Solid Earth Discuss.,
https://doi.org/10.5194/se-2017-54-AC8, 2017

Interactive comment on "Polycyclic aromatic hydrocarbon in urban soils of the Eastern European megalopolis: distribution, source identification and cancer risk evaluation" *by* George Avtandilovich Shamilishvily et al.

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Received and published: 31 October 2017

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Polycyclic aromatic hydrocarbon in urban soils of the Eastern European megalopolis: distribution, source identification and cancer risk evaluation

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Abstract

The study explores qualitative and quantitative composition of 15 priority PAHs in urban soils of some parkland, residential and industrial areas of the large industrial center in the Eastern Europe on example of Saint-Petersburg (Russian Federation). Aim of the study was to test the hypothesis on the PAH loading differences between urban territories with different land use scenarios. Benzo(a)pyrene toxic equivalency factors (TEFs) were used to calculate BaP_{eq} in order to evaluate carcinogenic risk of soil contamination with PAHs. Results of the study demonstrated that soils within residential and industrial areas are characterized by common loads of PAHs generally attributed to high traffic activity in the city. Considerable levels of soil contamination with PAHs were noted. Total PAH concentrations ranged from 0.33 to 8.10 $mg \cdot kg^{-1}$. A larger portion of high molecular weight PAHs along with determined molecular ratios suggest the predominance of pyrogenic sources, mainly attributed to combustion of gasoline, diesel and oil. Petrogenic sources of PAHs have a significant portion as well defining the predominance of petroleum associated low molecular weight PAHs such as phenanthrene. Derived concentrations of 7 carcinogenic PAHs as well as calculated BaP_{eq} were multiple times higher than reported in a number of other studies. The obtained BaP_{eq} concentrations of the sum of 15 PAHs ranged from 0.05 to 1.39 $mg \cdot kg^{-1}$. A vast majority of examined samples showed concentrations above the safe value of 0.6 $mg \cdot kg^{-1}$ (CCME, 2010). However, estimated incremental life time risks posed to population through distinct routes of exposure were under acceptable range. One-way ANOVA results showed significant differences in levels of pyrene, fluoranthene and phenanthrene – the most abundant individual PAHs in examined sampled, between parkland, residential and industrial land uses, suggesting the influence of land use factor on distribution of these pollutants.

1. Introduction

The quantity of toxic organic substances is extremely high, but in the world practice the evaluation of contamination levels of certain areas is produced mostly for polycyclic aromatic hydrocarbons (PAHs), an ubiquitous organic pollutants in environments, particularly in soils and sediments (Wilcke 2000). PAHs are a large group of aromatic organic compounds consisting of several hundred individual homologues and isomers containing at least two condensed aromatic rings. Their input to the environment has both natural and anthropogenic origins. Natural sources includes releases from vegetation fires, diagenetic processes and volcanic exhalations (ATSDR 1995; Wilcke 2000). In turn, anthropogenic PAHs occur from pyrolytic processes, especially incomplete combustion of organic during industrial activities, domestic heating, waste incineration, transportation and power generation (ATSDR 1995; Wilcke 2000). It is believed that by far most PAHs are released into environment by anthropogenic combustion of wood and fossil fuels (Wilcke 2000). Sign of anthropogenic contamination of soil with PAHs are even detected in such remote places as Antarctic Stations, which origin is doubted, whether it has natural sources, i.e. decomposition of plant and guano materials, or comes from anthropogenic sources, such as fuel combustion, petroleum products and long range transport with atmospheric solid particles (Abakumov et al. 2014; Abakumov et al. 2015). Some PAHs are of the most environmental importance because of the established carcinogenic, mutagenic and teratogenic effects in living organisms and in humans particularly (Yu 2002; Guo et al. 2013). A number of 16 PAHs have been listed as priority contaminants by both the US Environment Protection Agency (US EPA) and European Union (EU). Among them seven compounds, i.e. benzo(a)anthracene, chrysene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene are considered as probable human carcinogens (US EPA 2002). In Canada, US and some European countries normalization of soil contamination is provided upon developed soil quality criteria for selected PAHs or their sum. Only a few countries have established comprehensive soil guideline values (SGV) for particular land use at least for the sum 85 of priority PAHs (Σ7; 10;15; 16). Generally, the existing soil critical values provides only human health-risk based approaches and don't consider protection of other ecological receptors. In turn, US EPA has developed ecological soil screening levels(Eco-SSLs) for PAHs, which are derived separately for four groups of ecological receptors: plants, soil invertebrates, birds and animals. However these screening levels are intended to evaluate an unacceptable ecological risk to terrestrial receptors, they are not designed to be used as cleanup levels. For this

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Fig. 1.