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Jean Louis Morel, Claire Chenu & Klaus Lorenz

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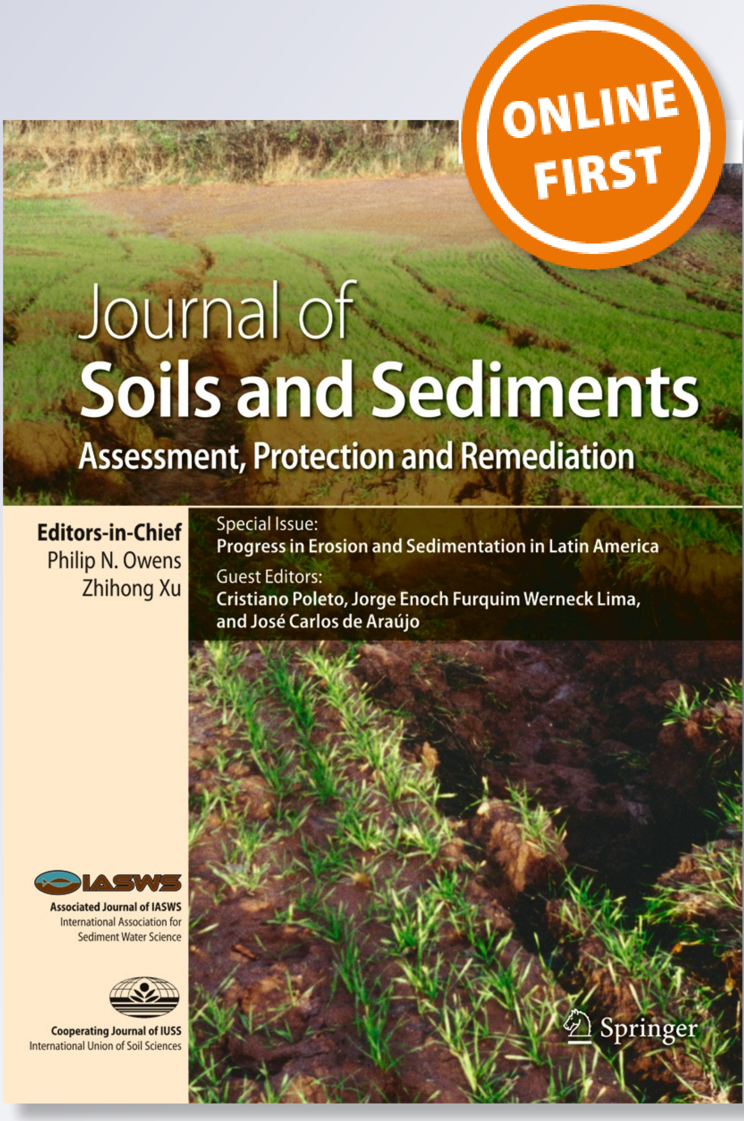

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Abstract
Purpose The sustainable use and management of global soils is one of the greatest challenges for the future. In the urban ecosystem, soils play an essential role with their functions and ecosystem services. However, they are still poorly taken into consideration to enhance the sustainable development of urban ecosystems. This paper proposes a categorization of soils of urbanized areas, i.e., areas strongly affected by human activities, according to their ecosystem services.
Materials and methods Focus is put first on ecosystem services provided by non-urban soils. Then, the characteristics and number of services provided by soil groups of urbanized areas and their importance are given for each soil group.
Results and discussion Soils of urbanized areas are here defined as SUITMAs, because they include soils of urban, sensu stricto, industrial, traffic, mining, and military areas. This definition refers to a large number of soil types of strongly anthropized areas. SUITMAs were organized in four soil groups, i.e., (1) pseudo-natural soils, (2) vegetated engineered soils, (3) dumping site soils, and (4) sealed soils. For each soil group, examples for ecosystem services were given, evaluated, and ranked.
Conclusions This proposal contributes to foster the dialogue between urban spatial planning and soil scientists to improve both soil science in the city and recognition of SUITMAs regarding their role for the sustainable development of urban ecosystems and, in particular, to enhance multifunctional soils in urban areas.

