Chapter 5

Soil Quality and Policy

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5.1 Introduction

Urban soils are very diverse and found in gardens, parks, cemeteries, allotments, grass verges, playing fields, and sometimes derelict and commercial land. Commercial land may include disposal sites, demolition and building sites, waste and derelict land, rubbish tips, spoil heaps, canal and railway land, collieries, docklands, power-station land, shipbuilding land, scrap yards, dried-out industrial lagoons, sewage works, and land associated with mining, smelting, and manufacture.

Of the main threats to soil sustainability (soil erosion; decreasing soil organic matter (SOM) content; loss of biodiversity; contamination; sealing; compaction; salinisation; and floods and landslides), sealing, and contamination are the greatest threats to soils in urban areas. In this chapter, we concentrate on the sources of pollution (contamination) of urban soils, the consequences for urban dwellers of polluted soils, and how policies developed or proposed to reduce soil pollution impact urban soils.

Urban areas were once the main locations of industry. Formerly, little or no attempt was made to limit hazardous emissions from that industry, and so many urban soils became contaminated with a range of pollutants. Domestic heating systems using coal, oil, or wood; waste treatment facilities; and road traffic have also contaminated urban soils. Subsequently, due to a combination of the migration of industry away from urban centres and limiting of emissions by legislation, the major source of some pollutants in urban areas may no longer be direct emissions from industry etc., but remobilization of pollutants in contaminated soils. The diversity, fragmentation, and complexity of urban soils may lead to contamination by numerous pollutants and also considerable variation in the degree of contamination.

5.2 Soil Pollutants and Their Sources

The major pollutants found in urban soils are:

- Heavy metals
- Hydrocarbons
- Polychlorinated biphenyls (PCBs)
- Dioxins
- Platinum group elements (PGEs)
- Rare earth elements (REEs)
- Nanoparticles

When assessing contamination of urban soils, soil sampling procedures developed for rural areas may be inappropriate due to the large spatial variability of contaminants, the fragmented distribution of soils, problems of accessibility, and rapid and unpredictable changes in land use (Ajmone-Marsan and Biasioli, 2010).

5.3 Consequences of Urban Soil Pollution

Due to their contamination, some urban soils can be sources of pollution following soil disturbance (e.g. Biasioli *et al*., 2006). This effect can be apparent for distances of 15–20 km, depending on the prevailing wind direction (Blum, 1998). Cachada *et al*. (2016) considered the assessment of potential risks to the environment and human health of contaminants present in urban soils can be difficult due to the heterogeneity and complexity of the matrix, the existence of multiple point and diffuse sources, and the presence of mixtures of contaminants. Below we summarise the size, origin and health impacts of the major soil contaminants.

5.3.1 Heavy Metals

Alekseenko and Alekseenko (2014) reviewed the metal contents of over 300 soils from cities and settlements from every continent and found that the metal contents of urban soils reflected those in the underlying Earth’s crust. Webb *et al*. (2012) also found that in general urban soil types are broadly similar to those occurring elsewhere in the region. However, in addition to the underlying geology, the spectrum of metals will be influenced by the activities currently or previously carried out in the urban area (Galušková *et al*., 2014). Consequently, the amounts of some potentially toxic elements (PTEs) are commonly larger than those in natural soils. For example, De Miguel *et al*. (1998; cited in Charlesworth *et al*., 2011) report enrichment factors of 2.3, 2.6, and 4.0 for zinc (Zn), copper (Cu), and lead (Pb), respectively, in the urban soil of Madrid relative to natural background levels. The mean concentrations of Cu and Zn in urban soils in the urban and country parks of Hong Kong (24.8 and 168 mg/kg, respectively) were at least four and two times greater than those of rural soils (5.17 and 76.6 mg/kg, respectively), while the mean Pb concentration of urban soils (89.9 mg/kg) was one order of magnitude greater than that of rural soils (8.66 mg/kg) (Li *et al*., 2016).

