Seasonal behavior of indoor and outdoor PAHs in different microenvironments of Rome, Italy

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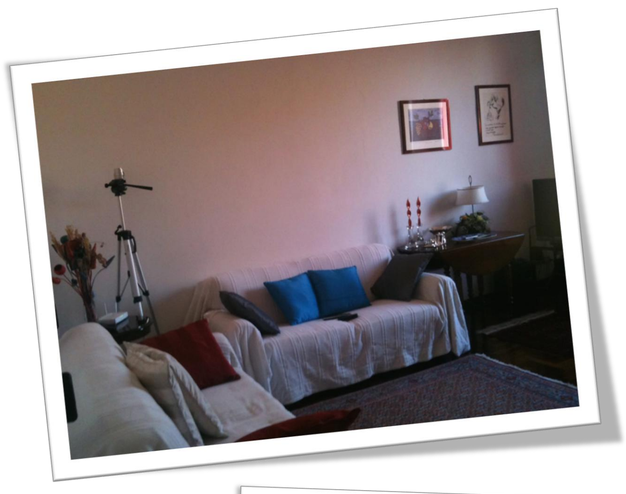
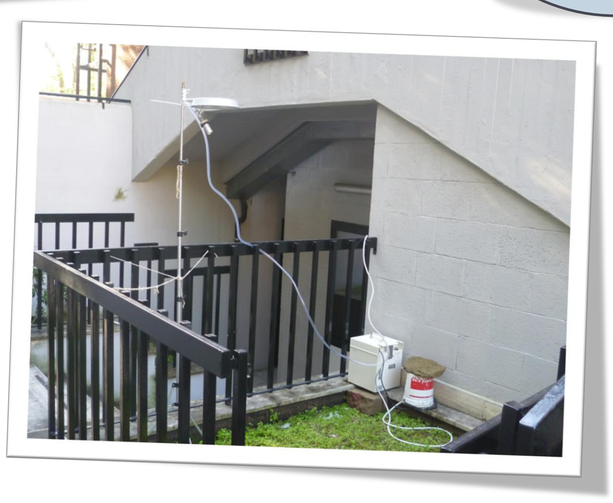
Among Persistent Organic Pollutants (POP), Polycyclic Aromatic Hydrocarbons (PAHs) are a class of complex organic chemicals of increasing concern for their occurrence in the environment. The International Agency for Research on Cancer (IARC) classified benzo[a]pyrene (B[a]P) as carcinogenic to humans (group 1); in addition, several other PAHs are classified as probably and possibly carcinogenic to humans, groups 2A and 2B, respectively[1]. PAHs can be found in the atmosphere in both the gaseous and the particulate form ($PM_{2.5}$ and PM_{10}) depending on their volatility which is governed by chemical structure[2,3]. To identify and to quantify population exposure among children and elderly people to PAHs content in particulate matter in highly urbanized areas and to assess the impact on human health, in order to support environmental policy and regulation in this field, EXPAH project has proposed an integrated approach based on measurements and modeling techniques.



Two seasonal in-field campaigns were performed by sampling both indoor and outdoor living/working microenvironments.



The PAH's monitoring method was based on $PM_{2.5}$ active sampling at low volume conditions on PTFE filters and GC/MS determination of non-volatile PAH congeners, characterized by higher carcinogenic and mutagenic potencies. In each seasonal campaign, 17 locations were monitored including six schools, two offices and nine houses (Figure 1).

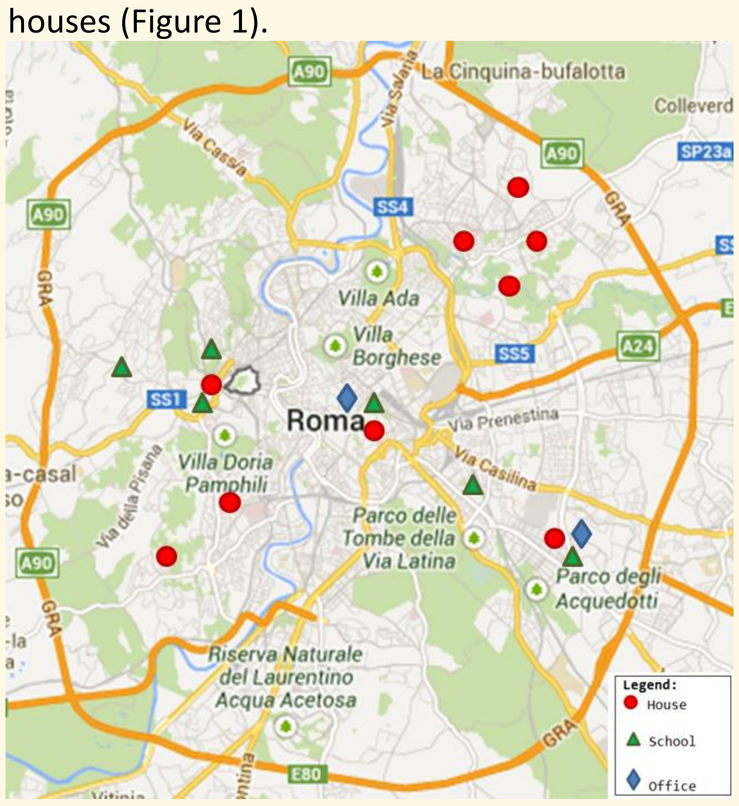


Figure 1. Sites monitored during the winter and the summer campaigns.

