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Classification of anthropogenic soil transformation

Jonas Volungevičius,

Ričardas Skorupskas

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After human activity has expanded to the global extent, the need to formulate a modern evaluation system for such effect became substantially important. The present paper provides a solution of the problem by means of developing the terminology and conception of soil as well as shaping the classification system. To implement these goals, peculiarities of the term 'soil' are examined along with analyzing the mechanism of interdependence between anthropogenization and renaturalization processes and the areal distribution patterns of anthropogenically affected soils as well as the nature of anthropogenic transformation. In classifying anthropologically affected soils, the authors suggest to consider the character of anthropogenic effect and the degree of its impact. Chemically affected soils are attributed to slightly anthropogenic soils. When natural soils have experienced physical transformation up to 50 cm deep, they are considered as moderately anthropogenic (moved, altered, overcoated or destroyed). Strongly anthropogenic soils are those the section of which is physically transformed. Soils that form on anthropogenic soil-generating sediments are distinguished as a separate group and are proposed to be classified as 'technogenic soils'.

Key words: soil classification, anthropogenization, renaturalization, anthropogenic transformation, anthropogenic soil, anthrosol, technosol

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Jonas Volungevičius, Ričardas Skorupskas. Department of Geography and Land Management, Vilnius University, M. K. Čiurlionio Str. 21, LT-03101 Vilnius, Lithuania. E-mail: jonas.volungevicius@gf.vu.lt; ricardas.skorupskas@gf.vu.lt

INTRODUCTION

When viewed in the context of the scientific concept of landscape, the soil cover of a particular area is an inter-componential formation generated by the interaction between geology and the living world (flora and fauna), with its design characteristics influenced by such landscape components as deposit texture (grain size, etc.), relief, and local climatic features. The emergence of man and his gradually intensifying activities significantly influenced their natural development. Natural soil in many cases was only fragmentally affected by anthropogenic influence before the age of strongly entrenched machinery, but later this effect became one of the main substantially soil-transforming or even soil-creating factors.

After the human activities have acquired global scale, an assumption springs out to believe that only very few directly or indirectly anthropologically affected soils survived (Gerasimova et al., 2003; Prokofyeva et al., 2011). To find natural soils unaffected by farming in Lithuania is practically impossible (Kavoliutė, 1997). The same is valid not only for urban and agrarian areas where agriculture and other economic activities have affected the top and in many cases even deeper soil horizons, but also for less populated areas. Therefore, the main purpose

of this study was to contribute to the identification of fully remoulded soils or even those newly formed by human economic activities and their relationship with underlying rocks in order to determine the anthropogenic-soil-related terminology and the problem of anthropogenically affected soil classification (Table).

METHODS

The methodology includes not only the selection and development of research methods or their systems, but also the concepts of terminology and the subject of research. Optimization of the terminology in all fields of science is an urgent and

Table. **Classification of anthropogenic and technogenic soils**

Lentelė. **Antropogenizuotų ir technogeninių dirvožemių klasifikacija**

Rank	Typological pieces	Description
	1. LOW ANTHROPOGENIC (/ATS)	
I	All natural physically unconverted soils, which have had immediate or mediate chemical influence • *purposive mineral manure or pesticide overspread in the natural ecosystem* • *diffused air and water chemical pollution*	
	2. MEANLY ANTHROPOGENIC (/ATV)	
I	All natural soils whose natural quality in the upper profile is changed not deeply (up to 50 centimetres)	
II	2.1. MIXED (m) (/ATv_m)	Meanly anthropogenic natural soils in which the upper profile is changed (mixed) up to 50 centimetres because of purposive (immediate) household work (physical-chemical influence)
III	*Soil types by the character of physical transformation*	• *Direct agricultural work (soil cultivation)* • *Exploitation of infrastructure related to agricultural work (irrigation and meliorations systems, ground roads and surroundings of different roads)* • *Creation of infrastructure inconsistent with agricultural work (surroundings of linear infrastructure elements (roads, electric lines))*
IV	*Soil subtypes by the character of chemical transformation*	• *Immediate or mediated, diffuse or concentrated chemical influence (mineral manure, pesticides, heavy metals, single chemical details, radioactivity)*
II	2.2. FILLED UP (u) (/ATv_u)	Meanly anthropogenic natural soils in which the upper profile varies because of purposive (immediate) household work by filling up to 50 centimetres of natural or mixed-genesis soil
III	*Soil types by the character of physical transformation*	• *Direct agricultural work (formation of arable terraces in a hilly territory)* • *Creation and exploitation of infrastructure related to agricultural work (irrigation and melioration systems (overspread excess ground), roads with gravel cover and surroundings of different roads)* • *Creation of infrastructure not related with agricultural work (surroundings of linear infrastructure elements (roads, electric lines (ways, electric lines) and roads without hard cover)*
IV	*Soil subtypes by the character of chemical transformation*	• *Immediate or mediated, diffuse or concentrated chemical influence (mineral manure, pesticides, heavy metals, single chemical details, radioactivity)*
II	2.3. DESTROYED (n) (/ATv_n)	Meanly anthropogenic natural soils in which the upper profile varies because of purposive (immediate) household work by destroying no more than 50 centimetres of soil profile
III	*Soil types by the character of physical transformation*	• *Direct agricultural work (soils appearing because of arable process)* • *Exploitation of infrastructure related to agricultural work (irrigation and melioration systems (overspread excess ground), road surroundings)* • *Creation and exploitation of infrastructure not related to agricultural work (surroundings of linear infrastructure elements (roads, electric lines))*
IV	*Soil subtypes by the character of chemical transformation*	• *Immediate or mediated, diffuse or concentrated chemical influence (mineral manure, pesticides, heavy metals, single chemical details, radioactivity)*

Table. (Continued)