Keywords Soil functions · Technosol · Urban environment · Urban soil groups

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J. L. Morel (✉)
Laboratoire Sols et Environnement, UMR 1120, Université de Lorraine, 2, Avenue de la Forêt de Haye, TSA 40602, 54518 Vandœuvre-lès-Nancy Cedex, France
e-mail: Jean-Louis.Morel@univ-lorraine.fr

J. L. Morel
Laboratoire Sols et Environnement, UMR 1120, INRA, 2 Avenue de la Forêt de Haye, TSA 40602, 54518 Vandœuvre-lès-Nancy Cedex, France

C. Chenu
Bioemco, AgroParisTech, Grignon, Thiverval Grignon 78850, France
e-mail: Claire.Chenu@grignon.inra.fr

K. Lorenz
Global Soil Forum, Institute for Advanced Sustainability Studies, 14467 Potsdam, Germany
e-mail: lorenz.59@osu.edu

K. Lorenz
The Ohio State University, College of Food, Agricultural, and Environmental Sciences, 414B Kottman Hall, 2021 Coffey Road, Columbus, OH 43210, USA

1 Introduction

The human society is increasingly confronted with the shortage of many natural resources as world population is projected to surpass 9 billion people by 2050 and even exceed 10 billion by 2100 (United Nations 2011). Associated with the population growth is the sharp increase in the urban population, with a projection of 70 % of the global population living in cities by 2050. As many planetary boundaries are being threatened and even transgressed as a result of increasing human demands (Rockström et al. 2009), there is an urgent need to radically change the way we use and manage natural resources. With the rise of the "ecosystem services" concept (Costanza et al. 1997) and proposals for a more sustainable management of natural resources (Millenium Ecosystem Assessment 2005), integrated approaches such as the Sustainable Development Goals (SDGs) are now being considered to secure human well-being, fight poverty, and preserve planetary stability (Griggs et al. 2013).

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Such approaches have also been initiated for urban ecosystem management to improve the well-being of urban dwellers (e.g., Rivera 2013). City managers are concerned with the creation of suitable conditions for the cities of tomorrow, and the future of urbanization is often qualified as "sustainable," "resilient," "self-sufficient," "biophillic," and/or "adapted to global change." Such ambitious goals rely on an integrated management of the urban ecosystem, taking into account every available local resource, and the management of ecosystem services in the city is regarded as a response to global change (Reeve 2012).

Among the services provided by urban ecosystems is the supply of clean water and food, control of air pollution, moderation of urban climate, and opportunity for recreation (Gómez-Baggethun et al. 2013). A large number of ecosystem services provided by urban areas result from the presence of green infrastructures (McPhearson 2011). Residential gardens, urban farms, and green-roofs support provisioning services (e.g., food). Climate and air quality regulation in urban areas rely to a certain extent on the presence of vegetation (e.g., moderation of the urban heat island effect, reduction of atmospheric greenhouse gas, and particulate matter concentrations). Pervious surface areas allow the infiltration of water and reduce risks of runoff and flooding, and the presence of a vegetation cover decreases the quantity of available water reducing risks of runoff and flooding. Green urban areas may also be reservoirs for native and rare species, and contribute to biodiversity maintenance in urban areas. Noise is a major environmental issue in urban areas that can be attenuated by green infrastructures.

Soil has a fundamental role for many of the urban ecosystem services, but it is considered as a secondary compartment beyond vegetation. Urban soils may be managed to fulfill specific functions, e.g., for supporting buildings, roads infrastructures, and urban agriculture, and for waste management. However, despite their importance, urban soils are still poorly taken into account to cope with the great challenges met by cities. Urban soils face the paradox of being of highest interest regarding property and building issues, and being almost totally ignored with regard to consideration of their functions and roles for the management of urban ecosystems. Soils of urban areas are mostly considered two-dimensionally. They are a surface that can harbor human activities, while their three-dimensional extension and functions are generally ignored by urban planning and management.

Soils of urban areas may be strongly affected by human activities (de Kimpe and Morel 2000). Their composition and functions and, thus, their ability to provide ecosystem services are different from those of natural soils and often impaired. Soils of natural, forest, and agricultural land are considered a natural heritage, which, in general, can be modified only marginally. In contrast, soils of urban areas are considered a resource that can be intensively managed to meet the needs of urban dwellers.

