Soils within Cities

Global approaches to their sustainable management

Editors: M.J. Levin, K.-H.J. Kim, J.L. Morel, W. Burghardt, P. Charzyński, R.K. Shaw

IUSS Working Group SUITMA

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Global approaches to their sustainable management – composition, properties, and functions of soils of the urban environment

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Maxine J. Levin, Kye-Hoon John Kim, Jean Louis Morel, Wolfgang Burghardt, Przemysław Charzyński, Richard K. Shaw

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1.1 The challenges for soils in the urban environment

Introduction

The vast majority of soils are now under human influence or in the urban environment and this is where almost 70% of human beings are expected to live by 2050 (Table 1.1-1). Surface areas strongly modified by human activities expanded very fast worldwide due to available efficient machinery and to monumental human projects that convert natural soil into urbanized surface without considering the loss of our Natural capital. Land Affected by Humans has increased 78% of the surface area of cities in Europe since the 1950's, with a loss of 10 000 km^2 of agricultural land per 10 years. About 2.3% of the European territory is now sealed representing 200 m^2 per citizen, and up to 250 ha are converted every day (http://ec.europa.eu/environment/soil/sealing_guidelines.htm).

Table 1.1-1. Percentage of Population residing in urban areas (United Nations 2011, in Burghardt et al. 2015).

Country/Year	1950	2000	2050
World	29.5	46.7	67.2
Japan	53.3	78.6	97.6
Germany	68.1	73.1	81.8
Nigeria	10.2	42.4	71.3

As a result, henceforth, humanity will thrive on strongly modified soils, and certainly mostly on artificialized soils. In urban areas soils are distinct from other areas by i) transformation through mixing, compaction, leveling, sealing, excavation and ii) exportation and input of soil and exogenous material (i.e., technogenic), wastes (organic, inert, toxic), and dredged materials (De Kimpe and Morel 2000). Also, some soils are designed to fulfill specific functions and provide a range of ecosystem services (e.g., transportation, water management, green infrastructures). In cities, deeply transformed soils coexist along with natural soils (showing only little changes except a very different environment), such as in urban forests.

"Urban soil" is often used to designate soils of anthropized areas. However, this definition is too restrictive to take into account all areas that are transformed by human activities. For that reason, SUITMA (*Soils of Urban*, *Industrial*, *Traffic*, *Mining and Military areas*) was proposed by Burghardt and Morel in 1998 to encompass all soils under strong human influence and to emphasize that the so-called "urban soils" are found in a large variety of strongly anthropized areas. "Military" was added in 2003 as those activities are of major impact on soils. However, if "SUITMA" better expresses the diversity of anthropized areas, each exhibiting specific features, in this book and in many other publications, "urban soil" is used with the generic meaning, making "SUITMA" and "urban soil" synonyms.

In this introductive chapter, we will briefly consider the challenges faced by urban humanity, and their consequences on soils. Then the general features of SUITMAs that will be described with more detail all along the book will be shortly given. Finally, the challenges that Soil Science faces regarding its role in urban areas will be addressed. The authors are well aware that those challenges are a view of soil scientists and that they should be challenged with views of other actors of the city environment (e.g., city planners). They are also aware of the necessity to adapt our semantic and scientific perspective to the urban environment to be understood and followed by the numerous stakeholders in charge of the development of sustainable cities.

Challenges for the urban environment

Building sustainable and enjoyable cities is one of the main expectations of humanity that involves a series of important challenges:

1. The increasing urban population produces an increasing demand in goods (food, water, energy). This leads to huge mass transfer from rural and mining areas towards cities; as a result, cities have long become a sink for elements, including energy and essential elements such as P (Nehls et al. 2014). Also, to minimize transport and reduce CO_2 emission, urban agriculture is a strong trend to produce food locally. In regions as in Africa, urban agriculture has been used for centuries, and probably represents a relevant model for city development.
2. Competition for land between agriculture and urbanization is also a major challenge. Cities need to increase their capacity to accommodate everyone; in a way they also preserve agricultural land. Brownfields are negligible regarding their total surface but are of considerable interest when considering their location, within the city borders. Being often seen as handicaps as they may conceal pollutants, they are a new resource for city development, provided appropriate restoration technologies are available. Also, belowground construction could be a trend to both expand urban surface and mitigate heat-island effect. If this trend was confirmed it would be necessary to design environments livable for permanent residence, i.e. in a complete artificial environment.
3. Climate change is a major issue that will probably affect cities more than rural environments. Mitigating heat waves, preserving urban vegetation, controlling green house gas emission, fighting against brutal floods are some of the major challenges faced by cities.
4. Biodiversity degradation or collapse is probably as important as climate change and closely related. Cities take this into account but, in general, in a way that mostly suits citizen expectations. Cities could have a prominent role in the general preservation of biodiversity within their borders, e.g., with the creation of specific habitats that favor organisms which contribute to the functioning of the urban ecosystem.
5. Finally, it is necessary to enable and stimulate healthier cities. Indeed, human health and social stability are important challenges for the prosperity of urban societies. Education and training, development of art, urban landscape, and preservation from transfer of contaminants are issues that receive much attention.

General features of SUITMAs

Soils of the urban ecosystem are under strong anthropic influence, and exhibit specific characteristics rather different than those of soils of natural environments. Composition, functioning, distribution and evolution of SUITMAs will be described in detail in the next chapters. The large diversity of soils in the urban environment is the result of the site history and management (e.g., transformation, excavation, input, changes of use), which makes soil classification and survey challenging operations (Fig. 1.1-1).

SUITMAs are now recognized in soil classifications or reference bases, e.g., *Technosols* and *Anthrosols* of the WRB 2006, and many belong to the Regosol group as young soils, with qualifi-