Rank	Typological pieces	Description
	3. STRONGLY ANTHROPOGENIC (/ATs)	
I	All natural soils whose natural quality in the upper profile because of anthropogenic influence has been changed deeper than up to 50 centimetres	
II	3.1. MIXED (m) (/ATs_m)	Strongly anthropogenized natural soils in which all profile or its part more than 50 centimetres deep is mixed because of purposive (immediate) household work (physical-chemical influence)
III	*Soil types by the character of physical transformation*	• *Creation of linear infrastructure objects (pipelines, cables and other underground infrastructure)* • *Surroundings of formatting constructional underground objects* • *Forming of necropolis*
IV	*Soil subtypes by the character of chemical transformation*	• *Immediate or mediated, diffuse or concentrated chemical influence (mineral manure, pesticides, heavy metals, single chemical details, radioactivity)*
II	3.2. FILLED UP (u) (/ATs_u)	Strongly anthropogenized natural soils in which the whole profile or its part are changed because of purposive (immediate) household work, filled up with natural or mixed-genesis ground over 50 centimetres
III	*Soil types by the character of physical transformation*	• *Forming the objects of overground infrastructure (embankment, dike)* • *Surroundings of constructional underground objects (forming terraces and rising surfaces)*
IV	*Soil subtypes by the character of chemical transformation*	• *Immediate or mediated, diffuse or concentrated chemical influence (mineral manure, pesticides, heavy metal, single chemical details, radioactivity)*
II	3.3. DESTROYED (n) (/ATs_n)	Strongly anthropogenized natural soils in which the whole profile or its part are changed because of purposive (immediate) household work, destroying more than 50 centimetres of soil profile
III	*Soil types by the character of physical transformation*	• *Forming the objects of overground infrastructure (road spoils, quarries)* • *Surroundings of constructional underground objects (forming terraces and lowering surfaces)*
IV	*Soil subtypes by the character of chemical transformation*	• *Immediate or mediated, diffuse or concentrated chemical influence (mineral manure, pesticides, heavy metals, single chemical details, radioactivity)*
	4. TECHNOSOL (/TN)	
I	From technogenic or mixed ground (natural ground composite, specially processed, or processed naturally), or on technogenic basement (asphalt, concrete, or woody construction) man-made soils	
II	4.1. FILLED UP (/AT_u)	From man-made materials or on a man-made surface, purposefully or accidentally formed soils
III	*Soil types by the character of physical transformation*	• *Forming dumps from different waste* • *Forming green roofs – terraces or different flat surfaces* • *Forming a cultural layer*
IV	*Soil subtypes by the character of chemical transformation*	• *Immediate or mediated, diffuse or concentrated chemical influence (mineral manure, pesticides, heavy metals, single chemical details, radioactivity)*

challenging problem. In sciences closely related to soils, this problem is no less urgent. The greatest controversies between different soil problem involving schools arise due to different approaches and the use of the term 'soil'. The first scientific definition of soil was given by Dokuchaev in 1883. According to him, soil is the naturally occurring upper mineral-organic rock layers always containing humus due to the influence of water, air, various living and dead organisms (Motuzas et al., 2009). His ideas influenced many later scientists working in the field. For example, V. Williams in "Soil Science" describes soil as follows: "When we talk about soil, we bear in mind loose upper dry

land horizons of the Earth globe, capable of giving vegetable yield. Soil and its fertility are inseparable conceptions" (Motuzas et al., 2009). In this definition, the key soil forming link between the mineral base of bedrock and the organic matter formed by plants and animals has been highlighted. P. Kostychev stressed the relationship between soil and organic matter and proposed the topmost layer of the earth in which the bulk of any plant species is distributed to be called as soil. Associating the concept of soil with the surface where the main root mass thrives significantly expands the geography of its occurrence, i. e. encompasses such soils (emerging in mountains on a hard surface with a patchy or very thin weathering crust, i. e. regosols) which, according to other concepts, could not be described as soil. In principle, the concept of soil should cover not only the surface with a yield sign, but also places where fertility (accumulation of organic matter or, in other words, plant development) under certain climatic conditions may occur, or is just starting to manifest. If we consider bedrock formations with poorly developed organics in mountains as soils, then, by analogy, only in this case of anthropogenic origin, we should consider as soils also the technogenic deposits in which life, due to the presence of organic matter, flourishes, and the surface itself has acquired the property of fertility. Thus, the concept of soil, at least geographically, might have a much broader sense than only a thick, loose, organic-rich upper lithosphere. Geographically, the soil is not only a deposit column in which bedrock and biosphere interaction takes place or might start under certain climatic conditions.

Using the traditional definition of soil and its different concepts in which soil is defined as a much thicker layer of the upper lithosphere, affected by soil-forming processes, there is no problem until we begin classifying strongly anthropogenic soils. This is exactly where such land surface variations (wiped off, harvested, surfaces affected by soil-forming processes and covered with ground, etc.) occur, which fit the commonly accepted concept of soil. In order to resolve this ambiguous situation, it is necessary to transform the concept of soil.

When using the expanded understanding of soil, it would be wise to determine it as directly or indirectly, physically and / or chemically affected by soil-forming processes in the uppermost lithosphere layer that has acquired or is still acquiring its present characteristics in relation with other components of landscape (water, atmosphere, plants, animals, man). According to the latter definition, the surface exposed to wiping off should be considered as soil when soil formation, in certain climatic conditions, begins during the very first vegetation period. As long as the bedrock remains in contact with the other elements of landscape, the soil exists independently of the stage of its formation. Removing the contact would lead to interruption of soil formation, which in its turn would destroy the soil or conserve it. Another difficult methodological issue is the explanation of the term "anthropogenic soils", because it is the latter term that causes most problems in classifying and epitomizing soils. The terms 'anthropogenic' and 'anthropogenized' are close but have some slight differences. For example, the term 'anthropogenic' shows that the natural object is human-affected (anthropogenically). The potential impact could range from eye-imperceptible to such an extent where the soil stays barely noticeable as a natural physical attribute. When it no longer exists, or where the soil is absolutely newly constructed from anthropogenic materials, the fairest term is 'anthropogenic soil'. In the case when the artificial soil body is made from human-made or modified materials, the best term is 'technogenic soil'. The term 'anthropogenic', which is close to the term 'anthropogenized', shows again that natural soil has been modified by man. As a synonym for strongly anthropogenically affected soils, another term – urban soils – is often used, which, we believe, is also not complete and would be more appropriate to describe the unity of soils (anthropogenic, anthropogenized and comparatively natural) in the city. Collation of urban soils with anthropogenic ones is not correct primarily because urban areas, while being very heterogeneous in nature, combine all three categories of soils (anthropogenic, antropogenized and relatively natural) (Fig. 1), despite being dominated by the anthropogenic one. In principle, there are two possible approaches to urban soils: urban soil in the classical definition of soils (Motuzas et al., 2009), i. e. not as soil; ideally, true urban soils are prevailing in city parks and suburban forests, and urban soils regarded as a derivative of solids,

