# ASSESSING THE FEASIBILITY OF EMPLOYING THE PASSIVE AIR SAMPLERS FOR THE LONG-TERM AIR QUALITY MONITORING PROGRAMS

Klánová J, Čupr P, Kohoutek J, Holoubek I

RECETOX - Research Centre for Environmental Chemistry and Ecotoxicology,
Masaryk University, Kamenice 3/126, 625 00 Brno, Czech Republic

**Abstract**

The potential of passive air sampling (PAS) devices to assess the influence of local pollution sources on the quality of surrounding environment was recently investigated as well as their sensitivity to the seasonal variations in the ambient air concentrations of POPs. Following the series of experiments focused on their feasibility in the long-term measurements, and influence of various meteorological conditions on their performance, PAS were employed in several monitoring programs. Monitoring network in the Czech Republic (MONET) was established in 2004, and included industrial, agricultural, urban, rural, and background sites. It was further extended in 2006 to cover the countries of the Central and Eastern Europe with the general lack of information on the ambient air pollution.

**Introduction**

It was confirmed that passive air samplers (PAS) have a very good capability to reflect temporal and spatial fluctuation in POP concentrations which makes them applicable for monitoring on the local and regional scales. They have been employed to assess the influence of local sources on the quality of surrounding environment as well as the air genotoxic potency. Even though they only provide the semi quantitative information on the atmospheric pollution, they still offer a valuable tool to study the fate and transport of POPs in the atmosphere. Based on several years of experience, the passive monitoring network was designed in the Czech Republic as the first attempt to use PAS in the long-term country-wide monitoring program. As a part of this project, several point sources (municipal as well as danger waste incinerators, oil refinery, chemical factory, cement factory and others) were selected for continuous monitoring, including the sites which are currently being remediated. Agricultural, urban, rural and background sites were added, and a set of 50 sampling sites was completed with the samplers located in the mountain regions along the Czech borders to assess the long-range transport from other European countries.

**Material and Methods**

Air sampling

Polyurethane foam based samplers were employed in this study as described elsewhere. [3-6] They consist of the polyurethane foam disks (15 cm diameter, 1.5 cm thick, density 0.030 g $cm^{-3}$, type N 3038; Gumotex Breclav, Czech Republic) housed in the protective chambers. Sampling chambers were prewashed and solvent-rinsed with acetone prior to installation. All filters were prewashed, cleaned (8 hours extraction in acetone and 8 hours in dichloromethane), wrapped in two layers of aluminum foil, placed into zip-lock polyethylene bags and kept in freezer prior deployment. Exposed filters were wrapped in two layers of aluminum foil, labeled, placed into zip-lock polyethylene bags and transported in cooling box at 5 °C to the laboratory where they were kept in freezer at –18 °C until the analysis. Field blanks were obtained by installing and removing the PUF disks at all sampling sites.

Sample analysis

All samples were extracted with dichloromethane in Büchi System B-811 automatic extractor. One laboratory blank and one reference material were analyzed with each set of ten samples. Surrogate recovery standards (D8-naphthalene, D10-fenantrene, D12-perylene for PAHs analysis, PCB 30 and PCB 185 for PCBs analysis) were spiked on each filter prior to extraction. Terfenyl and PCB 121 were used as internal standards for PAHs and PCBs analyses, respectively. Volume was reduced after extraction under a gentle nitrogen stream at ambient temperature, and fractionation achieved on silica gel column; sulfuric acid modified silica gel column was used for PCB/OCP samples. Samples were analyzed using GC-ECD (HP 5890) supplied with a Quadrex fused silica column 5% Ph for PCBs (PCB 28, PCB 52, PCB 101, PCB 118, PCB 153, PCB 138, PCB 180, and OCPs (α-HCH, β-HCH, γ-HCH, δ-HCH, *p,p´*-DDE, *p,p´*-DDD, *p,p´*-DDT). 16 US EPA polycyclic aromatic hydrocarbons were determined in all samples using GC-MS instrument (HP 6890 - HP 5972) supplied with a J&W Scientific fused silica column DB-5MS.

**Results and Discussion**

Following our pilot studies, [1-2] PAS have been used as a part of the regular EMEP background air monitoring program in the Kosetice observatory, Czech Republic since 2003 (Fig. 1). Simultaneous employment of PAS and high volume samplers at this site provided valuable information about the performance of the passive samplers.

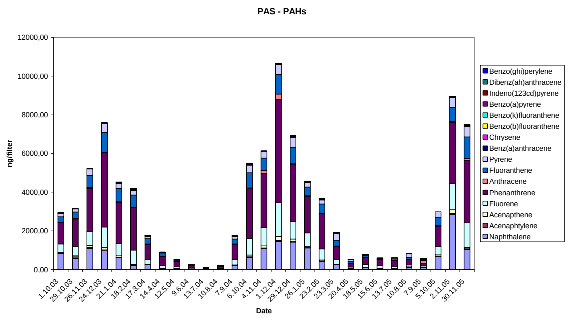


Figure 1: Seasonal variation of PAHs in the ambient air (ng/PUF filter), Kosetice observatory, Czech Republic.

The impact of meteorological parameters (temperature, wind speed) on the sampling rates as well as various approaches to the estimation of the PAS derived air concentrations were carefully evaluated, and based on the results of those studies, a model monitoring network was designed in 2004.