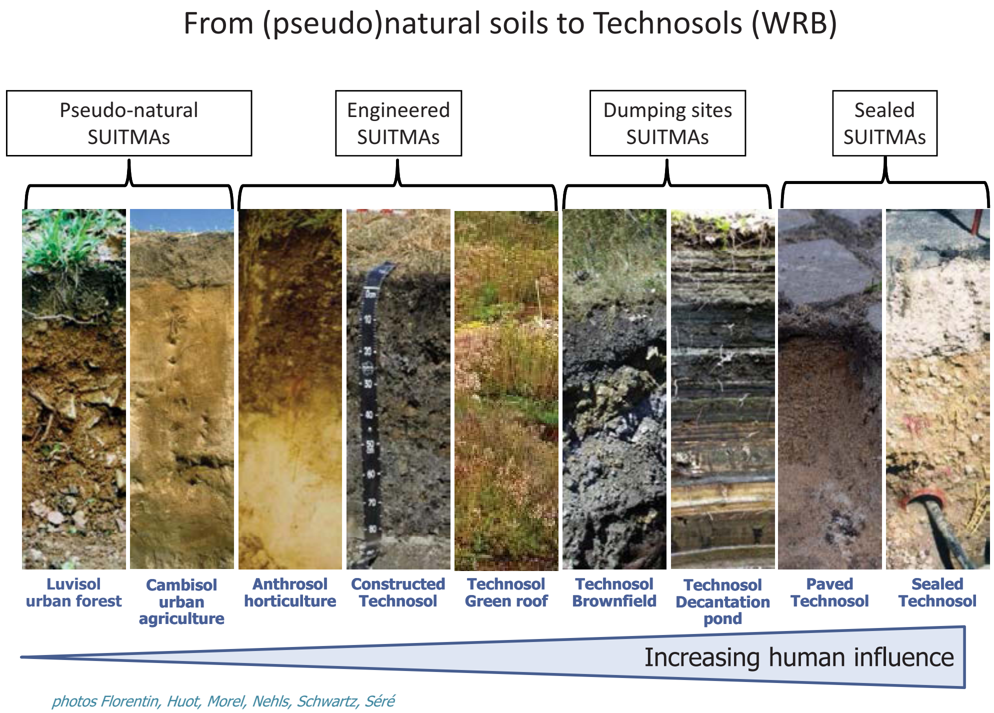

Fig. 1.1-1. Diversity of SUITMAs (after Morel 2015).

ers such like ekranic, linic (Charzynski et al. 2013) and recently proposed dialeimmic (Burghardt 2016). Urban soils were traditionally represented as white spots on maps or only depicted by the original natural soils. Nowadays, soil mapping of urban areas is generally based on soil functions in the city. For example, the New York City Soil Survey Staff (2005) proposed a map that stresses on a series of functions of open space to, e.g., management of municipal water and sewers, control of soil pollution, identification of wetlands and wildlife habitat, management of parks, control of runoff and stream flow in the urban environment.

SUITMAs have common features. They are mainly composed of coarse material (Burghardt et al. 2015), mostly of technic origin, urban waste (e.g., ash, bricks, coal, concrete, garbage, glass, gravel, oxides, plaster, plastic, rubble, sand, wood), and industrial waste (e.g., asphalt, ballast, dredged sediments, excavated bedrock, mine spoil, slag). They may contain organic and inorganic contaminants (e.g., hydrocarbons, metals). Technogenic materials often contain carbonates (concrete, mortar, lime) (Hiller 2000), and in many cases, they have properties of calcareous soils with high pH values (Kida and Kawahigashi 2015). SUITMAs used for horticulture or for waste and combustion residues disposal can be high in organic carbon. Black carbon is also a typical trait due to incomplete combustion of biomass and fossil fuel, and vehicle emissions (Nehls and Shaw 2010). From the high content of sand and gravel, SUITMAs have high water infiltration rates, but compaction is also a very common physical degradation of topsoil and subsoil that reduces infiltration (Burghardt 1996) and development of roots. Remarkably, SUITMAs can accommodate a large variety of organisms and are an efficient support for biodiversity (Pouyat et al. 2010, Santorufo et al. 2014).

Similar to natural soils, SUITMAs undergo pedogenic evolution that is closely dependent on parent material and environmental conditions (e.g., local climate). SUITMAs are young soils and often "polycyclic". Evolution is remarkably fast as observed in former battlefields (e.g., Verdun) and slag fields (Burghardt et al. 2000), and in constructed soils (Séré et al. 2010). The specificity of pedogenesis in Technosols is due to the original mixtures of constituents, making possible the simultaneity of pedogenic processes, which coexist rarely in natural soils (Huot et al. 2015).

Challenges for Soil Science in the urban environment

Cities rely on soils but most people ignore how fundamental are soils for a more sustainable urban environment. Soil management in cities is almost exclusively the privilege of civil engineering, and soils remain probably a marginal component being considered when it comes to urban planning and urban management. This is largely due to Soil Science itself, as it has long ignored urban areas. Soils of urban areas were not considered as "real" soils until the pioneering works 40 years ago (e.g., Blume and Runge 1978).

In urban areas, soils are important in the daily life of citizens (transportation, housing, socio-economical activities, landscape shaping, health and social stability, human memory). They also play a major role for urban agriculture (e.g., horticulture, gardening, green roofs), green infrastructures (parks and street trees), and biodiversity (fauna, flora, microfauna). They are important for water cycle regulation (urban hydrology, infiltration, transport and sequestration of pollutants), the control of air quality (fine dust and pollutants) (Hoeke and Burghardt 2001), and the mitigation of local climate (heat-island effect) (Hoeke and Wolff 2011).

Among the primary issues are the functions of SUITMAs (Nehls and Wessolek 2011), and the ecosystem services they provide (Morel et al. 2014). SUITMAs are often built to fulfill specific functions (e.g., sealed soils for transportation of people and goods, constructed soils for ecosystem restoration and landscaping, green roofs and walls). But, underestimated, is the fact that SUITMAs may be the base for multifunctional characteristics in the urban ecosystem.

Actually, Soil Science is facing fundamental questions about the urban environment and its management. These questions are related to the functions of soils; the way sustainable cities can be built while preserving our soil capital; and how to get more ecosystem services from the same surface area. Hence, Soil Science should be capable to answer the question that could be asked by city planners: "*What soil(s) is(are) required to provide the expected services for citizens*?" and the following scheme should be built then implemented: *expected services > functions required > soil needed > soil engineering*.

Basic knowledge is then needed about objects and soil characteristics that notably differ from the ones that soil scientists are used to working with. This can contribute to understanding the functioning and evolution of SUITMAs in a very specific environment (e.g., local temperature), characterizing their functions and identifying their potential for ecosystem services, and finally helping in the mapping operations. With the soil management, it will provide solutions to important issues, e.g., food production potential, storm water infiltration, hazards and soil contamination, and urban heat mitigation. Also, other requirements will be met, such as reduction in the loss of arable land, reclamation of degraded and polluted soils (e.g., brownfields), health improvement, preservation of biodiversity, and conservation of archives of settlement history. As natural soils, SUITMAs undergo evolution under the influence of climatic and anthropogenic factors (e.g., temperature, compaction, reactive compounds, control of water input) and generate various distinctive features of pedogenesis. This evolution should be addressed to better manage the urban ecosystem.