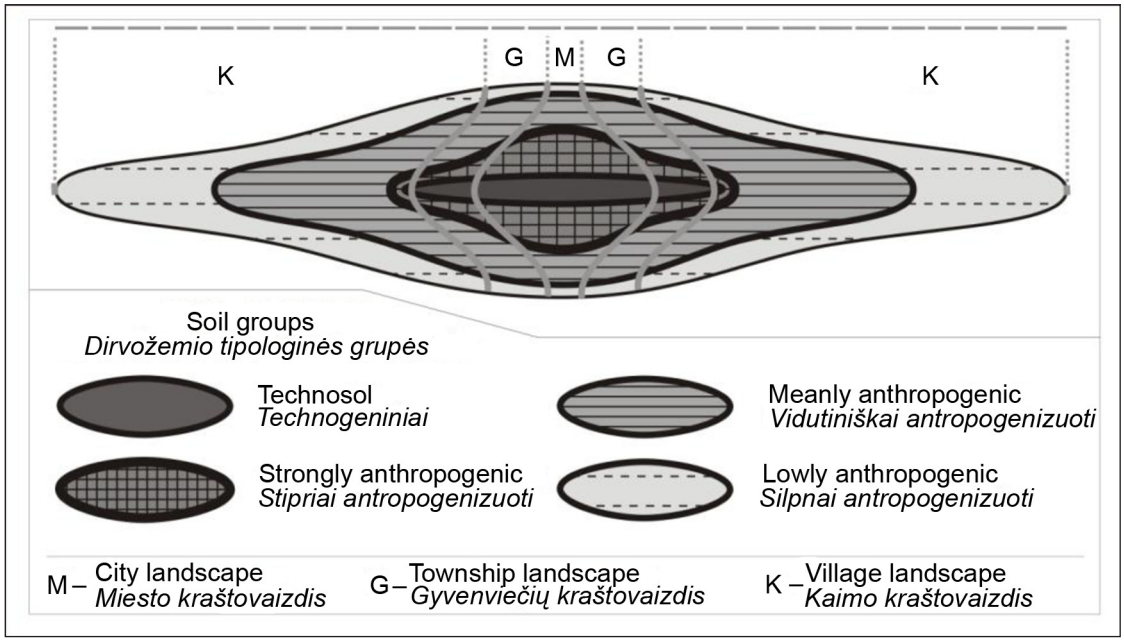

Fig. 1. Spatial differentiation scheme of anthropogenic soils
1 pav. Antropogeninių dirvožemių erdvinės diferenciacijos schema

liquids and gases emerging as a result of the same natural processes (in some cases much stronger expressed) and in many cases of anthropogenic impacts. The term 'urban soils', due to its impreciseness and inconceivable congruence with other terminologies, will not be discussed in this paper.

PREVIOUS RESEARCH OF ANTHROPOGENIC SOILS

There is a great amount of data concerning the chemical and agro-chemical state of urban soils in modern literature sources; however, only a few deal with their classification, function, and morphological structure. The constantly expanding area of soils with a different degree and extent of damage (effect) requires more attention to and efforts in their integration into the general soil classification system. In recent soil classifications (Buivydaitė et al., 2001), the focus is set on the origin of natural soils, and only a very small part is dedicated to anthropogenic soils (Anthrosols). This typological unit includes soils with only strong modifications caused by human activities (Buivydaitė et al., 2001). It is obvious that such soils are most prevalent in the active sites of human economic activities, i. e. in urban areas. As a consequence, in 1974 the term 'urban soils' has been suggested in the U. S. A. (Bockheim, 1974), although the meaning of the latter term is rather blurred. Urban soil was then described as "soil material" consisting of agriculturally untouched layers thicker than 50 cm of anthropogenic origin and formed by shuffling, covering or polluting land surface in urban and suburban areas. The examination of soils affected anthropogenically to various degrees has now achieved great progress. Most of the morphological and chemical (geochemical) characteristic features of anthropogenically affected soil sections have been identified (Galvydytė, 1968). In Lithuania, attention has been paid mostly to the anthropogenic soil contamination issues (Galvydytė et al., 1988). Russian scientists explored changes of chemical properties in the same soils (Nikodemus, Raman, 1984; Lepneva, Obuchov, 1987, 1990; Nikiforova, Lazukova, 1995). Peculiarities of the morphological structure common in anthropogenic soils have been quite extensively researched, identified and described as well as records of possible separate typological units have been formed (Gantimurov, 1966; Dolotov, Ponomareva, 1982; Rokhmistrov, Ivanova, 1985; Short et al., 1986). The abundance of typological soil units stimulates the need of a

practical and convenient classification; however, the issues of anthropogenic soil classification, in contrast to natural soils, have been considered only fragmentally (Prapiestienė, 1999). In the first Lithuanian classification of soils (1953), urban soils as a separate type was absent at all. Only later cultivated soils have been distinguished and included in a new classification. Furthermore, this classification has distinguished human-cultivated different soil types from those that have been created in urban areas, especially in historical city centres (Galvydytė, 1996). In the new Lithuanian soil classification (Buivydaitė, 1997), which is quite difficult to assess, the main criterion of soil evaluation is its morphological features regardless of whether they are natural or influenced by human activities. Recultivated anthropogenic soils are attributed to Anthrosol and Regosol. Meanwhile, among urban soils there is a huge amount of soils that have been moved, excavated or harvested to various extent. Soil genesis differs radically, but the similarity of morphological features puts them into one group (Galvydytė, 1999). Some of anthropogenically affected and modified soils are embroiled in the classification among natural soils, causing great confusion.