There are many reasons for the lack of consideration of soils in urban areas and, thus, the lack of sustainable management of urban ecosystems. Regarding soil science itself, a reason is the difficulty of soil scientists to communicate with stakeholders responsible for the management of urban areas, including city planners, politics, economists, civil engineering, etc., because of the gap between the soil as a scientific object, often described and presented in a conceptional language, and the soil as a supplier of ecosystem services. Concepts, definitions, angles, and objectives of both parts are too distant to sustain management where soil has a central position. Hence, efforts have to be made both ways to better integrate the soil resource into the whole process of urban ecosystem management.

This paper aims at improving the recognition of ecosystem services provided by soils in urban areas. It is conceived to conciliate the objectives of soil science, i.e., increase knowledge regarding the urban soil resource, and the objectives of urban planners, i.e., create the most suitable ecosystem for urban dwellers. It is based on a categorization of the soils of anthropized areas, which will be designated as SUITMAs, i.e., soils of urban, industrial, traffic, mining, and military areas, and their arrangement in groups of similar potential for providing ecosystem services. First, ecosystem services provided by natural soils are presented. Then, SUITMAs are described in relation to their potential as providers of ecosystem services. Finally, a tentative classification is proposed according to the ecosystem services provided by SUITMAs which offers new perspectives for soil science and for urban planning and management.

2 Ecosystem services provided by natural soils

As major components of terrestrial ecosystems, soils fulfill a range of functions of vital importance (European Commission 2010). Functions of natural soils include (1) supporting plant growth (reservoir of nutrients and water, support of roots), (2) maintaining biodiversity pool (habitats, species, and genes), (3) filtration and transformation of substances (C, water, nutrients, contaminants), (4) storage of substances (C, nutrients), (5) source of raw materials, (6) physical and cultural support of human activities (habitat, transport, landscape, waste disposal, transport of energy, and water), and (7) archive of geological and cultural heritage.

Soil functions are the soil processes which result from the interactions between biotic and abiotic components. Those functions generate products and services which are useful to human well-being (e.g., contribution to health, safety) (de Groot et al. 2002, 2010). Dominati et al. (2010) have introduced the concept of provision of ecosystem services from the soil natural capital. Ecosystem services provided by soils are the result of inherent properties and manageable properties.

Provisioning services of soils are physical support, food, wood, fiber, and raw materials. Regulating services are mitigation of flood, water quality, biological control of pest and diseases, recycling of waste and detoxification, carbon storage, and regulation of GHG emissions. Cultural services are related to spirituality, knowledge, sense of place, and aesthetic. Supporting processes are at the basis of soil formation and maintenance, i.e., nutrient cycling, water cycling, and soil biological activity.

Attempts have been made to evaluate ecosystem services provided by natural soils. Different approaches have been developed to assess the biophysical, economical, and sociological value of ecosystem services provided by soils. Regarding the biophysical evaluation, a deterministic approach can be implemented based on the knowledge of the mechanisms and our ability to accurately describe the processes controlling a given soil function. One example of application to ecosystem services provided by natural soils is climate regulation via carbon storage in soil. Carbon storage by soils can be directly measured or predicted with deterministic models. Another example is the natural attenuation of pollutants, e.g., pesticides, in soils, using models to predict the total of bioavailable concentration of a given contaminant (van Wijnen et al. 2012). When stocks of fluxes determining the function cannot be directly measured, indicators may be used and compared to reference situations or to threshold values of the indicator. A scoring approach has been historically developed to assess the suitability of natural soils to agricultural production. It relies on easily measurable properties, stable with time, relevant to agricultural production in a given pedological context. Most soils provide several services, and the bundle of services needs to be evaluated as well as tradeoffs between services. There, an equal importance may be given to the considered ecosystem services (e.g. Trabucchi et al. 2013). Also, a participative approach may be implemented to weigh the different ecosystem services (Rutgers et al. 2012). They solicited a large set of actors, wider than the sole agricultural stakeholders, including farmers, agricultural consultants, water and landscape managers, and regional and national authorities in the field of environment. Each member of the panel had to weigh each ecosystem service according to its importance from its perception. The scores of the members of the panel operating at different spatial scales, i.e., local, regional, and national, were lumped to weigh different ecosystem services.