Having a dedicated group within the IUSS helps to promote Soil Science in strongly anthropogenic areas, and increases the impact of soils science in the decision-making process for urban land management. It stimulates multi-disciplinary research and teaching for a better understanding and sustainable management of SUITMAs. However, the community should not be restrictive to soil science and should welcome other scientists dedicated to urban soil issues (e.g., geology, ecology, agronomy, horticulture, forestry, chemistry, physics) and actors of the urban management (e.g., economists, lawyers, geographers, policy-makers, engineers, artists, citizens). Also education strategies should be elaborated to promote awareness on urban soil ecological functioning. The SUITMA group is in constant movement as science makes progress and new generations take the lead. After more than 18 years of activity, SUITMA is recognized as a pioneer group, which has contributed to the increasing interest for soils observed worldwide in urban areas.

Finally, soil science should better communicate regarding the urban issues. SUITMA is now visible and can be an efficient vector for communication of soil science in the city. Dedicated journal and papers submitted to civil engineering journals are required. Books as this one and websites such are a good means to propagate information at a larger community than soil science itself, providing appropriate terminology is used.

Conclusion

SUITMAs are diverse, complex, distributed heterogeneously, and change rapidly with the city. They fulfill functions of the highest importance in the urban ecosystem and are "easily" manageable (soil design and soil construction). They are primary providers of ecosystem services that should draw the attention of city managers. Their economic value must be assessed. However, despite the growing awareness of their importance in urban areas, soils are still poorly valued for urban management (e.g., green infrastructures). Urban soil science covers all fields of traditional soil science, but it deals with a much larger number of soil uses and characteristics than occur in rural areas. It is necessary to increase knowledge on the properties, functioning, impacts and long-term evolution of soils under major human influence to better understand their role in anthropogenic areas, and better manage the urban ecosystem. Dialogue is essential between urban managers and soil scientists to improve the services that are expected from sustainable cities. Increase the impact of Soil Science in the decision-making processes for the sustainable management of the urban environment. Stimulate multidisciplinary research for understanding the urban environment, and share experiences and concerns from all over the world (e.g., case studies). This book is an initiative of IUSS fulfilled by the SUITMA working group. It is composed of a series of chapters, produced by colleagues who have shown interest over the years for urban soil issues, that cover many aspects of SUITMAs, including i) composition, properties, functions, evolution and classification of urban soils with examples of soil surveys, and ii) the management of soils in the urban environment with a special focus on soil sealing, urban agriculture, and the ecosystem services expected from urban soils.

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1.2 Activities of SUITMA: from origin to future

Introduction – first urban soil movements and foundation of Working Group SUITMA

Soil science in comparison to other scientific disciplines is relatively young, and the acknowledgment of the science of Soils of Urban, Industrial, Traffic, Mining and Military Areas (SUITMAs) is even younger. The science of SUITMAs is an interdisciplinary branch of investigation within the general topic of soil science. It has its origin in several fields such as soil survey, pollution and health impacts, green infrastructure, storm and sewage drainage, and urban planning and engineering (Burghardt et al. 2015). One of the earliest scientific documented investigations about urban, industrial and mining soils, and the effects of toxic wastes on soil fertility, was recorded by Ferdinand Senft in 1847 (cited in Lehmann and Stahr 2007). The first attempt to survey urban soils and to establish an urban soil map was implemented by Mückenhausen and Mueller (1951). They mapped part of the city of Bottrop, Germany, which was heavily destroyed during World War II. In Poland, Skawina (1958) researched the soil formation processes on the waste heaps of the coal industry. Zemlyanitsky (1963) gave an early description of the chemical and physical properties of soils of Moscow. The soils of Washington, D.C., United States, were surveyed in the early 1970s (Smith 1976).

An international symposium on urban soils in Berlin, Germany, organized in 1981 by Blume and Schlichting (1982), was a successful first attempt to bring together urban soil scientists. Due to its physical and political isolation in the Cold War due to wall construction (1953–1989), the western part of Berlin was forced to supply all needs of its population within the city border. Therefore the highly human-affected soils of Berlin could not be neglected and became the focus for urban investigations for food security, waste discharge, recreation and environmental issues. The soils of the area of Berlin are now completely mapped and used for soil interpretations to address urban issues (Berlin 2013).

In the mid-1980s, more and more soil scientists started to work in urban areas worldwide But Experiences about urban soils were scarce. To meliorate this situation, and to give urban soil scientists a home and promote the formation of a sub-discipline urban soil science, national urban soil working groups started in Germany and the United States. In 1987 a group of soil scientists decided during a meeting in Essen, Germany to establish a working group (WG) on urban soils within the German Soil Science Society (AKS – Arbeitskreis Stadtböden der Deutschen Bodenkundlichen Gesellschaft). The WG was chaired until 2007 by Wolfgang Burghardt of University Essen. He outlined essentials of soil research in an urban environment (Burghardt 1994). German governmental support for a large urban soil investigation and mapping project (Blume and Schleuss 1997) enabled the preparation of a soil survey instruction for urban soils (AKS 1997) which was included in the soil survey manual of the Federal States of Germany (Arbeitsgruppe Boden 2005). The U.S. working group ICOMANTH (International Committee on Anthropogenic Soils), after several years of collaboration, published its first Circular Letter in 1995 (ICOMANTH 1995) and had its first large meeting and excursion in 1998 in Las Vegas, California (NRCS 1998). In Moscow, Russia, an International Conference "Problems of Anthropogenic Soil Formation" took place in 1997 (Lyubimova 1997). In France, research on technogenic soils started in the early 90s with a special interest in the quality of garden soils as support for food production (Schwartz and Morel 1995), and more generally in urban and industrial soils (De Kimpe and Morel 2000). Then prominent institutions such as the Academy of Agriculture of France and the French Association for Soil Science (AFES) provided a significant place for these soils (1998–2002) with the inclusion of Anthrosols in the French Soil Reference base (Référentiel Pédologique Français 2008).

Cooperation between WG Urban Soils of the German Soil Science Society and the Laboratoire Sols et Environnement UMR 1120 UL-INRA of the Université de Lorraine, Vandœuvre-lès-Nancy, France was the impulse to establish an international working group Urban Soils. This was straightaway welcomed and supported by Wilfried E.H. Blum, the Secretary General of the International Soil Science Society (ISSS, today International Union of Soil Science, IUSS). During the 16th World Congress of Soil Science (16 WCSS), the International WG Urban Soils – Soils of Urban, Industrial, Traffic and Mining Areas (WG SU/SUITMA) of the ISSS was founded on August 20th, 1998 in Montpellier, France. The first Chair and Vice Chair, respectively, of the WG US became Wolfgang Burghardt, University Essen, Germany, and Jean Louis Morel, Université de Lorraine, Nancy, France, who held these positions until 2007. During the 4th SUITMA Congress 2007 in Nanjing, China the previous Vice Chair Jean Louis Morel was elected new Chair. Gan-Lin Zhang, Department of Soil Resources and Remote Sensing of the Institute of Soil Science of Chinese Academy of Science was elected as Vice Chair. During 8th SUITMA conference 2015 in Mexico City, Kye-Hoon John Kim from Department of Environmental Horticulture, University of Seoul, Korea was elected Chair.

