants.
Bioavailability of nutrients for plants is high in the upper part (0 - 15 cm) of slight acid soil with *p*H value of 6.4 and with 3.7 % humus.
At the depth of 15 - 100 cm the soil becomes slightly alkaline. We mention that the accessibility of the nutrients of phosphorus, zinc, copper decreases in alkaline soils.
The plasticity index has values of 17.2 and 15.6.
The total amount of water that can be retained by new constructed soil is estimated at 2120 $m^3 \cdot ha^{-1}$.
Soil has a good capacity to retain useful water due to lower values of wilting coefficient and small content of clay.
„Ekranic Technosols" have technic hard material like asphalt or concrete starting with depth of 0 - 5 cm from the soil surface, often exactly at the soil surface.
Our investigation noticed that some plants species such as *Tillia tomentosa,* that grow in the vicinity of asphalted paths lead unevenness, cracking and perforation of asphalt path.
Some Ekranic Technosols, such as those covered with asphalt, can be traversed by the roots of plants that extend laterally from the surrounding soil.
Asphalt alleys can be perforated by new plants that grow from the buds on the roots of trees or even on the rhizomes of perennial grasses (Figure 3 and Figure 4).

Figure 3. *Degradation of asphalt path by deformation cracks and perforation under influence of rooting system of Tillia tomentosa*

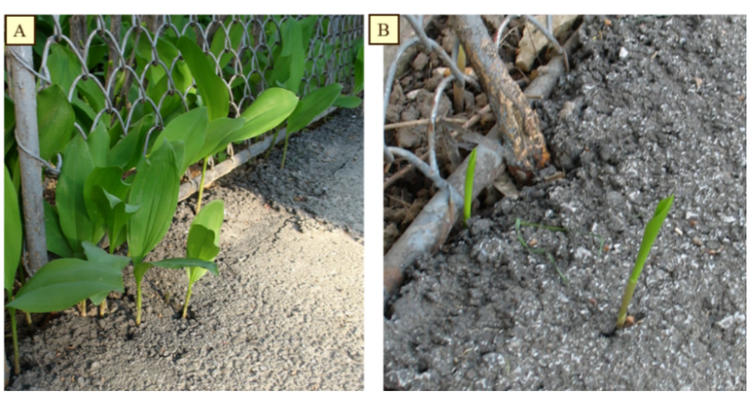

Figure 4. *Degradation of asphalt path by perforation under influence of rooting system of Convollaria majalis*

Soils covered with pavers can be infested with both annual and perennial plants. In some cases, paved alleys are infested with invasive and quarantine weeds (Figure 5) such as common ragweed (*Ambrosia artemisiifolia*).

Figure 5. *Infestation of alleys paved (Ekranic Technosols) with annual, perennial (A) and quarantine (B) plants*

CONCLUSIONS

Our investigations conducted in several locations of urban areas showed that Ekranic and Linic Technosols keeps some undisturbed soil properties such as particle size, mineralogical composition and allows some plants roots to develop their roots.

Some studied Linic Technosols have been constructed intentionally in order to ensure drainage and prevent soil contamination with gaseous compounds which result after anaerobic decomposition of garbage materials from deposit.

Some Ekranic Technosols, such as those covered with asphalt, can be traversed by the roots of plants that extend laterally from the surrounding soil.

Asphalt alleys can be perforated by new plants that grow from the buds on the roots of trees or even on the rhizomes of perennial grasses.

Paved alleys (Ekranic Technosols) could be infested with annual and perennial plants and even with quarantine weeds such as *Ambrosia artemisiifolia*.

"Technosols" are recently introduced in the international classification and are constantly updated after the obtaining of new data following the mapping of urban soils.

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