3 Soils of urban, industrial, traffic, mining, and military areas (SUITMAs)

3.1 Definition of SUITMAs

Soils in urban areas may be strongly modified by human activities, with drastic changes in composition and functions, and therefore, soil's ability to provide ecosystem services may be impaired. It should be noted, however, that deeply transformed soils and pseudo-natural soils showing only little changes may coexist in urban areas. "Urban soil" is often used to designate soils found within urban areas. However, human-influenced soils are found in many other places where human activity strongly modifies soils and is the main factor of soil formation and evolution.

Thus, a more appropriate definition for soils of anthropized areas is SUITMAs, *soils in urban*, *industrial*, *traffic*, *mining*, *and military areas*. The acronym SUITMA was first proposed by W. Burghardt in 1998. Then, it became an IUSS Working Group devoted to anthropized soils. SUITMAs range from slightly modified soils to very intensively managed and disturbed soils, through processes such as (1) transformation, mixing, increasing in depth, compaction, land leveling, sealing; (2) excavation, i.e., removal of soil material and accelerated erosion; and (3) input of exogenous soil material (artifacts) such as wastes (organic, inert, toxic), construction debris, dredged materials, and land filling.

SUITMAs are very diverse but have common features beside their location. Some examples of the characteristics and distribution of SUITMAs has been given for Poland (Charzynski et al. 2013). Common features are linked to soil parent material composition, which makes them very different to natural soils experiencing strong pedogenesis. SUITMAs may be more or less composed of coarse natural and anthropogenic materials (e.g., bricks, concrete, asphalt), and coarse constituents may contain high concentrations of pollutants in contrast to non-urban soils. Some SUITMAs contain significant amounts of inorganic and organic carbon, as observed in soils derived from demolition waste and combustion residues disposal or soils used for urban agriculture. Also, soil organic carbon can be relatively enriched in the sub-soil as result of deep incorporation of carbon-rich topsoil material during civil engineering operations. Due to mechanical compaction, SUITMAs may exhibit a high bulk density of both top- and sub-soil. Also, SUITMAs may be impacted by organic (e.g., hydrocarbons) as well as inorganic contaminants (e.g., heavy metals). Urban areas are sometimes rich in alkaline materials, which confer high pH values. Finally, SUITMAs are often sealed soils to meet urban needs. This phenomenon is a threat to the soil resource in many regions, as urban expansion is putting a heavy load on agricultural soils. Urban expansion converts large surface areas of often productive surrounding soils leading to a decrease in the global potential to produce food. For example, in Europe, the surface area covered by cities has increased by 78 % since the 1950s, and an estimate of 2.3 % of the EU territory is sealed, which represents 200 m^2 per citizen (European Union 2012).

3.2 Current classification of soils of anthropized areas

According to the world reference base (WRB) (IUSS Working Group WRB 2006; Rossiter 2007), strongly anthropized soils are classified into two groups, i.e., Anthrosols and Technosols. Anthrosols are soils with extreme human influence showing high content of organic matter. They result from a long and intensive agricultural use (e.g., horticulture) with addition of organic matter, irrigation, and cultivation, and exhibit a hortic, irragric, or plaggic horizon. They cover more than 500,000 ha globally. The Technosol group was introduced in 2006 in the WRB. Technosols are soils containing many artifacts (technic materials), i.e., 20 % (*w*/*w*) or more in the upper 100-cm soil profile or a continuous cemented layer. Technosols result from many human activities and predominantly occur in urban and industrial areas, roads, dumps, and mine sites (IUSS Working Group WRB 2006). For both groups, pedogenesis and properties are dominated by the technic origin of parent materials. National classifications take to some degree into account these soils with different importance and designation (e.g., USDA Soil Taxonomy, Référentiel Pédologique Français).