The IUSS WG SU/SUITMA had its first symposium at the 16 WCSS in Montpellier on 'Urban and suburban soils: nature, management and risks for human health' (Burghardt 1999). The symposium was visited by 34 participants from 16 countries. The excursion 'A-l of the 16th WCSS': Lorraine, Alsace, Franche-Comté' offered the study, evaluation and management of urban and industrial soils (including a quick visit beyond the French border, in the Saarbrücken, Germany). The excursion was attended by 22 soil scientists (Rasio 1998).

The WG SU/SUITMA has been present at all subsequent World Congresses of Soil Science organizing special sessions dedicated to technogenic soils:

- in Bangkok, Thailand during the 17th Congress (2002) with symposium *Improving knowledge about soils and their functions in urban, industrial and mining areas for better life*;
- in Philadelphia, USA during the 18th Congress (2006) with symposium *Soils in Urban Eco-systems: Characteristics and Functioning*;
- in Brisbane, Australia during the 19th Congress (2010) with symposium *Pedogenesis and functioning of soils in urban and industrial areas*;
- in Jeju, South Korea during the 20th Congress (2014) with symposium *Urban soils – properties*, *functions and evolution.*

SUITMA conferences

Since the creation of IUSS WG SU/SUITMA, eight conferences dedicated exclusively to soils of urban areas (in a broad sense) have already been organized: in Essen, Germany, in 2000; Nancy, France, in 2003; Cairo, Egypt, in 2005; Nanjing, China, in 2007; New York City, USA, in 2009; Marrakech, Morocco, in 2011; in Toruń, Poland, in 2013 and in Mexico City, Mexico, in 2015. Since 2003, SUITMA meetings have taken place every second year.

The original 2000 SUITMA conference in Essen, Germany, was organized as several parallel sessions. This concept was changed by Jean Louis Morel at the second SUITMA Conference in Nancy, France. Since then, at SUITMA conferences (Burghardt 2003, 2006, 2008) all presentations are given in one block. Thus, all participants can stay together to convene throughout the conference. This concept has proved very successful by bringing the conference attendants much closer together, to cooperate and to form a community of urban soil scientists.

A summary of each conference held so far is as follows:

Essen 2000

The first international conference of the WG SUITMA was in Essen, Germany from July 12th to 18th 2000 in co-operation with DBG-Deutsche Bodenkundliche Gesellschaft/German Soil Science Society, AFES – Association Francaise pour l'Etude du Sol/French Soil Science Society (Burghardt 2001) and the University Essen, Germany (Burghardt 2001). The 1st SUITMA Conference was chaired by Wolfgang Burghardt.

The Conference was attended by 161 colleagues from 37 countries. A great advantage for the SUITMA-Conference was the participation of colleagues from Africa, Asia, Australia, South and North America. There was a strong demonstration of the necessity that soil science had to go into cities all over the world. Accordingly, the motto of the conference was 'the CITY has SOILS – the CITY needs SOILS ' (Burghardt 2001). There were 3 days of 214 oral and poster presentations, as well as small group discussions on the objectives of the conference themes, a research partner mediation event, presentations of 19 cities, the presentation of five urban soils maps (Kiel, Eckernförde, Oberhausen, Herne, Stuttgart) and 5 one day excursions.

The contributions were published as proceedings in 4 Volumes of 1149 pages (Burghardt and Dornauf 2000) and distributed at the conference.

The program of the first SUITMA conference was divided into themes (Burghardt 2001), with the intent to highlight the themes of SUITMA at its inception. There were three major themes of the conference and subdivided into 22 subtopics:

A – the Unknown Urban Soil – Detection, Resources and Face;
B – Application of Soil Information;
C – Soil Quality and Problems.

The contributions to theme A were numerous. They concerned field and laboratory methods, historical urban soils, field survey and soil maps, classification of urban soils, man-made substrates. Definitely lower was the number of contributions to theme B. This topic was only just discovered by soil scientists at that time so the subject research was preliminary. At the conference, sludge and waste, storm water infiltration, vegetable gardens, green areas, playing grounds and city planning issues were represented. The session C had a very good resonance with the participants. The great number of contributions dealt with soil quality, soil degradation, soil protection, soils of biotops/pedotops, soil remediation, specific problems of industrial, traffic and mining areas. Two of the proposed 22 subtopics did lack contributions: City management and soils of burial grounds. For us soil scientists it meant that we would need to encourage research about these very important themes (Burghardt 2001).

Similar to all later SUITMA conferences, the 1st SUITMA Conference had a main aim to show urban soils and to discuss their features and problems in the field. The large old industrial area of the Ruhr with its heavy and chemical industry and hard coal mining areas was very qualified for that purpose. Five one day excursions were organized:

A – Modified soils (by stratification, mixing, compaction, contamination, humus accumulation, fine earth reduction by skeleton content, ground water lowering);
B – Soils from man-made substrates (ruble, waste, sludge, ash, slag, thermal cleaned soil);
C – Urban soil use (park, forest, vegetable garden, playground, storm water infiltration, biotopes);
D – Extreme contaminated soils, soils as sources of fine dust (PM_{10}),
E – Soils from hard coal mining and soil reclamation.

In total, 25 soil profiles were presented and discussed, and 9 additional sites were visited (Burghardt 2001).

Nancy 2003

Three years after the successful Essen conference, it was decided to pursue the activities with a biannual frequency. The second conference, chaired by J.L. Morel, was organized from July 7 to 11, 2003, in Nancy, Lorraine, France (Palais des Congrès). It was organized by the GIS-FI (*Groupement d'Intérêt Scientifique sur les Friches Industrielles* – Scientific Consortium for Research on Brownfields – http://www.gisfi.fr) under the umbrella of IUSS, AFES and DBG. This conference put a special emphasis on industrial sites (Burghardt 2003). Indeed, as in many areas where heavy industry had been predominant during the 20th century, the Lorraine Region faced a dramatic depression of its industrial activity from the 80's. As a result, large brownfields appeared, which were characterized by deeply disturbed soils that presented high levels of pollution (e.g., PAHs, metals). Attendance reached 130 participants from 20 countries. The conference was organized in six sessions, including:
– methods for the study of urban soils and classification (14 contributions)
– biological properties of urban soils (13 contributions),
– pollution dynamics and transfer risks (30 contributions),
– physical and chemical properties of urban soils (16 contributions),
– remediation of degraded or polluted soils (11 contributions),
– historical (7 contributions), health (6 contributions) and legal aspects (6 contributions).