5.3.1.1 *Sources*

Metals continue to be emitted directly from traffic due to the combustion of fossil fuels, and indirectly due to the erosion of road surfaces and abrasion of vehicle components (Wiseman *et al*., 2015). Formerly, a major source of heavy metals was the lead (Pb) added to petrol. The implications of Pb pollution of urban soils are dealt with in a separate subsection. Wiseman *et al*. (2015) concluded from work in Toronto that amounts of cadmium (Cd), antimony (Sb), and Pb were continuing to increase due to traffic.

5.3.1.2 *Characterisation*

Evidence suggests that the behaviour of elements predominantly of anthropogenic origin (e.g. Cu, Pb, and Zn) differs from that of elements primarily of geochemical origin (e.g. iron (Fe) and manganese (Mn)) (Madrid *et al*., 2009).

Rodrigues *et al*. (2013) distinguished between the availability in soil for plant uptake and leaching and via oral ingestion. The pH of urban soils is usually higher than that of rural soils due to the addition of calcareous materials from building (e.g. Rodrigues *et al*., 2013). The concentrations of reactive PTE, determined by 0.43 M HNO_3, were reported to indicate bioaccessibility by Rodrigues *et al*. (2013). Hong *et al*. (2016) found that bioaccessibility of PTEs was better associated with neurodevelopmental conditions in children than total concentrations.

Due to their observed sensitivity to heavy metals, plants may be good indicators of environmental pollution. For example, Diatta *et al*. (2003) evaluated dandelions and concluded they are suitable plants to indicate contamination.

5.3.1.3 *Health Risks*

The PTEs in urban soils may be a significant source to the atmosphere, particularly in the form of street dust. Metals retained by soils and subsequently dispersed may lead to ingestion by the human population long after the industrial activity that led to the original emissions has ceased. The accumulation of the PTEs Cd, Cu, Pb, and Zn increases the risk of exposure to PTEs, since PTEs from anthropogenic sources tend to be more available than those from natural sources (Rodrigues *et al*., 2013), and PTEs are persistent as they are not biodegradable (Diatta *et al*., 2003). The exposure of children to trace metals can increase greatly through their ingestion of metal-laden soil particles and dust via frequent hand-to-mouth activities (Wong *et al*., 2006).

5.3.1.3.1 Lead

Of the PTEs in urban soils Pb is considered to pose the greatest and most persistent threat to human health (Cai *et al*., 2016). There are concerns that soils are a permanent repository for Pb (Watmough *et al*., 2004 cited in Walraven *et al*., 2014). Nevertheless, Walraven *et al*. (2014) reported that Pb concentrations in soils have decreased following the decline in Pb emissions from traffic. However, if soils are not always permanent sinks for Pb, the loss of Pb from urban soils may lead to groundwater pollution. Walraven *et al*. (2014) calculated that 35%–90% of the anthropogenic Pb deposited from 1962 to 2003 had entered groundwater. Flooding may mobilise PTEs in soil leading to adverse effects on aquatic biota in streams, ponds and lakes (Mukwaturi and Lin, 2015).

The total concentration of Pb in soil is not the best predictor of the impacts of soil ingestion on children (Cai *et al*., 2016), since the availability of Pb in soils differs according to many factors including soil texture, pH, SOM content, and the reactive iron (Fe) content. Cai *et al*. (2016) found the gastric bioaccessibility (GB) of Pb to be <20% in all of the size fractions of the urban soils analysed while the gastro-intestinal bioaccessibility (GIB) was generally <15%. The percentage of both GIB and GIB tended to decrease with increasing SOM. Walraven *et al*. (2014) concluded that only the litter layer and topsoil retain anthropogenic Pb.

5.3.2 Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) in urban soils originate from both industrial activities that burn hydrocarbon fuels and from road traffic (Nadal *et al*., 2004). There may be ≤~10 times the concentrations of PAHs in urban soils than in rural soils (Nadal *et al*., 2004; Stajic *et al*., 2016). Being generally insoluble, PAHs can be adsorbed rapidly onto soil particles, especially on SOM (Means *et al*., 1980, cited in Stajic *et al*., 2016). Due to the dispersion by surface run-off and dust production, soils are a source of PAH in the atmosphere (Tang *et al*., 2005, cited in Stajic *et al*., 2016).