FEATURES OF ANTHROPOGENIC SOIL AREAL DISTRIBUTION

The problem of the concept of natural and anthropogenic soils equals to that of identifying natural and anthropogenic landscape. In today's world, a conversation about completely natural soils would not be entirely correct, since almost every exposed surface area has experienced a stronger or weaker impact of the direct (physical-chemical) and indirect (chemical) human activity (Lebedev et al., 2003; Tonkonogov, Gerasimova, 2005). In this case, it would seem appropriate to use the three-staged category system showing the degree of anthropogenic soil violation: relatively natural or mildly anthropogenic (indirectly and weakly affected by human activities), meanly anthropogenic (with an average impact of direct economic human activity) and strongly anthropogenic – Anthrosol (seriously damaged by human economic activity, or formed by it). The above-mentioned three categories of anthropogenic impact on soils have quite a regular areal distribution (Fig. 2). Gradually moving from urban to natural areas along the system, proportions between anthropogenically affected (to a different degree) and relatively natural soils vary quite obviously. The apparent predominance of anthropogenic soils is observed in urban areas, and here natural soils are almost or absolutely absent. The situation is opposite in natural or relatively natural areas. Addressing the issues of the spatial distribution of anthropogenic soils, the concept of cultural landscape becomes very apparent (Basalykas, 1965). According to the latter, components of the anthropogenic landscape are forming a fictitious continuous layer of uneven thickness (depending on the degree of anthropogenisation) and resembles the so-called "cultural landscape clothing" (Basalykas, 1965) or "cultural landscape coating" (Keisteri, 1990; Kavaliauskas, 2000). By analogy with cultural landscape, this concept is suggested to be applied in terms of only one component of the landscape, i. e. soil. Natural soils in various stages of direct or indirect anthropogenization, after passing the so-called cultural (anthropogenic) soil evolution stage (Kavoliutė, 1997) are being "buried" by the cultural coat which, in its turn, can be differentiated through the area by its "thickness" directly dependent on the intensity of impact and the degree by which natural soil has been affected. Natural factors of soil formation are also enforced by human economic activity (Mucha, 1988; Lebedeva, Tonkonogov, 1994). As a consequence, soil experiences changes of physical and chemical properties in its upper horizons and often also changes in the morphology of the whole section. The cultural soil coating, according to the features of changing properties of natural soils, can be further divided into cultural and acultural. In the first case, the anthropogenic impact does not spoil or even improves the physical and chemical properties (humus, fertility) of soil; in the second, the anthropogenic impact, or some changes influenced by it, worsens the physical and chemical properties (eroded or otherwise degraded soils). Of course, at first sight such a distinction, though simple, is quite problematic in identifying and distinguishing between the positive and the negative anthropogenic impacts. The concept of the cultural