A book of abstracts of oral and poster communications was published along with a CD-ROM. The region around Nancy, Lorraine, and of the Saarland next to it, offer excellent possibilities for tours about the themes of SUITMA (coal and iron mining, iron and steel production, First World War). Four one-day tours were organized (C. Schwartz, L. Florentin):
– Industrial soils from mining residues, dumps and coal mining areas;
– Soils with modified physical properties due to mining and military activities in the Red Zone of Verdun;
– Industrial soils from an iron-steel industry area
– Urban soils.

Two main decisions were made during the closing session: i) addition of "Military" areas to take into account soils deeply transformed by wars and military activities, and cover the total spectrum of SUITMAs, and ii) to settle the Working Group SUITMA under the roof of Division III "Soil Use and Management" which was chaired from 2002 to 2010 by Wolfgang Burghardt in the new structure of IUSS. Finally, the working group decided to have the third and fourth conferences outside Europe and North America, in countries where strong growth of urban agglomeration occurs, i.e. in Cairo for the third SUITMA-conference in 2005, and in Nanjing, in 2007.

Cairo 2005

The third SUITMA conference was convened from 17th to 25th November 2005 in Cairo, Egypt. The organizers belong to the soil science department of the University of El-Zagazig, assisted by personnel from the Egyptian Geological Survey and the Egyptian Society of Crystallography. Professor Salah A. Tahoun was the president of the conference. Adopted themes were: properties of unconventional soils; methodology and classification; industrial, traffic, and mining pollution; cycling of city fluids and solid refuse; desertification and urban expansion; consumed mining and military areas; historical sites; and conventional soils.

Activities of the conference comprised field excursions and scientific deliberations. The first pre-conference excursion visited the bentonite quarry of El-Fayoum Province and the mineral extraction plant from the brackish water of Lake Karoun, 100 km west of Cairo. The second excursion visited stabilized sand dunes 50 km northeast of Cairo, followed by an afforestation project utilizing treated sewage effluents. The post-conference excursion over the period of 22–25 November visited the Mediterranean Coast, Siwa Oasis, El-Alamain as a remnant military area of World War II, and Alexandria as a coastal urban center. Time was taken to dig representative soil profiles in localities, features were discussed, and samples were collected.

On November 19th, a total of 194 registered participants including 76 international guests coming from 22 countries began their scientific deliberations. There were 10 oral presentation sessions dealing with 47 contributions (Burghardt 2006). Ample time was allocated to specific and general discussions. There were also three poster presentation sessions dealing with 70 contributions. The authors of the best three posters were recognized with encouragement and appreciation. A book of abstracts carrying 117 volunteered contributions was published in hard and digital copies. Accepted peer-reviewed papers were edited by Salah A. Tahoun and subsequently published in 2008 at www.eun.eg/suitma

Nanjing 2007

The 4th International Conference on Urban Soils – Soils of Urban, Industrial, Traffic, Mining and Military Areas (US/SUITMA) was held in Nanjing, China, during October 18–27, 2007, taking the Institute of Soil Science, Chinese Academy of Sciences as the conference venue. The Chair of the organizing committee was Prof. Gan-Lin Zhang. More than 120 participants from 19 countries attended the conference. The indoor session consisted of three major parts:

Part 1: Methodologies, including: i) Soil survey, description, terminology standardization and sampling in urban areas; ii) Laboratory methods for urban soils; iii) Soil classification and mapping in urban areas;

Part 2: Impacts of urbanization on soil resources, including: i) Land use change under urbanization; ii) Pedogenesis and quality changes of urban soils; iii) Physical aspects of urban soil changes; iv) Chemical aspects of urban soil changes; v) Biological aspects of urban soil changes; vi) Historical aspects of urban soil formation and characterization;

Part 3: Urban soils in relation to urban ecosystem, including: i) Ecological impact of urbanization in regional and global scales; ii) Urban soils and greenery plants; iii) Urban soils in relation to water environment; iv) Biogeochemical cycling of life-dependent materials in urban ecosystem; v) Pollution status and control of urban soils; vi) Remediation of contaminated SUITMA; vii) Ecological assessment of urban soil quality; viii) Ecology-based urban land use planning.

There were 43 oral and 85 poster presentations. From the 1st to the 4th, SUITMA conferences experienced a shift of their main topics. In the beginning pollution and classification of urban soils were the main topics. At SUITMA 4, the effect of diverse types of urban land use on soil characteristics, the new properties soils inherited from them, functions, and methods of assessment of it, from particular urban properties and for urban services, have become top themes (Burghardt 2008).

Pre- and post-conference tours were organized. The pre-conference tour was devoted to major urban soils (including sub-urban areas as well) in Nanjing. The 2-day post-conference tour was arranged in an ancient copper mining city – Tongling of Anhui Province where copper tailings and rehabilitation of mining areas were investigated.

The election of the chair persons was conducted. Prof. Jean-Louis Morel from University of Lorraine, France was elected as Chair of SUITMA WG and Prof. Gan-Lin Zhang from Institute of Soil Science, Chinese Academy of Sciences was elected as the Vice Chair.

New York City (NYC) 2009

SUITMA held its fifth conference from September 20 to 25, 2009, in New York City, marking the first time the group met in the Americas. Hosting were the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) and the New York City Soil and Water Conservation District (NYCSWCD), along with the Queens College School of Earth and Environmental Sciences. Cooperators included the New York City Department of Parks and Recreation (NYCDPR) and Department of Environmental Protection (NYCDEP); the GAIA Institute, the Central Park Conservancy (CPC), and the USDI-National Park Service (NPS).

The main program was held at the City University of New York (CUNY) Graduate Center in midtown Manhattan. In attendance were 125 participants from 16 countries representing 5 continents (Fig. 1.2-1). The 37 oral presentations and 36 posters were organized to highlight the direction of current research in urban soil science: Urban Hydrology, Soil Contaminants, Soil Carbon and Land Use, Technosols, and Urban Soil Survey.

Two days of field tours through all five boroughs of NYC emphasized urban applications of soil survey information and highlighted NRCS partners in the City. The NPS tidal marsh restoration project at Big Egg Marsh, the subaqueous soil survey work conducted by the NRCS for eelgrass restoration, both in Jamaica Bay; the Pennsylvania Avenue Landfill native plant revegetation project (NYCDEP) in Brooklyn; and a Million Trees project site (NYCDPR) in Kissena Corridor Park, Queens, were visited. A tour was provided of the (NYCDPR) Native Plant Center in Staten Island, a 13-acre greenhouse, nursery, and seed bank complex providing native plants

Fig. 1.2-1. Participants of SUITMA 5 conference in New York City (2009).

and seeds for restoration efforts. Storm water management projects included an example of the NYCDPR's *Greenstreets* program in upper Manhattan, and an innovative system designed by the GAIA Institute at the City's metal and plastic recycling center on the Bronx River.

