

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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Discussion paper



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

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

27 1. Introduction

28 The quantity of toxic organic substances is extremely high, but in the world practice the evaluation of
29 contamination levels of certain areas is produced mostly for polycyclic aromatic hydrocarbons (PAHs), an
30 ubiquitous organic pollutants in environments, particularly in soils and sediments (Wilcke 2000). PAHs are a large
31 group of aromatic organic compounds consisting of several hundred individual homologues and isomers containing
32 at least two condensed aromatic rings. Their input to the environment has both natural and anthropogenic origins.
33 Natural sources includes releases from vegetation fires, diagenetic processes and volcanic exhalations (ATSDR
34 1995; Wilcke 2000). In turn, anthropogenic PAHs occur from pyrolytic processes, especially incomplete combustion
35 of organic during industrial activities, domestic heating, waste incineration, transportation and power generation
36 (ATSDR 1995; Wilcke 2000). It is believed that by far most PAHs are released into environment by anthropogenic
37 combustion of wood and fossil fuels (Wilcke 2000). Sign of anthropogenic contamination of soil with PAHs are
38 even detected in such remote places as Antarctic Stations, which origin is doubted, whether it has natural sources,
39 i.e. decomposition of plant and guano materials, or comes from anthropogenic sources, such as fuel combustion,
40 petroleum products and long range transport with atmospheric solid particles (Abakumov et al. 2014; Abakumov
41 et al. 2015). Some PAHs are of the most environmental importance because of the established carcinogenic, mutagenic
42 and teratogenic effects in living organisms and in humans particularly (Yu 2002; Guo et al. 2013). A number of 16
43 PAHs have been listed as priority contaminants by both the US Environment Protection Agency (US EPA) and
44 European Union (EU). Among them seven compounds, i.e. benzo(a)anthracene, chrysene, benzo(a)pyrene,
45 benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene are considered as
46 probable human carcinogens (US EPA 2002). In Canada, US and some European countries normalization of soil
47 contamination is provided upon developed soil quality criteria for selected PAHs or their sum. Only a few countries
48 have established comprehensive soil guideline values (SGV) for particular land use at least for the sum 85 of
49 priority PAHs (Σ7; 10;15; 16). Generally, the existing soil critical values provides only human health-risk based
50 approaches and don't consider protection of other ecological receptors. In turn, US EPA has developed ecological
51 soil screening levels(Eco-SSLs) for PAHs, which are derived separately for four groups of ecological receptors:
52 plants, soil invertebrates, birds and animals. However these screening levels are intended to evaluate an
53 unacceptable ecological risk to terrestrial receptors, they are not designed to be used as cleanup levels. For this

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Fig. 1.

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