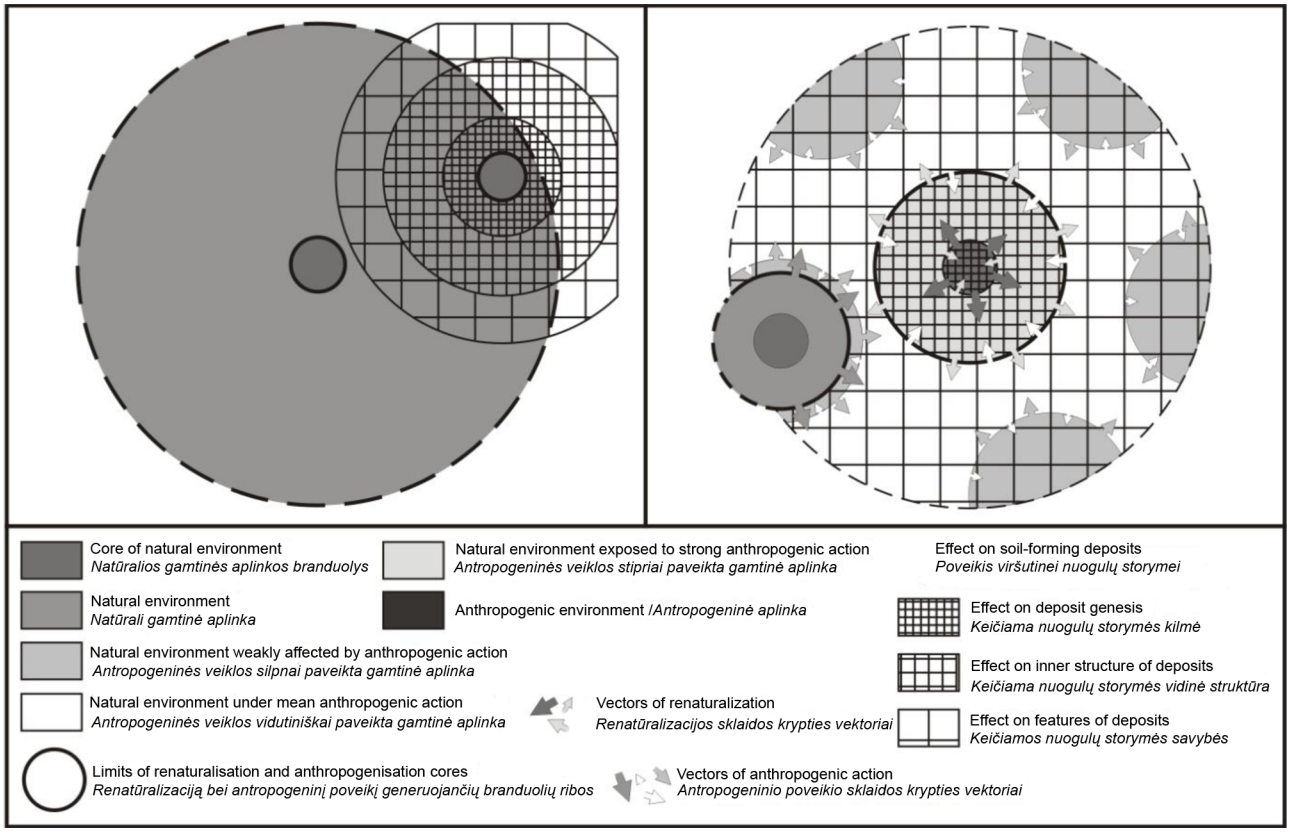

Fig. 2. Interaction between soil anthropogenization and renaturalization processes
2 pav. Dirvožemių antropogenizacijos ir renatūralizacijos procesų sąveikos struktūra

soil coat makes sense only since the time when human economic activities and their impact on the natural environment, after being only very fragmented, have become global, although not in all places equally intense, direct and distinctly visible.

PECULIARITIES OF INTERACTION BETWEEN NATURAL AND ANTHROPOGENIC SOILS

Human economic activities play an important role in soil formation and development. It determines not only the nature of anthropogenic impact, but also its intensity. After economic agricultural activities have become global, only a small part of soils develop free of a direct anthropogenic impact. For the rest part of soil cover, anthropogenic effect becomes an active agent, i. e. it intensely changes soil structure and properties, and while the anthropogenic impact on soils has become more and more intensive (Stroganova et al., 2005), in natural environments certain opposite processes still exist, which are designed for reducing the degree of soil anthropogenization (renaturalisation) (Fig. 3).

Anthropogenized soils should be treated from the position of interaction between transformation and renaturalization processes, i. e. from the many antinomic aspects that form and transform them. The latter antinomy can be approached in several ways.

Process trend

Looking at the landscape (of which soil is an integral part) as a system composed of natural and anthropogenic environmental cores and bonds connecting them, we can identify the sources of naturalness and anthropogenization dispersion in soil cover. Thus, there is a source in the soil cover itself causing its naturalness, and a source generating the spread of anthropogenization. Thus, formation of two distinctly opposite forces of anthropogenization and renaturalization is taking place. Soil renaturalization originates on the margins where a minimal soil anthropogenization effect is still detectable.

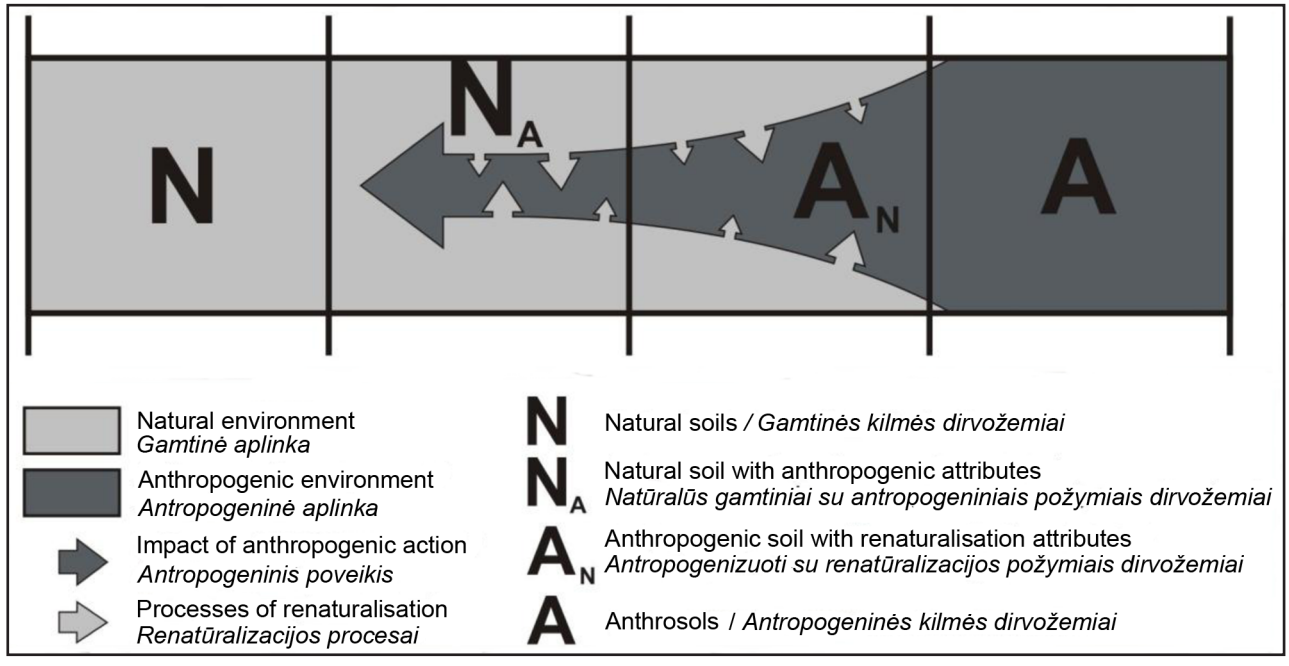

Fig. 3. Principal model of interaction between comparatively natural and anthropogenic soils
3 pav. Santykinai natūralių ir antropogeninių dirvožemių sąveikos principinis modelis

Process intensity

In the antinomic anthropogenization–renaturalization pair, anthropogenization is an active agent, i.e. soil is being intensively changed; as for renaturalization, it is a passive agent, i. e. stabilizing and preserving the present soil condition and its properties. Soil anthropogenization rate is not constant in time and space. It differs depending on the distance from the source of anthropogenic effect. Moving away from it, anthropogenization wears off and acquires a less concentrated form.