Health Risks

PAHs are of concern due to their carcinogenic and/or mutagenic potential (Cachada *et al*., 2016, and references cited therein).

5.3.3 Polychlorinated Biphenyls (PCBs)

Soil is an important environmental receptor of PCBs, particularly soils rich in organic matter (Schuster *et al*., 2011, cited in Glüge *et al*., 2016). Although the worldwide production and usage of PCBs was prohibited in 2004, substantial amounts of PCBs are still emitted from primary sources in cities or landfills (Glüge *et al*., 2016). As a result, some workers have concluded that PCBs may originate from urban areas (e.g. Jamshidi *et al*., 2007 cited in Glüge *et al*., 2016)). However, on the basis of the results of a modelling study, Glüge *et al*. (2016) concluded that for all PCB congeners, emissions from environmental reservoirs do not exceed primary emissions.

Health Risk

PCBs are fat-soluble substances to which people are exposed through ingesting animal fats, inhalation, or dermal contact. Exposure to PCBs suppresses the immune system, with carcinogenic, mutagenic, or endocrine disrupting consequences. Exposure to PCBs, especially during foetal and early life, can reduce IQ and alter behaviour. After ingestion, PCBs can alter thyroid and reproductive functions in both genders, thereby increasing the risk of developing cardiovascular and liver disease and diabetes. Women exposed to PCBs have an increased risk of giving birth to infants of low birth weight, who are at high lifetime risk for several diseases (Carpenter, 2006).

5.3.4 Dioxins

Urban *et al*. (2014) considered that dioxin-like compounds are ubiquitous in soils due to the wide variety of sources that have contributed to background levels. Data reported by Urban *et al*. (2014) for the United States indicate that the toxic equivalent (TEq) concentrations in background rural soils ranged from 0.1 to 22.9 ng/kg, while mean rural TEq concentrations ranged from 1.1 to 7.1 ng/kg across the 14 studies that reported data for rural soils. While rural mean concentrations were relatively small, 4 of the 14 studies had maximum concentrations over 20 ng/kg. The concentrations of dioxins in background urban/suburban soils were substantially larger and more variable than those in rural soils, with TEQ concentrations ranging from 0.1 to 186.2 ng/kg. It was also noted that the data for urban soils were considered less robust than for rural soils. The range of mean TEq concentrations in urban/suburban soils was also substantially higher and ranged from 2.2 to 56.6 ng/kg. Importantly, 4 of the 11 studies with data for background urban/suburban soils reported maximum concentrations that exceed 100 ng/kg.

5.3.4.1 *Health Risks*

Dioxins are considered to be carcinogenic and are also reported to have adverse cardiovascular- and endocrine-related effects (Bertazzi *et al*., 2001). Most of the exposure (~90%) to dioxins in the general population is from diet (mainly animal products), whereas <10% comes from exposure to dioxins in other sources (water, inhalation of air, ingestion of soil, soil dermal contact, and vegetable fat intake) (Lorber *et al*., 2009 cited in Urban *et al*., 2014). Hence, the greater concentrations in urban soils do not pose a significant risk to urban populations.

5.3.5 Platinum Group Elements

Catalytic converters were introduced in the mid-1980s in Europe. With increasing use of multi-element analytical techniques such as inductively coupled plasma atomic emission spectroscopy (ICP–AES), it was realised that PGEs, which included platinum (Pt), palladium (Pd), rhodium (Rh), ruthenium (Ru), iridium (Ir), and osmium (Os), had begun to accumulate in the environment (Ravindra *et al*., 2004, cited in Charlesworth *et al*., 2011).