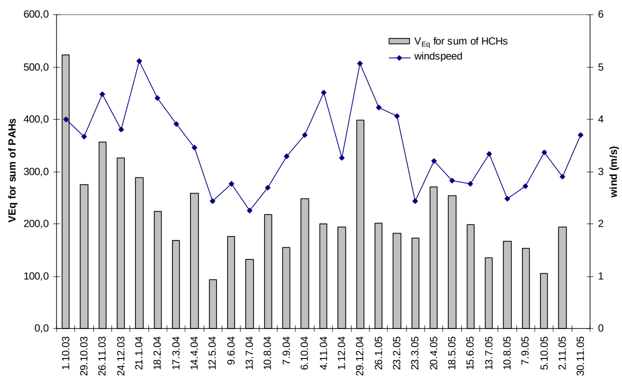


Figure 2: Correlation of the sampling rates with a wind velocity, Kosetice observatory, Czech Republic.

Fifty passive samplers were applied to continuously monitor various local sources as well as rural sites to assess the atmospheric fate of the persistent organic substances. Spatial and seasonal variations can be seen in Fig. 3.

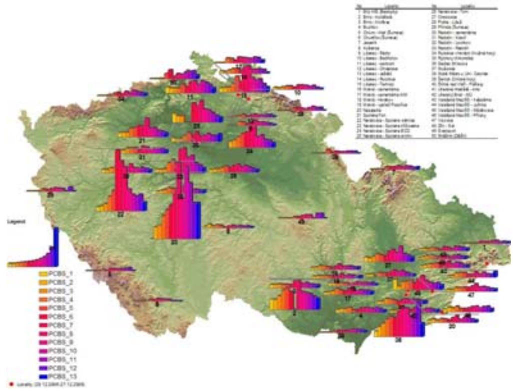

Figure 3: Seasonal variation of PCBs in the ambient air (ng/PAS filter), Czech Republic, 2006.

Based on the promising results of the Czech PAS monitoring program, this project was extended to cover most of the Central and Eastern Europe. New network was designed to investigate a feasibility of employing PAS as a tool for evaluation of the effectiveness of the international conventions with the special attention to the countries suffering the lack of air monitoring data. Sampling sites in Bosnia and Herzegovina, Estonia, Latvia, Lithuania, Romania, Serbia, and Slovakia have been monitored since 2006, while Bulgaria, Croatia, Hungary, Macedonia, Moldavia, Poland, Russia, and Slovenia joined the project in 2007.


Figure 4: Levels of PCBs in the ambient air (ng/PAS filter), Central and Eastern European countries, 2006.

Results of this continuous monitoring are used not only to fill the gaps in data about the ambient air contamination in Central and Eastern European region, but also for the identification of the sources of pollution, and estimation of their impact on the air quality. PAS samples were, for instance, used for radiocarbon-based source apportionment project, and the results of this study clearly indicated that combustion of non-fossil fuels has a significant impact on the amount of PAHs emitted into the southern European atmosphere.[7] Since the soil samples have been collected from each sampling site together with the air samples, fugacity fractions can be calculated to estimated the volatilization fluxes of various pollutants from contaminated soils.

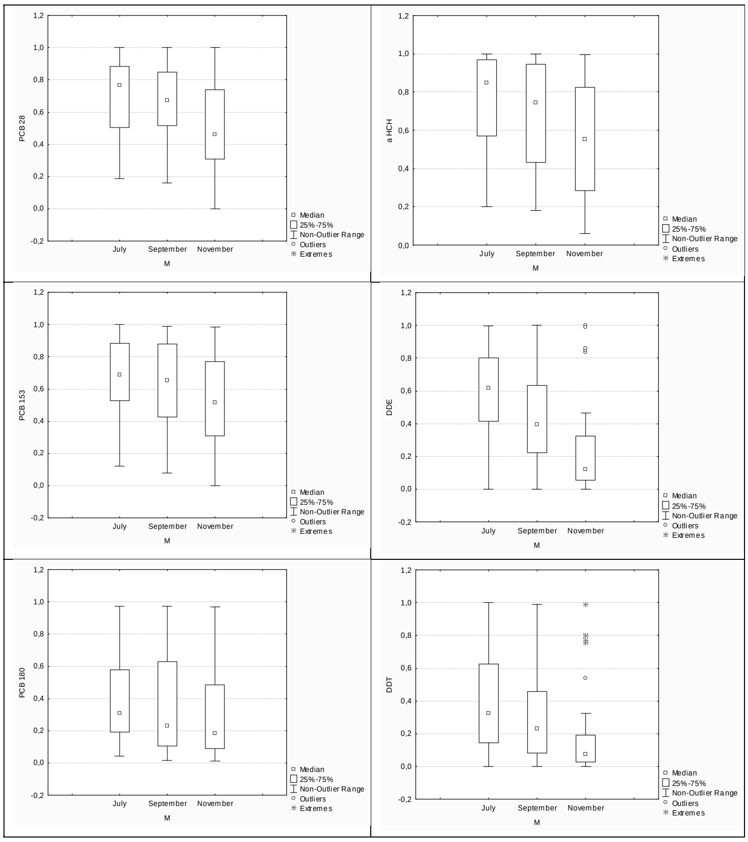


Figure 5: Seasonal variability (August, October, December) of fugacity fractions, *ff = fs/(fs + fa)*, of selected PCBs (left, from the top to the bottom: PCB 28, 153, 180) and OCPs (right, from the top to the bottom: a-HCH, p,p'-DDE, p,p'-DDT].

All our results confirm the feasibility of employing passive air samplers in various monitoring projects as valuable tool capable of providing new data on the fate and transport of POPs in the atmosphere.

## Acknowledgements

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