The conference proved to be a valuable networking event that not only brought together the SUITMA community, but connected it to New York City environmental professionals and USDA-NRCS soil scientists, fostering several new cooperative efforts. It also served to underscore some practical applications of urban soil science and strengthen the USDA-NRCS presence in New York City and the urban environment at large.

Marrakech 2011

The 2011 Sixth SUITMA conference was held in Marrakech, Morocco from 3 to 7 October. It was co-organized by the Faculté des Sciences et Techniques of Marrakech, University Cadi Ayyad and the GISFI (http://www.gisfi.fr). The Chairman of SUITMA 6 Scientific Committee was Prof. Boularbah Ali. More than one hundred participants (Fig. 1.2-2) attended the conference and a total of 45 communications and 48 posters were presented in four sessions: session 1: SUITMA properties and diversity, contamination, and remediation; session 2: role of SUITMAs in global change and water quality; session 3: biodiversity in SUITMAs; and session 4: SUITMAs as buffer for human health and social stability (Dickinson et al. 2013). Eleven selected papers were peer reviewed and published in special issue of the Journal of Soils and Sediments (13(3), 2013), which focuses on the properties, processes, evolution, and management of soils in urban and human-altered environments. Besides a three-day conference, two days were spent on field trips in Marrakech and its vicinity to examine soils and landscapes, soil-based restoration, research, and mapping projects under semi-arid climate and to study the impacts of the mining activities on the soils. During the field tour, different profiles of urban soils of Marrakech and industrial soils from Kettara mine, were presented and their chemical, physical and some biological (total number of culturable cells of bacteria and fungi, dehydrogenase and respiration activities) properties were discussed. Also a post-conference tour was organized in Senegal to address issues related to urban soils under tropical conditions. The 3 days tour was organized by Ndeye Fall of the Institut National de Pédologie (INP/DG), Dakar, Senegal.

Fig. 1.2-2. Participants of SUITMA 6 conference in Marrakech (2011).

Toruń 2013

The 2013 Seventh SUITMA conference was held in Toruń from 16th to 20th September. It was co-organized by the Department of Soil Science and Landscape Management, Faculty of Earth Sciences, Nicolaus Copernicus University and the Polish Soil Science Society. The Chairman of the SUITMA 7 Scientific Committee was Przemysław Charzyński. More than 110 participants

Fig. 1.2-3. Participants of SUITMA 7 conference in Toruń (2013).

(Fig. 1.2-3) from 24 countries from all inhabited continents attended the event, and a total of 47 oral and 74 posters were presented in six sessions, apart from the plenary one (Morel et al. 2015a):

- Classification of SUITMAs (13 contributions);
- SUITMAs as a resource of goods (18 contributions);
- Degradation of SUITMAs and human health (58 contributions)
- SUITMAs and climate change (6 contributions)
- Biodiversity in SUITMAs (13 contributions);
- SUITMAs and culture (10 contributions).

Selected papers based on presented reports were published in special issues of *Journal of Soils and Sediments* (15(8), 2015) and *Soil Science and Plant Nutrition* (61 (S1), 2015).

Two days of conference were spent on field trips in Toruń and in the nearby places in Kuyavian-Pomeranian Province. *Ekranic Technosols* of Toruń Airfield, constructed soils (Linic Technosols) on Toruń Strongholds, 'Paleotechnosols' of Grodno–Lusatian fortified settlement from older part of Hallstatt period, soils of military training fields and *Spolic Technosols* in the area affected by soda industry (Inowrocław) were presented. The conference was completed with a 4-day post conference tour in Poland and in Czech Republic (organised in cooperation with *Research Institute for Soil and Water Conservation*, Prague, Czechia). Soils of the reclaimed external dumping ground of opencast brown coal mine in Bełchatów, the problems with landscape slumps under mining spaces in the area around Karvina and Orlova, problems of soil contamination by petroleum hydrocarbons and reclamation of the area of abandoned military range and military airport in Mlada Boleslav district were presented.

Two books were published especially for the conference, including *Technogenic Soils of Poland* (Charzyński et al. 2013a) and *Technogenic Soils Atlas* (Charzyński et al. 2013b), and can be downloaded here: http://www.suitma7.umk.pl/.

Mexico City 2015

The Eighth SUITMA conference was held in Mexico City from September 20th till 25th, 2015 at the National Autonomous University of Mexico (UNAM). It was organized by soil scientists from the Institutes of Geology and Geography, the chairpersons being Christina Siebe, Silke Cram and Eleonora Ramírez. There were 112 registered participants attending the meeting, coming from 18 different nations (Fig. 1.2-4).

Fig. 1.2-4. Participants of SUITMA 8 conference in Mexico City (2015).

Within the 3 conference days 10 sessions with a total of 49 oral and 74 poster presentations took place, covering the topics: (i) soil ecological functions in urban planning and management, (ii) urban soils and human health, (iii) restoration and reclamation of environmental liabilities, (iv) soil forming processes in Technosols, (v) soil and city biodiversity, (vi) soils as archives of settlement history, (vii) food production in urban and peri-urban areas, (viii) soil conservation to improve water management in urban areas, and (ix) geological hazards in urban and peri-urban areas (www.geologia.unam.mx:8080/~cisu/suitma8/).

One and a half days of the conference were further dedicated to field trips in the metropolitan area of Mexico-City. Problems such as accelerated surface sealing, land subsidence due to groundwater overexploitation, flood hazards and surface runoff regulation, groundwater pollution and overexploitation, wind erosion in peri-urban areas affecting air quality, waste production and disposal, rehabilitation of industrial liabilities were discussed at the different excursion stops. Soils developed out of rubble debris, saline-alkaline lake deposits, or in prehispanic floating gardens were shown, as well as soils which function as archives of more than 2000 years of settlement history within the basin of Mexico. Also examples of reforestation of environmentally strategic ravines, clean-up strategies of former industrial sites, green roofs installed by different institutions and the conservation program of ecological soil functions at the university campus were demonstrated.

Half day of the meeting was dedicated to a soil education fair, in which conference participants showed outreach activities to promote social awareness on soil ecological functions to conference participants and to children from a nearby primary school. The outreach program of the Institute of Geology named "Terramóvil" can be seen here www.geologia.unam.mx:8080/igl/index.php/terramovil.