Wong *et al.* (2006) cited UK results between 1982 and 1998 which demonstrated that there had been an increase in PGEs in road dust. Further indications that traffic was the source of Pt were obtained by comparing Pt with gold (Au) in soils and dust sampled in the London Borough of Richmond in 1994 (Farago *et al.,* 1995, 1996). Concentrations of Pt, like those of Pb, which originate from traffic, were greater in road dust than in soil samples. For Au, which does not originate from traffic, concentrations were greater in soils than in road dust. Ajmone-Marsan and Biasioli (2010) considered the data available to be inconsistent due to their being based on different sampling strategies and analytical procedures combined with the extreme variability of urban soils. They concluded that a ‘sampling design adapted to local urban patterns, a prescribed sampling depth, and a minimum set of elements that deserve to be measured could be the core of a common methodology’.

5.3.6 Rare Earth Elements

The most frequently detected anthropogenic REE is Gadolinium (Gd), which is issued from magnetic resonance imaging and released into the environment through hospital effluents (Brioschi *et al*., 2013).

5.3.7 Particulate Matter

Soil particles dislodged from the soil matrix can be a component of the coarse fraction of particulate matter (PM) in urban areas (Charlesworth *et al*., 2011). Both the particle size and chemical composition determine the potential health impacts of PM. Coarser (>10 μm) particles are usually considered to be trapped in the nose, throat, and upper respiratory tract. The <10 μm (PM_{10}) is considered ‘inhalable’, reaching the alveoli of the lungs and potentially causing irritation and disease. The <2.5 μm ($PM_{2.5}$) fraction is regarded as ‘respirable’, since they can be drawn deep into the respiratory system, generally beyond the body’s natural clearance mechanisms, and are more likely to be retained and absorbed. Consequently, $PM_{2.5}$ is associated with adverse health effects, such as asthma and even death (Kappos *et al*. 2004, cited in Charlesworth *et al*., 2011).

5.4 Soils Legislation

5.4.1 The European Strategy for Soil Protection

The European Commission (EC) has developed proposals to improve environmental quality for many years, but soil protection was not a specific objective of any EU legislation. Nevertheless, soil protection features in various legislation as a secondary objective. To close the gap, the commission launched a communication entitled ‘Towards a Thematic Strategy for Soil Protection’ in April 2002. This document is a comprehensive analysis of the state of Europe’s soils, highlighting the importance of soil as a threatened and non-renewable natural resource. This EC approach was noticeably innovative in incorporating new and wider environmental perspectives including the identification of the following soil functions: (a) biomass production, including agriculture and forestry; (b) storing, filtering, and transforming nutrients, substances, and water; (c) biodiversity, habitats, species, and genes; (d) physical and cultural environment for humans and human activities; (e) source of raw materials; (f) carbon pool; and (g) archive of ecological and archaeological heritage. The communication also identified soil contamination as one of the eight soil threats expressed in the thematic strategy and the proposed directive.

To develop the communication, an advisory forum was created, a secretariat and five technical working groups (Monitoring, Erosion, Organic Matter, Contamination, and Research) which prepared several important documents as background information on the status of soil and soil problems including the one related to Pollution and Land Management (Van Camp *et al*., 2004; http://www.ec.europa.eu/environment/soil.

After several years of political discussions, negotiations, and confrontations due to the different economic, political, and social interests of the EU member states (MSs) and stakeholders related to soil, in 22 September 2006, the EC proposed a Soil Thematic Strategy (STS) (COM (2006) 231) and a Soil Framework Directive (SFD) (COM (2006) 232) with the objective of formulating a pan-European common framework for soil protection.

The objective of the STS was the ‘protection and sustainable use of soil by preventing further soil degradation and preserving its functions and also restoring degraded soils to its functionality and considering cost implications’ (COM 2006, 231). The STS includes four pillars: (a) the development of framework legislation, (b) integration and horizontal implications, (c) identification of knowledge gaps on soils, and (d) the need to enhance public awareness in relation to soil. The STS also includes the identification of ‘specific risk areas’ related to erosion, organic matter decline, soil sealing, contamination, and landslides.