3.3 Categorization of SUITMAs according to their role in the urban ecosystem

The terms Anthrosol and Technosol refer to pedological characteristics of soils but remain of negligible interest regarding their role for the functioning of urban ecosystems. To have soils taken into better consideration for the evaluation and development of ecosystem services in urban areas, it is necessary to use a classification scheme that provides direct information regarding the potential of each soil category. SUITMA has been introduced to highlight the relation between soils and their location, a definition that is close to that for land use. However, this definition is too vague and not appropriate by itself to discriminate the various soil types according to ecosystem services they are able to provide. For example, soils in urban areas can fulfill major services such as the control of infiltration and runoff coming from roofs and streets, therefore, limiting the cost induced by other technical means. Hence, the definition should be completed later by specific "qualifiers" that provide information on the expected functions and services.

SUITMAs cover a wide range of soil types, which can be arranged according to a gradient of anthropization and the capability to support vegetation (Fig. 1). Here, a categorization in four groups of SUITMAs is proposed ranging from soils showing little changes compared to the corresponding natural soils, i.e., the pseudo-natural SUITMAs, often covered by urban forest or urban and sub-urban agriculture, to extremely modified soils usually not considered as soils by many soil scientists, i.e., sealed SUITMAs. Pseudo-natural ecosystems developed on pseudo-natural SUITMAs are multifunctional and are able to provide a wide range of ecosystem services, similarly to forest and agricultural soils. Conversely, ecosystems of sealed soils support only a limited number of services. Between both ends of the categorization are dumping site SUITMAs sporadically re-vegetated and engineered SUITMAs deliberately vegetated.

Examples of SUITMAs and the services they provide are given in the following section.

3.3.1 Vegetated engineered SUITMAs

Engineered SUITMAs are soils deliberately built to fulfill specific functions. For vegetated SUITMAs, attention is given to the capacity of soils to support plant growth and favor plant development in the long term. Two types of vegetated engineered SUITMAs are considered here: (1) soils created and modified by civil engineering, and (2) soils of green-roofs.

Civil engineering operations often require soil restoration activities for landscaping purposes. The goal is to create favorable conditions for plant establishment and growth, and encourage water infiltration and drainage. In general, soil is constructed with a layer of material originating from agricultural areas spread on a sub-surface layer composed of various natural and anthropogenic materials. Alternatively, wastes and other secondary materials (e.g., bricks, concrete, compost, sludge) are recycled to build a soil specifically designed to fulfill a wide variety of functions (Sere et al. 2008).

Green-roofs are another example of engineered SUITMAs, mainly composed of technic materials to create multifunctional soils, which ensure a wide range of ecosystem services and, thus, mimicking functions of natural soils. Green-roofs are entirely artificial soils and their importance is rapidly increasing in urban areas, with a varying potential for the regulation of the urban environment (Oberndorfer et al. 2007).

Constructed soils including green-roof soils offer several ecosystem services. They may be close to natural soils regarding their capacity to fulfill a range of functions (i.e., multi-functional soils). Provisioning services range from non-food biomass used for the production of energy and fiber to food biomass production (e.g., roof gardening). Regulating services provided by vegetated engineered SUITMAs are control of water quality and water flow in the city, maintenance of biodiversity, pollutant mitigation, air quality (e.g., capture of greenhouse gases and particle matter by plant foliage), local climate (control of urban temperature, local thermal insulation), carbon storage, and protection of the natural soil capital (i.e., by the use of secondary materials for soil construction).

3.3.2 Dumping sites SUITMAs

In this group are soils developed on a range of solid wastes originating from human activity (e.g., household waste, civil