Nature of changes

Anthropogenic effects on soil determine changes of its nature, structure and properties. Being close to the source of anthropogenization, soils are experiencing the strongest impact and most significant changes. Meanwhile, when moving away from it to the area of a weaker anthropogenic impact, these changes are decreasing. A sort of a conditional chain of changes is forming. The latter may begin with changes in soil genesis when the soil is forming in anthropogenic sediments, then pass to the transformation of the structure, and eventually only to changes in soil chemistry. The chain of changes is directed towards diminishing the anthropogenization of the natural environment and thus of soil.

Understanding the mechanism of spatial interaction between processes of soil anthropogenization and renaturalization is important for evaluating the anthropogenic impact, highlighting the problematic areas and creating an objective and practical classification.

CLASSIFICATION OF ANTHROPOGENICALLY AFFECTED SOILS

Horizontal-type classification in which anthropogenic soil types separated by qualitatively different characteristics are grouped is unsuitable. Application of a combined horizontal-vertical-type classification method (Fig. 4) would simplify the understanding of the diversity of anthropogenic soils, facilitate the problem of identification of new types and assign their place in the classification. Such anthropogenic soil classification system would alleviate the identification of anthropogenic change and pattern in soils. The principle of vertical differentiation of anthropogenically affected soils would be the criterion to represent one of the four classification stages. For the first – the 'roughest' – classification, we apply the most integrated

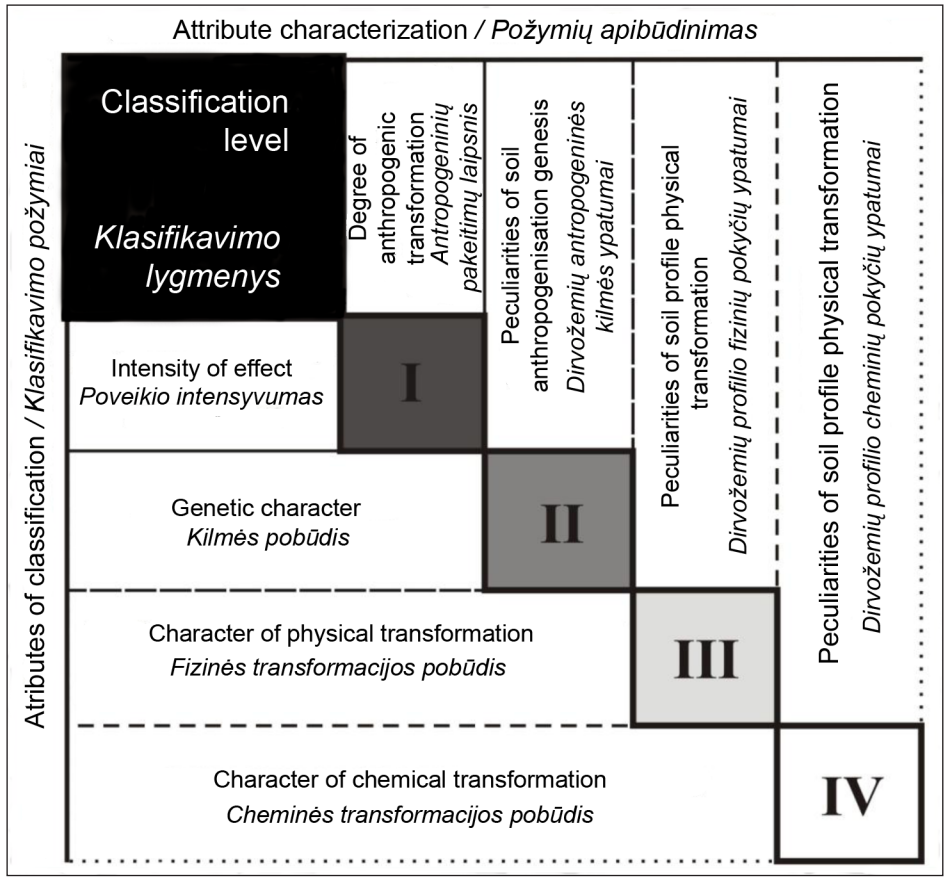

Fig. 4. Hierarchical structure of soil classification
4 pav. Dirvožemių klasifikacijos hierarchinė struktūra

general criteria and for the lower, more detailed stages more detailed criteria. This article offers a vertical (hierarchical) four-staged classification system which is a representative of the so-called 'cultural soil clothing', or the entirety of soils with a various degree of anthropogenic impact, which serves not as an integral part of the classification of natural soils, but as a separate classification incorporating all types of natural soils. In the first stage of the newly formed classification, the criterion for describing anthropogenic soil is the degree of anthropogenic impact. According to this criterion, soils, depending on the impact increase direction, are divided into four groups (which are easily visually described): a) mildly anthropogenic, b) meanly anthropogenic, c) strongly anthropogenic, d) anthropogenic or technogenic. Weakly anthropogenic soils as a typological unit have been distinguished on the assumption that soils are indirectly or chemically intentionally affected and no sign of physical human impact can be observed (Fig. 5). Meanly anthropogenic soils are described by visually traceable and determinable signs, i. e. anthropogenic soil profile transformation up to the depth of 50 cm, which highlights the impact of agriculture. Strongly anthropogenic soils are physically affected to the depths greater than 50 cm, which shows anthropogenic impact to be of much greater intensity related mainly to construction (building) activities. The soil layer affected or disrupted to the depth of up to 50 cm has been chosen so that any profile after experiencing anthropogenic impact and additional less than 50 cm covering sedimentation more or less retains the characteristics of the natural soils; it behaves as a natural body if it does not undergo other significant changes. Of course, both weakly and strongly anthropogenic soils experience direct and indirect chemical effects. The fourth group of anthropogenic or technogenic soils that have features not common to natural soils in most cases comprises transformed natural or synthetic

