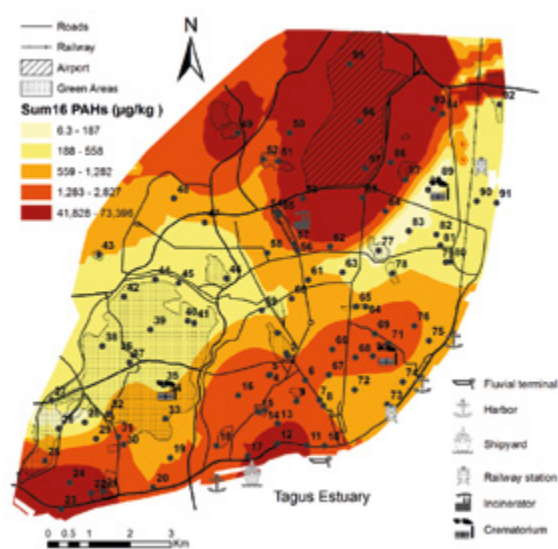


Multivariate analysis for assessing sources, and potential risks of polycyclic aromatic hydrocarbons in Lisbon urban soils

Anabela Cachada^{1,2}, Ana Cláudia Dias³, Amélia Paula Reis^{3,4}, Eduardo Ferreira da Silva³, Ruth Pereira⁵, Armando da Costa Duarte¹, Carla Patinha³

Urban soils may be severely affected by the presence of complex mixtures of organic and inorganic contaminants resulting from diffuse pollution caused by urban activities. However, the assessment of soil quality and characterization of potential risks to the environment and human health can be a very difficult task due to the complexity of the matrix, heterogeneity, and patchy nature these soils. For compounds such as polycyclic aromatic hydrocarbons (PAHs), which are probably the most relevant and widely studied compounds in urban soils, these difficulties are enhanced by the poor understanding about the fate of contaminants in the soil matrix, scarcity of toxicological/ecotoxicological data and variability of guidelines. Thus, the traditional risk assessment (RA) frameworks may have to be adapted for urban areas, for example through a first tier based on a chemical screening in combination with geostatistical tools. This is what was done in the present study, which aimed to assess the levels of PAHs in soils from Lisbon (Portugal), their potential risks to the environment and human health, and to identify their major sources. Results showed that geostatistical tools are very useful to obtain a characterization of the entire urban area, allowing to evaluate the spatial distribution and major inputs of contaminants in urban soils (Fig. 1). As a first tier of the RA process it was proposed to calculate risks using the chemical data (based on existing models and soil quality guidelines) and build prediction maps which allowed to identify areas of potential concern for both human health (Fig. 2) and to the environment, where a more detailed risk assessment should be performed. These maps can be very useful for urban planning, for example, by crossing information obtained with land uses, it is possible to define the most problematic areas (e.g., playgrounds and schools).



1 — Department of Chemistry & CESAM, University of Aveiro
2 — CIIMAR, University of Porto
3 — Department of Geosciences & Geobiotec, University of Aveiro
4 — Department of Earth Sciences & Centre of Earth Sciences, University of Minho
5 — Department of Biology & GreenUPorto, University of Porto

FIGURE 1

Location of the sampling sites and contour map interpolated by ordinary kriging of the distribution of PAHs in Lisbon urban area. The class limits correspond to the minimum, the quartiles (25, 50 and 75), the upper outlier limit, and the maximum value. Source: <https://doi.org/10.3390/min9030139>

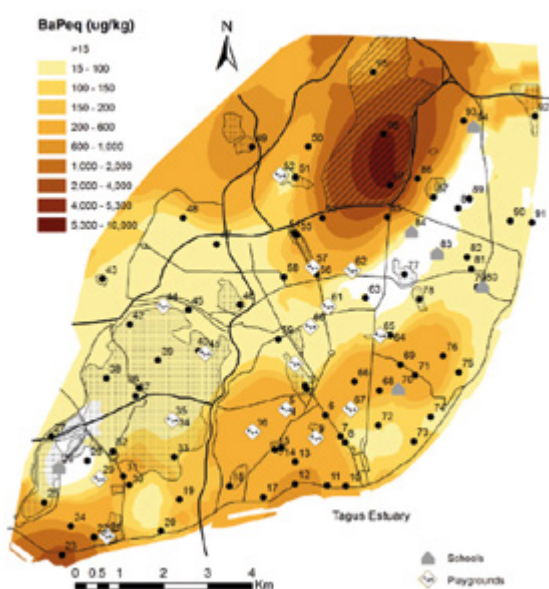


FIGURE 2

Contour map for Benzo(a)Pyrene equivalent levels in Lisbon area, which was interpolated by ordinary kriging; the class limits correspond to the different guideline values for human health protection. Source: <https://doi.org/10.3390/min9030139>