The STS was received favourably by the Committee of the Regions (February 2007) and the European Economic and Social Committee (April 2007), and in November 2007 it was adopted by the European Parliament (EP), which supported the commission in its general approach and underlined the importance for climate change mitigation, biodiversity loss, and desertification. The EP also adopted a favourable opinion on the directive. In the amendments adopted, the EP maintained all the key elements of the commission proposal, providing more flexibility in some provisions and strengthening others.

Despite these positive and important decisions, the soil strategy faced many problems. The development of a proposed SFD produced not only conceptual and technological disagreements among EU MSs, but also societal problems related to the absence of a shared common vision on soil protection under legislation, scope of protection, economic considerations, definitions, and governance aspects.

Another long period of intense discussions among all soil actors and MSs followed. Substantial changes were introduced, adding flexibility for the MSs. However, the EC did not reach a political agreement by 20 December 2007. Five MSs (Germany, France, the United Kingdom, the Netherlands, and Austria) formed a blocking minority against the favourable opinion of the majority of MS. The negative decision was for reasons of subsidiarity in the case of Germany, the Netherlands, and Austria and of proportionality/costs in the case of the United Kingdom and France.

The blocking status of the SFD implied that discussions would be continued. Meanwhile, the EP was in favour of an SFD. The EC was functioning with the communication on the Soil Thematic Strategy for Soil Protection (22 September 2006) as a common legislative framework for soil 'to halt and reverse the process of soil degradation ensuring that EU soils stay healthy for future generations and remain capable of supporting the ecosystems on which our economic activities and our well–being depend' (JRC, 2012)

However, repeated discussions could not secure agreement by a qualified majority for an SFD, and in October 2013 the EC adopted the communication on 'Regulatory Fitness and Performance (REFIT)', in which it noted that 'the proposal for a SFD had been pending for eight years during which time no effective action has resulted'. On 30 April 2014, the EC took the decision to withdraw the proposal of a SFD. The decision entered into force 21 May 2014. However, using diplomatic wording, the EC stated that it 'remains committed for soil protection and will examine options on how best achieve this'.

The current situation is one of internal reflection by the commission, including soil global issues (food security, climate change, …) and the implications of outcomes from Rio+20 and Post 2015 Sustainable Development Goals. At present, the EC is working along two lines, which include soil contamination as one of the main concerns:

(a) preparation of a communication on 'Land as a Resource' with focus on more efficient land use planning including environmental, economic, and social aspects

(b) Further developing the sustainable management of soil as an ecosystem

5.4.2 EU Legislation Related to Soil Contamination

As there was no agreement for the establishment of the SFD, legal requirements for the general protection of soil, including contamination, only exist in individual MSs. As a general principle, arising from Article 191(2) of the Treaty on the Functioning of the European Union, EU policy on the environment aims at a high level of protection taking into account the diversity of situations in the various regions of the Union, and is based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should, as a priority, be rectified at source and that the polluter should pay (Payá Pérez *et al*., 2015). In general, the protection of urban soil contamination is indirectly addressed as part of other environmental protection policies, such as the EU Water Framework Directive (WFD), the Waste Directive, and the Integrated Pollution and Prevention Control Directive (IPPC), not aimed directly at soil protection, but providing indirect controls on soil contamination.

There are important difficulties in the appraisal and development of soil policies for contaminated sites in urban environments. These are due to the wide range of contaminated sites in municipalities and the enormous heterogeneity of the criteria by which different countries define contaminated soils, quantify acceptable risks, and characterise tools and adopted methodologies. To improve the situation, some efforts have been made regarding the identification and management of contaminated sites. For example, Panagos *et al*. (2013) described an initiative of the European Environment Agency on the development of an indicator of soil contamination (Progress in the Management of Contaminated Sites) (Van Liedekerke *et al*., 2014). This indicator quantifies progress in the management of local contamination, identifies sectors with major contributions to soil contamination, classifies the major contaminants, and finally addresses issues of budgets spent for remediation. With this indicator, several activities causing soil pollution can be identified across Europe. The indicator also supports the implementation of existing legislative and regulatory frameworks (IPPC directive, Landfill Directive, and WFD) as they should further decrease soil contamination.