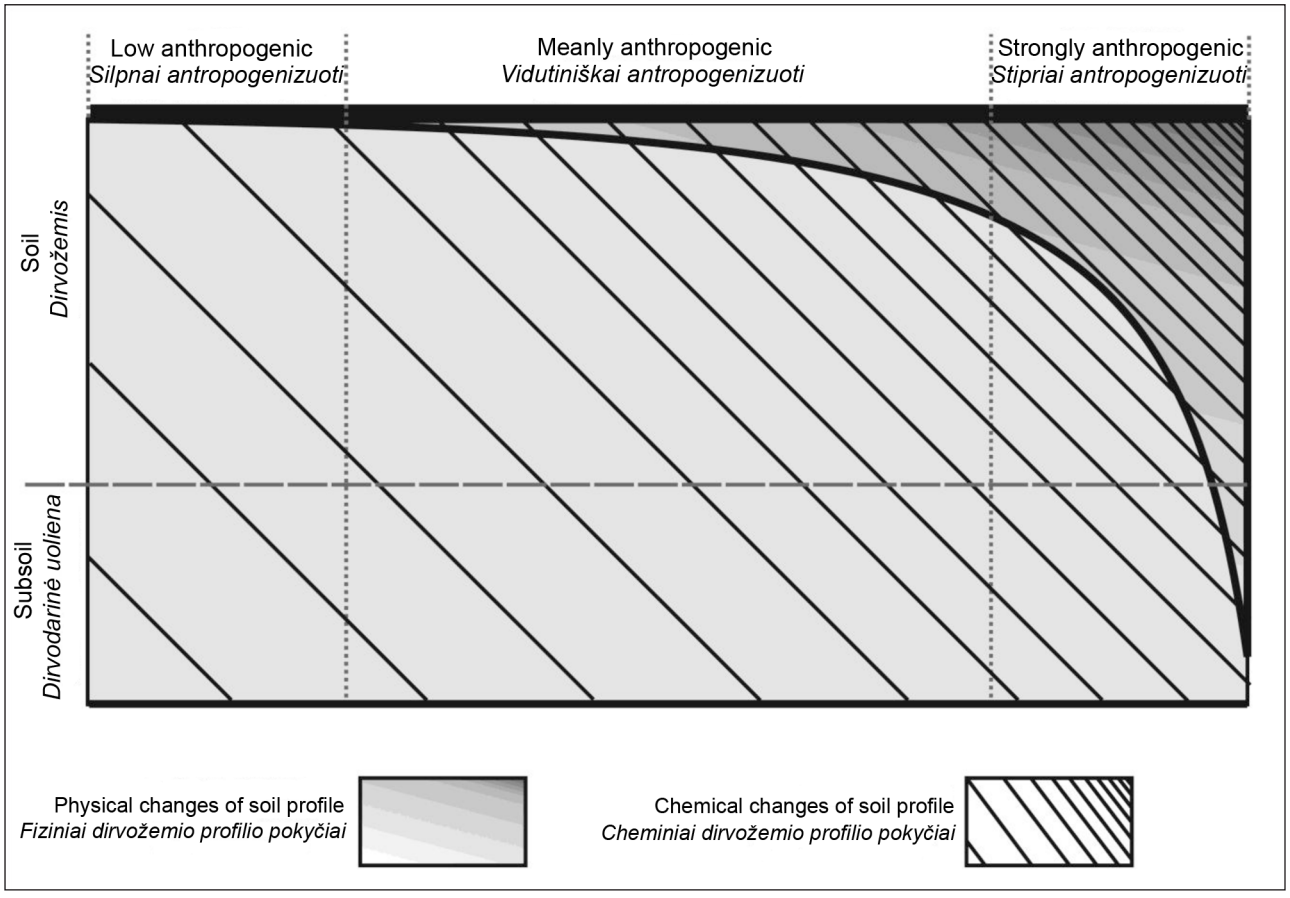

Fig. 5. Scheme of anthropogenic changes in soils
5 pav. Antropogeninių pokyčių dirvožemyje schema

materials of anthropogenic origin. To the latter type, it would be appropriate to attribute the so-called ecranozyoms – surfaces with anthropogenic covers, in spite of the fact that they do not have the basic natural fertile layer identifying the soil horizon. The second stage of the classification of anthropogenic soils is based on their genesis, which is caused by different types of anthropogenic activities or, to put it more accurately, by a combination of different activities more often found in reality. Anthropogenic activity is an abstract name of physical soil amendment methods (mixing, harvesting (digging), filling). These methods are not common for all typological units of the first stage of classification. Weakly anthropogenic soils that have not experienced any physical effect are not differentiated further by its types. Meanly and strongly affected soils are divided into all three types. Anthrosols have only one filling, because soils are being formed anew and from anthropogenic materials. In practice, it is difficult to find soils formed by only one effect. It happens very often that soils are constituted by a logical sequence of many effects harvested at the start and covered later, or mixed in the beginning and covered in the end, or likewise. Finally, one must take into account the whole section and the last formation process, even though one should describe all noticeable traces of other effects.

The third stage of the classification of anthropogenic soils is based on the emphasis on physical characteristic differences in their profiles, which are usually affected by the transformation observed among higher stages of the classification. These changes should be associated with anthropogenic transformations due to intensive human activities in soil horizons. The most characteristic examples here could be formation of the compressed, infertilized or A-horizon bottom.

The fourth (lowest) stage of anthropogenic soil classification is based on the peculiarities of chemical soil transformation characteristics within

the boundaries of higher stages of classification. The nature of chemical transformation in most cases is visually imperceptible, except when certain chemical substances contained in the soil are clearly reflected in its physical properties. Chemical transformation of the soil profile occurs because of a deviation of the content of a chemical material from the standard if normally an equivalent material can be found in the soil profile, or during the emergence of new chemical compounds. The chemical transformation of the soil profile can be influenced by a series of processes such as expedient soil fertilization or introduction of materials with another attribution, as well as soil pollution from sources of various origin. Similar or even identical chemical changes in soil profiles are possible in different successions of classification. Repetition of chemical properties is one of the classification features in its lower stages.