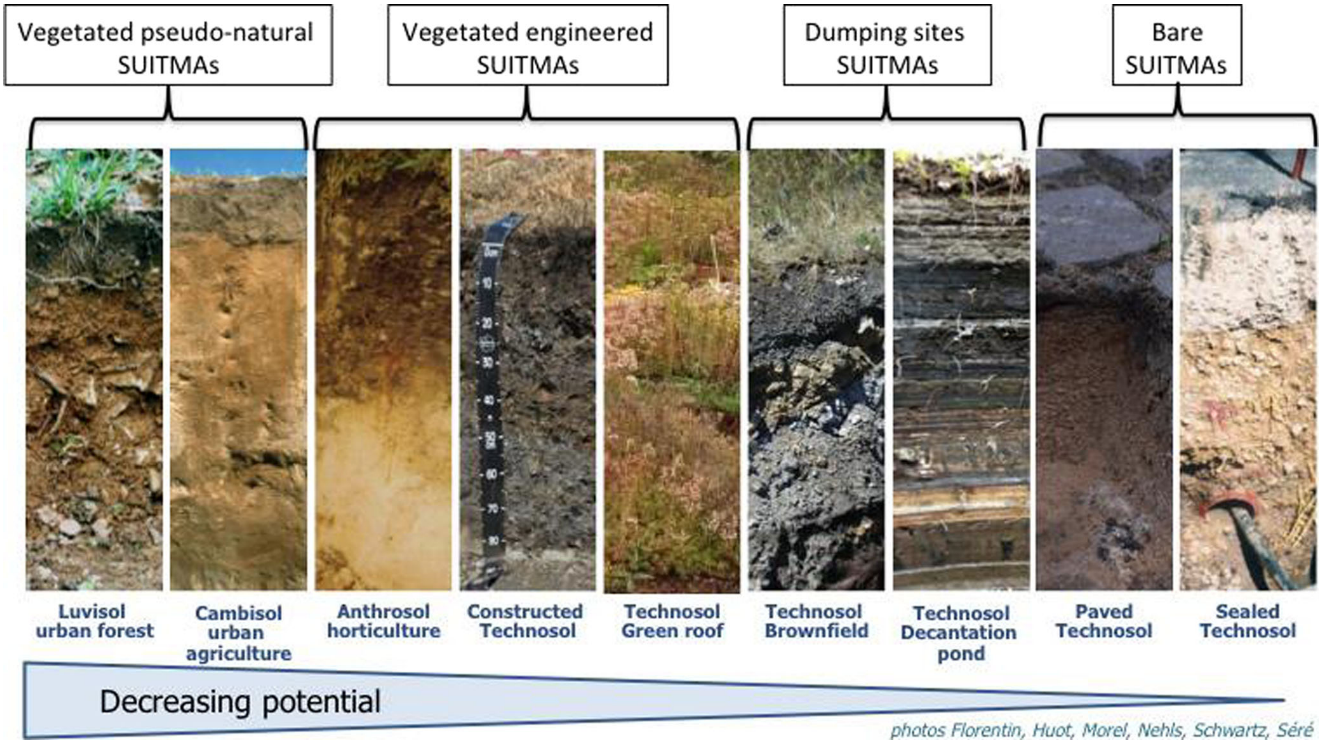

Fig. 1 Proposition of groups of SUITMAs according to their potential as vegetation support systems

engineering, industry) and landfilled at specific areas. The sites may be subsequently used for various purposes with or without restoration, including new housing development, gardening, parks, or left unused (e.g., brownfields). Three examples of dumping sites SUITMAs, i.e., brownfields, landfills, and settling ponds, are described in the following section.

1. Soils of brownfields are characterized with a wide range in composition. In general, brownfield soils are young containing significant amounts of technic materials (Technosols) with organic and inorganic pollutants. Unless action is undertaken to increase soil fertility, the potential of brownfield soils for biomass production is rather low. Also, due to the presence of pollutants, brownfield soils may produce disservices regarding water quality, and should be treated adequately to eliminate pollution sources and flows. Their contribution to regulating services is mostly marginal, e.g., water and air quality. But their contribution can be high for some aspects, e.g., storage of anthropogenic carbon, raw materials, and strategic metals (e.g., rare earth elements). Regarding biodiversity, brownfield soils may harbor a specialized biotic community adapted to extreme conditions. As they result from past human activities, brownfield soils also hold archives of human history and may be of interest for education and source of inspiration for artists.
2. Former urban waste landfills may consist partially of Technosols (New York City Soil Survey Staff 2005). Landfill soils support several regulating ecosystem services. Designed initially for receiving waste disposal, they may support new services to meet the increasing demand in surface area arising from urban expansion. An example is New York City landfills. Large surface areas of former tidal marshes have been filled with wastes (Walsh and LaFleur 1995) and are now used for airport infrastructures (e.g., JFK airport). They are also a source of raw materials of various kinds and of energy from anaerobic decomposition of organic wastes. However, similarly to the leaching of toxic compounds, gas emissions are major regulating disservices of soils at landfill sites. Other provisioning services are negligible as biomass production is limited to non-woody plants to avoid the impact of growing root trees on porosity and leachate infiltration. Similarly to brownfields, landfill soils are archives of human history.
3. Former settling ponds of the heavy industry (e.g., steel production) are characterized by very high concentrations of metals. The ponds were designed to eliminate industrial effluents and are nowadays considered potential secondary sources of elements of interest. When soil metals are poorly available, settling pond soils are favorable for plant development (Huot et al. 2013), and a large diversity of organisms may be develop. Also, metal leaching can be a low-limiting risk for groundwater quality, provided soil pedogenesis in the presence of plants does not change soil chemistry and favor metal release into the soil solution.