In urban environments, the priority has been to reduce emissions of contaminants. However, according to the JRC Report on Soil Threats in Europe (Stolte *et al*., 2016), historically contaminated (brownfield) sites remain important contamination sources in many European cities. Ferber *et al*., (2006) defined brownfields as 'sites that have been affected by the former uses of the site and surrounding land; are derelict and underused; may have real or perceived pollution problems; are mainly in developed urban areas; and require intervention to bring them back to beneficial use'. There is no EU regulation concerning brownfields, and few countries have developed national strategies to deal with them. Especially problematic brownfield types are smelter waste deposits that are usually barren due to the phytotoxicity of high-metal waste and therefore constitute secondary sources of pollution.

Some directives indirectly introduce elements to protect soil from contamination. These include The Sewage Sludge Directive (1986/278/EEC), which defines conditions for sewage sludge application to soils. The directive provides threshold trace metals contents in soil and sludge as well as allowed annual inputs of the following elements: Zn, Pb, Cd, Ni, Cu, and Hg.

The Urban Waste Water Treatment Directive (1991/271/EEC) is increasing the quantities of sewage sludge requiring adequate disposal and the number of households connected to sewers and increasing the level of treatment.

The purpose of the Directive on Environmental Liability with Regard to the Prevention and Remedying of Environmental Damage (2004/35/CE) is to establish a framework of environmental liability to prevent and remedy environmental damage. The directive aims at ensuring that the financial consequences of certain types of harm caused to the environment will be taken by the operator who caused this harm. This prevention instrument refers to various natural resources including protection against soil pollution.

The IPCC Directive (2010/75/EU) on Industrial Emissions aims to establish a general framework for the control of the main industrial activities, giving priority to intervention at the source, ensuring prudent management of natural resources and taking into account, when necessary, the economic situation and specific local characteristics of the place where the industrial activity is taking place.

The Landfill Directive (1999/31/EC) introduces stringent technical requirements for waste and landfills to prevent or reduce the adverse effects of landfill on the environment, in particular on surface water, groundwater, soil, air, and human health. It defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste, and inert waste) and applies to all landfills, defined as waste disposal sites.

The Directive on the Incineration of Waste (2000/76/EC) aims to prevent or reduce damage to the environment caused by the incineration and co-incineration of waste. The directive sets emission limit values and requires monitoring of pollutants to air such as dust, nitrogen oxides (NOx), sulphur dioxide (SO_2), hydrogen chloride (HCl), hydrogen fluoride (HF), heavy metals, dioxins, and furans. Most types of waste incineration plants fall within the scope of the WI Directive, with some exceptions such as those treating only biomass (e.g. vegetable waste from agriculture and forestry) and phytotoxicity of high-metal waste, and therefore constitute secondary sources of pollution.

With the steady increase in urban population and the growing awareness of contamination impacts, society is demanding an urban soil strategy which should include the establishment of a specific and common legal framework to protect urban soils from contamination. This legal framework should be integrated into the general strategy of soil protection of national and EU policies by strengthening the knowledge base and by taking into account the specific aspects of urban environments.

5.4.3 UK Soils Legislation

On 2 June 2016, The Commons Environmental Audit Committee (CEAC, 2016) warned that polluted soils are a potential health hazard in many urban areas because the UK government no longer provides grants to decontaminate them. Previously there had been national funds to help local councils clean up polluted land, but this has now been closed. The government response is that planning policy sets a clear framework for the clean-up of land to be developed. But the CEAC Chair stated: ‘Relying on the planning system to clean up contaminated land may be fine in areas with high land values, but it means that contamination in poorer areas will go untreated. Ministers must rethink their decision to phase out clean-up grants’. There were potentially now 300,000 contaminated sites in the United Kingdom, she added. The government has declared an objective of safeguarding all soils by 2030, but the MPs say there are no policies in place to deliver that promise.