One post conference tour showed archaeo-urban soils at the Teotihuacan archaeological site, soils of the largest wastewater irrigated area worldwide in the Mezquital valley and soils on mine waste deposits of the Guanajuato mining district in Central Mexico. Another three days tour went to the city of Xalapa, state Veracruz, east of Mexico City. Deep weathered soils formed on volcanoclastic materials were shown as well as their degradation by accelerated urban growth and deforestation, which leads to increasing landslide hazards and liquefaction processes. Preventive and remediation solutions that have been taken by the government such as contention walls or vegetation covers were demonstrated and their effectiveness discussed.

Other SUITMA activities

The WG SUITMA is not only active for the biannual conferences but it is present as mentioned above at the IUSS congresses with a dedicated symposium on the features of strongly anthropised soils. It also actively participates to the EUROSOIL congresses (Freiburg, 2004; Vienna, 2008; Bari, 2012; Istanbul, 2016), and was present at the ASA-CSSA-SSSA annual meeting (e.g., Long Beach, 2014), and at meetings of other national Soil Science societies, such as in Brazil (Natal, 2015), France (e.g., Chambery, 2014), Germany (e.g., Munich, 2015). It also participates in other related distinguished scientific meetings to spread the advances in knowledge of those particular soils (e.g., EGU, Vienna; INQUA, Nagoya, 2015).

The best papers presented at biannual SUITMA conferences are published in the Journal of Soil and Sediments (JSS). So far, three special issues have been published, related to the conferences of Marrakech (2011), Torun (2013) and Mexico (2015). This association between SUITMA and the J. Soils and Sediments is described in a short note: "*An interdisciplinary working group of the 'International Union of Soil Science" dedicated to soils strongly modified by human activities*" (2008) 8:206–207. Also, special issues of scientific journals are published under the SUITMA umbrella, e.g., Journal of Soil and Plant Nutrition (2015). Finally a wiki was created to offer a collaborative platform (2009) and contribute to increase the visibility of SUITMA: http://ticri.univ-lorraine.fr/urban_soils.en/index.php/Soils_of_Urban,_Industrial,_Traffic,_Mining_and_Military_Areas

Last but not least, SUITMA activities are also strong interactions between colleagues who have known each other for more than 15 years, which generate close collaboration, including joint projects, joint publications, and joint actions.

SUITMA future

WG SUITMA recently established a website: https://sites.google.com/site/wgsuitma/. It will be a platform to share knowledge about technogenic and anthropogenic soils and to exchange important information about it. It also will be a place of intercommunication and establishment of cooperation and serve to promote knowledge about SUITMAs as well.

Despite its history of nearly 20 years, WG SUITMA still needs to know more on the properties, functioning, impacts and long-term evolution of the soils under major human influence for better understanding of their role in anthropogenic and technogenic areas and for better managing of the urban ecosystem. Communication between stakeholders of SUITMA and soil scientists to improve the services that are expected from sustainable development of SUITMA is essential.

The next two SUITMA conferences will be organized in Moscow, Russia in 2017 and in Seoul, South Korea in 2019.

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2 Composition, properties, and functions of soils in the urban environment

2.1 Main characteristics of urban soils

Introduction

An urban world population of 0.75 billion in 1950 and expected 6 billion in 2050 shows the tremendous potential growth of urban areas. Most urban areas are young. They have some similarities to natural alluvial plains which exhibit a juvenile landscape stage. Both have a dynamic periodic change of cover and new deposits on exiting soils. There is a typical rapid succession of vegetation and fauna as well as the beginning of soil formation. Different from alluvial plains are the shape of surface and the composition of surface layers of urban areas that are less homogeneous and contain numerous niches. At the local scale there is a richness of diversity in urban soils that you do not see in alluvial plains.

The urban environment creates a specific habitat for humans as well as for soils that is unique and different than in natural areas. For soil scientists it is fundamentally accepted that soils develop specific characteristics under the influence of environment, whose main driving factors are geological and anthropogenic substrates, climate, water, biosphere, topography and time. When we assume specific characteristics of urban soils, and we design a specific urban soil community and soil landscape, we have to consider the differences between soil, soil forming factors and impacts on soils of today and those before urbanization. That means that soils in urban areas are different from soils of natural and rural landscape and have different drivers of pedogenesis (Burghardt 1994).

What we see every day is the cut and cover of soils, and change of their environment in urban areas. We find scalped, buried and relict soils. Many of them recall characteristics of soils of eroded landscapes with cut and colluvial soils. Some natural soils stay undisturbed but keep their original characteristics. Thus they become relicts, similar to Paelososls. The appearance of soil changes and deviations rise generally from the outskirts to the center of towns as an “age of settlement and population density effect”.

There are several specific impacts on soils by urbanization which can alter characteristics of soils and soil landscapes and act as new drivers of soil formation (Burghardt 1994). The most important would be the urban soil water regimes created by altered landscapes, urban soil material regime by material import and waste production, and occurrence of new land use types. In short, I will show how they contribute to characteristics and the richness of urban soils.

Urban Soil Water Regimes

What happens to soils in urban areas depends on demands of men on an area as a place to live. The foundation of Rome by Romulus and Remus teaches us that the site should by dry. The local valleys and swamps were drained and later landfills were performed for establishing the Forum Romanum (About 2016). This increased the stability of soils to bear the weight of construction, made the land walkable and prevented the disease malaria that time. The drainage provides ter-

Fig. 2.1-1. (a) Relict Gleysol covered in part by hard coal waste (right), under relict and recent Ah horizons of an abandoned vegetable garden soil (b) compacted, low aerated, stony deposits of a recent established high block residential area; (c) very stony soil from mixtures containing bricks and concrete; (d) organic matter containing soil deposit above a disturbed Ah horizon of a Luvisol; (e) soil from layers of an Ah-horizon above silt loam deposit, ash layer and rubble layer; (f) soil from a former coke plant site; Luvisol with tar oil intrusion (black areas on the profile bottom), under layers of cyanides (blue color) containing deposited material, under two additional layers from loess loam (Fotos from Burghardt).

restrial soils in urban areas. Original semi-terrestrial or aquatic soils of ponds, lakes etc. were reduced or disappeared. If those soil layers stayed undisturbed, original Gleysols are now relictic Gleysols (Fig. 2.1-1a). The colorful pattern of iron accumulation and depletion horizons stays in Gleysols long after the soil water is drained (Lindbo et al. 2010). One can observe it still after many hundreds to thousands of years. Soils that were ground water affected prior to drainage could potentially be rehydrated by rain or runoff and the effectiveness of low permeable soil layers will cause perched water tables to occur.

Surface drainage reduces ground water renewal. Groundwater levels will drop. Drainage and ground water pumping for drinking and industrial supply can severely affect the water balance in the urban hinterland. Less water flows by way of groundwater to the rivers. On the other hand fast rain water discharge to rivers by urban drainage systems creates floods in rivers, and land of towns down-stream may be flooded (Konrad 2003).