3.3.3 Sealed SUITMAs

Sealed SUITMAs are soils without or with only little vegetation cover, i.e., sealed soils, which are designed to fulfill specific services. A thorough analysis of sealed soils was discussed previously in Wessolek (2008). Roads and pavements are examples of sealed soils. They allow transportation of human beings, goods, energy, and wastes, including underground pathways (e.g., pipes, wires). Buildings are also included in this group unless vegetation is deliberately grown on roofs and walls. The natural soil functions are strongly affected and, in general, irreversibly destroyed. Thus, provisioning services of sealed SUITMAs are essentially the supply through transportation in and out of the city. As they mainly originate from the consumption of agricultural land by urban expansion, sealed SUITMAs are synonyms of large loss of potential crop yields (European Union 2012). Further, they probably support only a low biodiversity. However, they may contain elements of interest (e.g., carbon). Sealed soils generate several disservices as they may contribute to the urban heat island effect, enhance the risk of flooding as they favor surface runoff, and reduce the infiltration of rainwater. An alternative to soil sealing is paving using pervious surface materials which increases significantly water infiltration and temperature control. Micro soil profiles may develop between pavements where water infiltrates faster and plants can germinate and grow, producing cooler areas on the mosaic pavement (Nehls et al. 2008). There is an increasing interest for vegetated engineering SUITMAs built on sealed soils, e.g., parks created on underground parking lots. Such trend is an answer to the need for multifunctional soils in urban areas.

4 Proposed categorization of SUITMAs according to the ecosystem services they provide in urban areas

SUITMA groups are evaluated according to the ecosystem services they provide (Table 1). Attention is drawn on the type of services and the extent to which each soil group contributes to a service. A score is proposed with 4 levels from "o" which refers to soils that poorly contribute to a given service and produce significant disservices to "+++" for soils that strongly contribute to the corresponding service. This qualitative analysis results from the knowledge of the soil properties and the state of their functions. Score is given for each soil group individually. Taking into account that the range of variation of the state of functions may be large for a given group, score represents an "average" appreciation of the soil group regarding each ecosystem service.

An example is the provisioning service food production. This service is negligible, "o", or very low, "(+)", for sealed and dumping site SUITMAs. It is much higher, "++", for the two other soil groups, which can be specifically designed for food biomass production. However, most of the engineered soils are currently not aimed at food production. They are mostly designed for re-vegetation of degraded sites from which non-food biomass can be collected, i.e., "++(+)". Dumping sites are sometimes used for gardening, and a score "(+)" can be considered for food biomass production, but this practice is not recommended when contaminants are present and taken up by food crops. In this case, "o" appears to be more appropriate.

A second example is the regulating ecosystem service runoff and flood control. Sealed soils may increase flood risks as they have a little effect on mitigating intense water flow. A "+(+)" is proposed as paving may provide a better state for water infiltration in urban areas than fully sealed soils. The vegetated engineered or pseudo-natural SUITMAs offer an important contribution to flood control, via their rugosity and mainly their infiltration capacity, and are attributed a "+++" or a "++(+)." A potential "+++" score is possible for engineered soils as, for example, green-roofs are considered as means to control water flow release (and water quality). The ability of given SUITMAs to mitigate runoff and flood depends on their intrinsic properties, such as porosity, infiltrability, and structure stability toward rain events. These properties may vary greatly not only among soils of a given SUITMA group but also on vegetation cover (which may attenuate the energy of rain drops, evaporate a fraction of the precipitations), and on their position in the urban landscape. For this service, as well as for others, the approaches described above to evaluate ecosystem services provided by natural soils may be applied to SUITMAs, with, in some cases, additional difficulties due to the adaptation of sampling and measurement methods to SUITMAs and to the paucity of data and references. Attention should be drawn also on cultural services provided by soils in urban areas, as they are of utmost importance for soil science and for other disciplines, such as archeology and art. SUITMAs hold a large array of prints of human history (e.g. human residential activity and settlement history; Vasenev et al. 2013) and are the support of expression for artists (Toland and Wessolek 2010). Stressing on this particular service would help to increase the interactions with other disciplines such as archeology and art.