5.4.3.1 *Current UK Soils Legislation*

In 2009, the UK Department for the Environment, Food and Rural Affairs (Defra) published 'Safeguarding our Soils – A Strategy for England' (Defra, 2009). This strategy was claimed to support the aims of the EU Thematic Strategy on Soil Protection. However, it arose due to a perceived need for *national* action to protect soils 'which is responsive to local circumstances' and, in effect, was a rejection of the harmonised European approach that had been proposed in the draft EU SFD.

The UK strategy envisaged that by 2030, 'all England's soils will be managed sustainably and degradation threats tackled successfully. This will improve the quality of England's soils and safeguard their ability to provide essential services for future generations', the specific goals being that:

- Agricultural soils will be better managed, and threats to them will be addressed.
- Soils will play a greater role in the fight against climate change and in helping to manage its impacts.
- *Soils in urban areas will be valued during development, and construction practices will ensure that vital soil functions can be maintained*.
- *Pollution of soils is prevented, and our historic legacy of contaminated land is dealt with* (the two latter goals have been italicised to emphasise their particular relevance to urban soils).

There was also an undertaking to 'review the effectiveness of existing planning policy to protect important soils and consider whether there is a need to update it'. In addition there was a promise to 'publish new best practice guidance on decision making later this year to help Local Authority officers make proportionate and robust decisions more confidently. It will also continue to encourage moves to more sustainable remediation practices that do not involve the wholesale removal and replacement of soil'.

UK government policy on defining contaminated land takes a risk-based approach. Specifically, land is assessed in terms of whether contaminants pose a 'significant possibility of significant harm' (SPOSH) (Defra, 2008). As a consequence, current guidance considers that the amounts or concentrations of any contaminants are not the only factors to be taken into account. It is also necessary to consider to what extent the contaminants present may harm human health or the wider environment, that is, what is the risk caused by contaminants, and is that risk unacceptable? In short, the approach to be taken is one of risk management, not risk avoidance.

5.4.3.2 *Planning Policy*

Soil protection is mentioned in a number of Planning Policy Statements (PPSs), for example, PPS1 (Delivering Sustainable Development, Office of the Deputy Prime Minister (ODPM) 2005) and its Supplement on Climate Change and PPS11 (Regional Spatial Strategies), as well as in the Strategic Environmental Assessment and Environmental Impact Assessment directives. PPS1 recommends that development plan policies should take account of environmental issues including the conservation of soil quality. However, the document does not give any indication of the properties that characterise soil quality or any guidance on how those properties may be maintained or enhanced.

5.5 Conclusions

Sealing and contamination are the greatest threats to soils in urban areas. The major source of some pollutants in urban areas can be soils that are already contaminated due to historic pollution. Due to this contamination, some urban soils can be sources of pollution following soil disturbance. Estimating the potential risks to the environment and human health of contaminants present in urban soils can be difficult due to the heterogeneity and complexity of the matrix, the existence of multiple point and diffuse sources, and the presence of mixtures of contaminants. Soil sampling procedures developed for rural areas may not be appropriate for the assessment of the contamination of urban soils, due to the large spatial variability of contaminants, the fragmented distribution of soils, problems of accessibility, and rapid and unpredictable changes in land use. Metals continue to be emitted directly from traffic due to the combustion of fossil fuels, and indirectly due to the erosion of road surfaces and abrasion of vehicle components. Cadmium, Sb, and Pb continue to be added to urban soils as a result of traffic.

Metals retained by soils and subsequently dispersed may lead to ingestion by the human population long after the industrial activity that led to the original emissions has ceased. Soil PTEs from anthropogenic sources tend to be more available than those from natural sources. Lead is the PTE considered to pose the greatest threat to human health. Although there are concerns that soils are a permanent repository for Pb, concentrations in urban soils have decreased following the decrease in Pb emissions from traffic.

Due to their carcinogenic and/or mutagenic potential, PAHs are of concern. There may be up to ≤~10 times the concentrations of PAHs in urban soils than in rural soils.

Polluted soils are acknowledged to be a potential health hazard in many urban areas, yet the UK government no longer provides grants to decontaminate them. Although the government has declared an objective of safeguarding all soils by 2030, there are no policies in place to deliver that promise.

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