Urban drainage and pumping systems dissect the catchment area of a river into numerous small catchments (Burghardt 1993). A change of the drainage pattern occurs also by filling up of depressions and valleys with any material and by leveling or raising of the existing terrain. We can expect that an increased distance of soil surface to groundwater reduces evapotranspiration. The soils and local air will be drier and the groundwater recharge rate will increase. Similar effects can be expected by groundwater table lowering for establishment of constructions such as tunnel or metro lines. In some of the active or former industrial areas, the groundwater level is kept permanently and artificially deep to prevent water contact with overlying polluted deposits.

Soil and air humidity of urban areas are affected by the large sealed areas of today. Water infiltration and water evapotranspiration are strongly reduced. Not in all urban areas of the world the surfaces are sealed by hard material. Often the soil surfaces are compacted by continuous walking and traffic. The water permeability is stopped similar to sealing with hard material.

Soil compaction is particularly a characteristic of the recently established construction areas where soil is moved by heavy machinery (Burghardt 2007) (Fig. 2.1-1b). Most of today's and future new urban soils will exhibit this characteristic. The compaction of these areas is not limited to the surface only but can exhibit compaction deep into the profile, for example to the ceiling of underground carparks. Compacted soils have very low large pore content and thus, soil water permeability and aeration are low, and water storage capacity is reduced.

Irrigation can also play an important role in urban areas, with water percolation and leaching becoming much more than within natural soils of the area. By irrigation dissolving carbonates creates pH decrease, and dissolving carbonates and gypsum could create soil collapses. In dry semi-arid and arid areas, soils that contain low permeable layers will develop perched water tables. A strong increased evaporation occurs. The result will be an accumulation of salt from irrigation with time, and formation of saline soils at the site.

Efforts are made to keep the rain water in the city by infiltration on specific infiltration ditches (Winzig and Burghardt 1996) which is already required by law in German states (Burghardt et al. 2011) and practised in "rain gardens" in the United States. That means that high amounts of water are percolating on a small area. The effect is a strong leaching of soluble compounds of soils (Arnz et al. 2000). Heavy metals, nitrate and organic pollutants are transported to deeper soil layers and the groundwater.

A strong effect will also have an increased skeleton (stone) content of urban soils (Fig. 2.1-1c). It reduces the water holding capacity, and influences the depth and way of water and solute transport (Bätjer et al. 2000).

Urban soil material regime

A second main characteristic of urbanization impact on soils is the balance of interactions of anthropogenic source materials. From archeologists we can learn that they search for old settlements by mapping the soil phosphorus content (Holliday and Gartner 2007). One essential effect of concentrated occurrence of men is the accumulation of waste in their environment. One of the compounds of early organic waste was phosphorous (Yuan et al. 2006) which stayed in soils after decay of waste.

Urban areas are hot spots of civilization and industrialization development. With human civilization and industrialization occur numerous kinds of waste inclusive construction, production and mining residues (Burghardt 1994) which form cultural layers. Waste compounds are mixed in soils to different degrees. There are also entire soil profiles composed of waste as in landfills.

From the occurrence of many different kinds of waste, and construction, production and mining residues we can expect numerous and a high variety of soil characteristics in urban areas.

Accumulation of organic matter is not a specific characteristic of soils of urban areas. What is specific are ways and distribution patterns of accumulation of organic matter in soils of urban areas. Organic matter in old European towns has been observed in large part from decayed and buried wooden building material. Layers of decayed wood in soils were reported from Moscow (Alexandrovskaya and Alexandrovskiy 2000). Some towns had a large population of farmers. Organic matter from manure and animal food was stored within the limits of the town. Organic wastes from markets, crafts and trade were dumped outside the city wall (Röber et al. 2000). Small vegetable gardens with Hortisols from deep accumulated organic matter occurred in the city and in monasteries. In Nekrosols, the soils of the widespread burial grounds a deep accumulation of organic matter took place too.

With upcoming industrialization and mining, industrial residential centers were established. Most of the workmen came from rural areas and cultivated a small piece of land beside their new home. For improvement of soil fertility, they applied compost and small animal manure. This way, by deep organic matter accumulation, more than 50 cm, Hortisols could develop. Similar occurences happened in allotment gardens (Burghardt 2016). Today the use of compost from green waste recycling is widely spread on urban ground. Additional sources of organic matter in urban soils are street trees, trees in gardens and parks, and forestation of abandoned industrial and mining land. Also dumped soil can contain organic matter (Fig. 2.1-1d). On the other hand, for large urban areas the stock of organic matter was reduced by cutting of top soil layers rich in organic matter and replacing them by soil material of low organic matter content.

An attribute of human civilization is heating and generating energy by burning wood, lignite, hard coal, oil and organic waste. Large amounts of ash were produced over time in settlements and became part of urban soils source material (Fig. 2.1-1e). Ashes were stored in dumps and used to fill up depressions or to construct railway dams. Granular grid ashes can have a high shear resistance. Therefore ashes were also found as construction materials of walkways, places, streets and sport ground. Ashes contain potassium and phosphorous. Therefore domestic ashes were used for fertilizing vegetable patches. Ashes were accumulated also from fires in towns. Soil layers from massive fires or conflagrations are the historical evidence and witness of these catastrophes in human settlement.

Ashes may occur in confined spaces as waste from fire but also as fly ash over large areas of surface ground. Large amounts of ashes are released by chimneys as fly ash to the environment. In towns of the 19^{th} and 20^{th} century, chimneys formed a dense pattern over the towns. In large industrial areas fly ashes were spread over dozens of kilometers. Thus a characteristic of many soils of industrial towns is a nearly uniform deposit and accumulation of fly ash.

Urban areas are locations of increased formation of dust. Hoeke (2003) reports about thick soil layers of several decimeters from dust in the Ruhr area, Germany. Sources of dust are fly ashes, construction works and traffic. The transport of dust is fostered by a fast drying of soil surfaces and construction surfaces in a dry urban climate. Thus, a characteristic of urban areas and their soils is an increased occurrence of dust deposits. Beside waste, dusts are also a main source of hazardous elements and compounds such as heavy metals and PAH's. Heavy metals, PAH's and other pollutants are released from domestic burning, industry, power plants, traffic and by mining, and deposited on soils. They occur not only in the top soil. By soil material tipping their distribution reaches great depth (Fig. 2.1-1f).

A main characteristic of urban areas is the cover of ground by building construction. Thus, construction debris is a major source material of urban soils. During the construction and after the end of the life span of construction, construction material can be disposed on the ground or mixed with soil. Main construction materials are wood, natural sand, gravel and stones, and manufactured bricks, lime sand bricks, concrete and slag stones, construction elements from