The proposed typology is a general overview on the ecosystem functions provided by the soils in the city. Thus, soils are no longer seen from their pedogenetic characteristics but for their ability to provide ecosystem services. However, pedogenetic processes are not ignored in this overview as they are at the basis for evaluating the soil groups, considering both actual soil functioning (e.g., biological, chemical, and physical properties) and soil evolution (e.g., fertility, weathering, and the subsequent release of harmful compounds into groundwater). Sub-categories will be required in the future to take into account the variability of the soils within a given

Table 1 Proposed categorization of SUITMAs based on the ecosystem services they provide

Ecosystem services		Groups of SUITMAs			Sealed
		Vegetated pseudo-natural	Vegetated engineered	Dumping sites	
Provisioning services	Food production	++	++	(+)	o
	Non-food biomass	++	++(+)	++	o
	Reservoir of minerals	+	+	+++	o
	Fresh water supply	o	+	o	+++
Regulating services	Water storage	++	+++	++	+
	Runoff and flood control	+++	++(+)	+	+(+)
	Pollution attenuation	++	+++	++	+++
	Global climate	+++	++	++	+
	Local climate	+++	++	+	o
	Biodiversity	+++	+++	++	o
	Invasive species	o	++	o	o
	Air purification	+++	++	+	o
	Noise control	++	+++	++	+
Cultural services	Recreation/tourism	+++	++	o	o
	Archives of human history	+	+	+++	++
	Landscape	++	+++	+	+
	Education	+++	+++	++	+

Symbols used in this table are scores that express the value of each ecosystem service provided each soil group. For a given soil group, significance of the symbol is as follows: "o" ecosystem service of no value (this symbol refers also to soil groups that provide a significant number of disservices); "+" ecosystem service of low value; "++" ecosystem service of medium value; and "+++" ecosystem service of high value. Brackets are used to introduce intermediate scores

group. A composite system taking into account the huge variety of SUITMAs is therefore required. This approach supports the idea that soils in the city should be managed concurrently with the other elements of the urban ecosystem. In other words, building the city must also include building its soils, which hold a major part of the potential urban ecosystem services.

5 Conclusions

The Earth system must be managed more sustainably to meet increasing human demands. This concept has led to significant changes in the way the urban environment is managed. Soils are in the first row of the factors that must be taken into account for sustainable development, and urban soil use and management must be considered to create sustainable cities. Here, we have proposed a simple way to present and rank soils of urban areas to enhance their consideration with regard to ecosystem services. As such, independently of their origin or state (e.g., pollution), urban soils are seen as a resource to enhance the quality of the urban environment. However, functions and ecosystem services provided by urban soils are currently not sufficiently described and quantified.

Our common future relies on the ability of city planners to design the suitable city ecosystem that provides the highest level of services (e.g., food, water supply and quality, biodiversity, air quality). Questions should be addressed to soil science regarding the roles and management of soils in the urban environment. A full chain of knowledge should be developed based on the cooperation of soil scientists and urban planners to answer questions such as how to build sustainable cities suitable for human well-being and preserve our soil capital, and how to get more ecosystem services from the same surface area.

A trend is detectable to have multifunctional soils in the city instead of a mosaic of soils fulfilling a narrow range of functions. Development of ecosystems based on this idea requires a thorough basic knowledge of SUITMAs regarding the needs expressed by the cities and the way soils can be deliberately designed to enhance ecosystem services. Soil engineering dedicated to the improvement of the urban environment is a promising area. It will help to respond to the needs of developing ecosystem services based on soil functions in urban areas and minimize disservices based on soil properties and management practices.

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