Indoor and outdoor $PM_{2.5}$ sampling on PTFE filter at low flow condition (6÷10 L/min)

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Ultrasonic extraction by using (5mL/15 minutes) dichlorometane (twice) and acetone

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Drying to low volume (N_2)

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Purification of extracted PAHs through neutral alumina column (isoctane-dichloromethane 3:2)

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Internal standard addiction (isotopic PAHs)

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Solvent evaporation under N_2 stream and PAHs recovery with toluene (V_f= 100 µL)

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PAHs analysis by GC/MS in SIM modality

Figure 2. Flow-chart of the procedure adopted

The study was focused on seven "carcinogenic" PAHs (benz[a]anthracene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene and dibenz[a,h]anthracene) and a mutagenic congener (benzo[ghi]perylene).

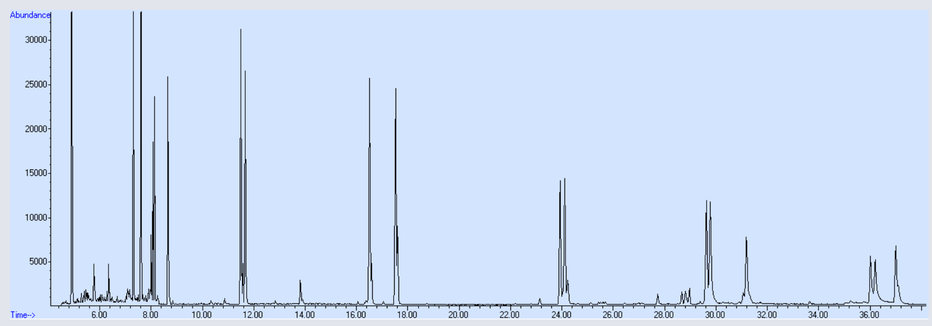

Figure 3. Exemplary GC-MS chromatogram of PAHs contained in fine particulate matter (diameters <2.5 µm).

Large differences between winter and summer indoor and outdoor PAH's values were found in the city of Rome (see Fig. 4).

During the winter in-field campaign (December 2011-March 2012), the target PAHs ranged from 6.0 to 7.4 ng/m^3 (indoor), and 8.4 to 13.2 ng/m^3 (outdoor). The typical indoor/outdoor ratio was roughly 0.7. During the summer campaigns (lasted from May to July 2012), the target PAHs ranged 0.40÷1.35 ng/m^3 (indoor), and 0.62÷1.52 ng/m^3 (outdoor).

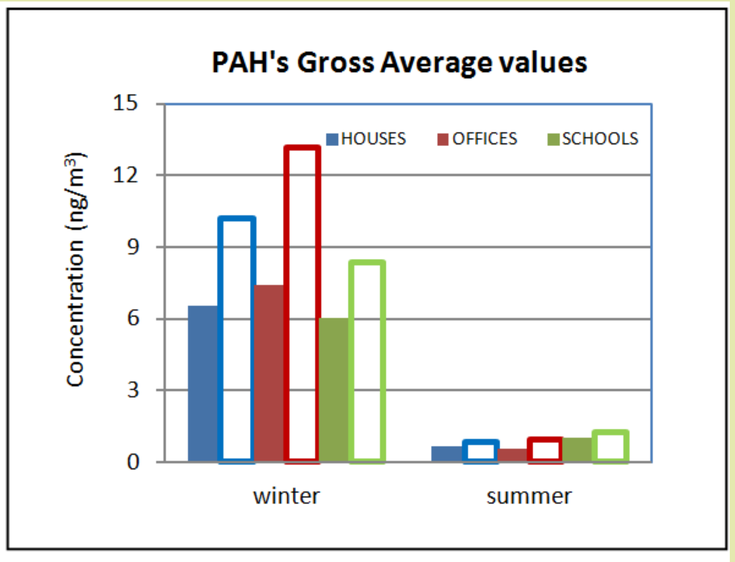

Figure 4. Total PAHs in the investigated microenvironments: full bars refer to indoor; empty bars refer to outdoor.

Heating and biomass burning during winter were presumably responsible of this finding. The winter values were well above the guideline value for B[a]P (1 ng/m^3) whereas the summer values were well below[4]. During the winter the average B[a]P detected indoors ranged from 0.94 (offices) to 1.14 (schools) ng/m^3, and the respective outdoor values ranged from 1.4 and 2.0 ng/m^3; during the summer BaP ranged from 0.04 to 0.15 ng/m^3 indoors and 0.06 to 0.19 ng/m^3 outdoors .

According to results, in the principal life environments, humans seem to be exposed to PAH levels similar to those typical of outdoor air. In winter, these level can exceed the guideline values of ambient air quality.

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