CONCLUSIONS

1. When considering the problem of anthropogenic soil classification, it is reasonable to expand the concept of soil for the sake of geographic setting. This term would encompass the upper lithosphere layer formed by direct and indirect physical and / or chemical soil-forming processes, which has acquired (or is still acquiring) its properties in interaction with other components of the landscape.

2. The term 'soil' should encompass not only lithomorphic but also anthropomorphic soil-generating sediments.

3. When integrating the term 'soil cover' into the modern concept of landscape, it is expedient to start a discussion about soil cover as a distinct landscape component, to expand its conception by naming it 'cultural landscape coating' as its precursor, physically and chemically affected cultural soils in historical city centres (old towns) should be considered.

4. Understanding the mechanism of spatial interaction between processes of soil anthropogenization and renaturalization is important for assessing the anthropogenic impact, highlighting the problematic areas and compiling an objective and practical classification.

5. The cultural coating of soil cover, by means of changing properties in natural soils, could be differentiated into those cultural and untouched by agriculture: in the first case the anthropogenic impact has not worsened or even has improved physical and chemical soil properties, and in the second, the anthropogenic effect, or changes influenced by it have worsened the physical and chemical properties of natural soils.

6. The four-staged classification system presented here reflects the variety of 'cultural transformation' in natural soils, or the entirety of soils with a different degree of anthropogenization; the latter system could serve not as an integrated classification part of natural soils, but as a separate classification encompassing all types of natural soils.

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Jonas Volungevičius, Ričardas Skorupskas

DIRVOŽEMIŲ ANTROPOGENINĖS TRANSFORMACIJOS KLASIFIKAVIMO PROBLEMA

S a n t r a u k a

Žmogaus veiklai įgijus globalinį mastą atsiranda prielaida manyti, kad labai nedaug teliko tiesiogiai ar netiesiogiai antropogeniškai nepaveiktų dirvožemių. Šiuo straipsniu siekiama prisidėti prie žmogaus ūkinės veiklos performuotų ar visiškai suformuotų dirvožemių identifikavimo, jų santykio su geologiniu pagrindu įvertinimo, su antropogeniniais dirvožemiais susijusios terminijos bei antropogeniškai paveiktų dirvožemių klasifikavimo problemos sprendimo.

Sprendžiant antropogenizuotų dirvožemių klasifikavimo problemą, tikslinga praplėsti dirvožemio sampratą, ją labiau geografizuoti. Dirvožemio samprata turėtų apimti ne tik litomorfines, bet ir antropomorfines dirvodarines uolienas.

Dirvožemio dangos terminą integruojant į šiuolaikinę kraštovaizdžio sampratą, tikslinga diskutuoti apie dirvožemio dangos kaip atskiro kraštovaizdžio komponento sampratos plėtojimą, įvardijant ją „dirvožemio kultūriniu rūbu“, kurio pirmtaku reikėtų laikyti intensyviai fiziškai ir chemiškai paveiktą miestų senųjų dalių kultūrinį sluoksnį.

Vertinant dirvožemių antropogenizacijos mastą svarbu suvokti dirvožemių antropogenizacijos bei renatūralizacijos procesų erdvinės sąveikos mechanizmą. Į antropogenizuotus dirvožemius būtina žvelgti per juos formuojančių ir transformuojančių antropogenizacijos ir renatūralizacijos procesų santykį. Pastarąją antinomiją galima nagrinėti proceso krypties, jo intensyvumo bei pokyčių pobūdžio aspektais.

Vertinant šiuos aspektus siūloma pritaikyti kombinuotą horizontalaus ir vertikalaus klasifikavimo būdą antropogeninių dirvožemių įvairovei suvokti. Ši klasifikacinė sistema padėtų lengviau nustatyti naujus tipus ir lokalizuoti juos klasifikacijoje. Tokia antropogeninių dirvožemių klasifikavimo sistema padėtų lengviau nustatyti dirvožemių antropogeninio pakeitimo laipsnį, būdą ir pobūdį. Šiame straipsnyje pateikiama keturių pakopų vertikali (hierarchinė) klasifikacinė sistema, kuri reprezentuoja įvairiai antropogeniškai paveiktų dirvožemių visumą. Ji būtų ne integruota gamtinių dirvožemių klasifikacijos dalis, bet atskira visus gamtinių dirvožemių tipus perdengianti klasifikacija.

Naujai formuojamos klasifikacijos pirmosios pakopos antropogeninių dirvožemių skirstymo kriterijus yra dirvožemių antropogenizacijos laipsnis. Pagal šį kriterijų dirvožemiai poveikio didėjimo linkme skirstomi į keturias antropogeninių pakitimų grupes: a) silpnai antropogenizuotus,

b) vidutiniškai antropogenizuotus, c) stipriai antropogenizuotus ir d) antropogeninius, arba technogeninius.

Antroji antropogeninių dirvožemių klasifikavimo pakopa paremta jų geneze, kurią lemia skirtingas fizinio dirvožemių pakeitimo būdas, išskiriant sumaišymą, nukasimą ir užpylimą.

Trečioji antropogeninių dirvožemių klasifikavimo pakopa paremta jų profilių fizinių savybių skirtumų išryškinimu, kurie dažniausiai būna nulemti transformacijos pobūdžio, matomo aukštesnėse klasifikavimo pakopose.

Ketvirtoji antropogeninių dirvožemių klasifikavimo pakopa paremta dirvožemių cheminės transformacijos ypatumais tam tikrose aukštesnėse klasifikavimo pakopose.

Raktažodžiai: dirvožemių klasifikacija, antropogenizacija, renatūralizacija, antropogeninė transformacija, antropogeninis dirvožemis, technogeninis dirvožemis