Air as source of PAH in surface water and possible measures to reduce it

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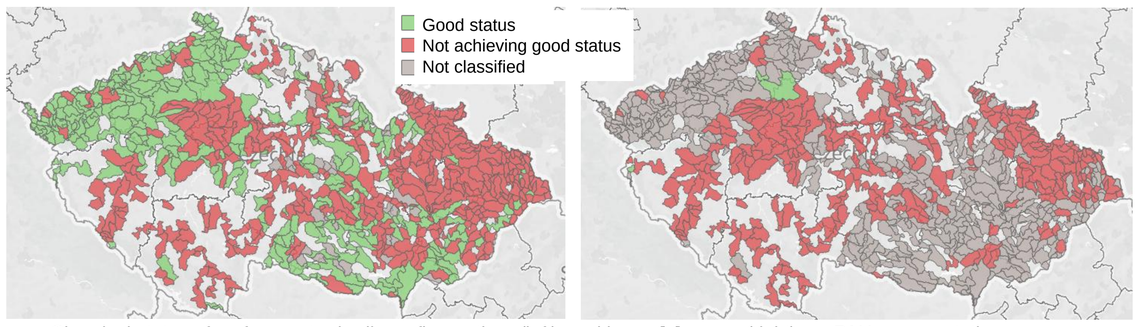
Abstract

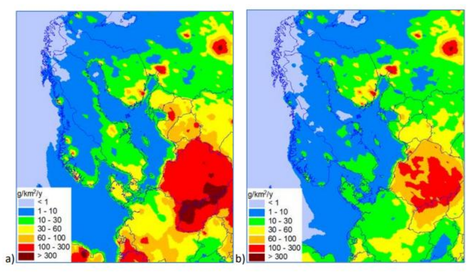
In the Czech Republic, polycyclic aromatic hydrocarbons (PAHs) are very often among the substances causing the failure to achieve good chemical status of surface waters. The most significant load has been detected in the industrial area of the Moravian-Silesian Region in the Odra river basin, but this problem applies to varying degrees throughout the Czech Republic, including the Elbe river basin. In a research project the athors monitored both the inputs of PAHs from the air to the ground surface and their increase in urban agglomerations and near roads, as well as their occurrence in surface waters. It turns out that in addition to measures aimed at improving air quality, which are needed in any case, some measures that were not originally intended to eliminate PAHs are also working. In particular, measures targeting water erosion, measures to capture and treat surface runoff and, more generally in cities, elements of blue-green infrastructure, specifically stormwater management measures, can have an impact. The poster presents in a simplified form the results obtained from the literature and older datasets, as well as from own measurements in Výrovka catchment Upper Elbe region.

PAH IN SURFACE WATERS AND ATMOSPHERIC DEPOSITION



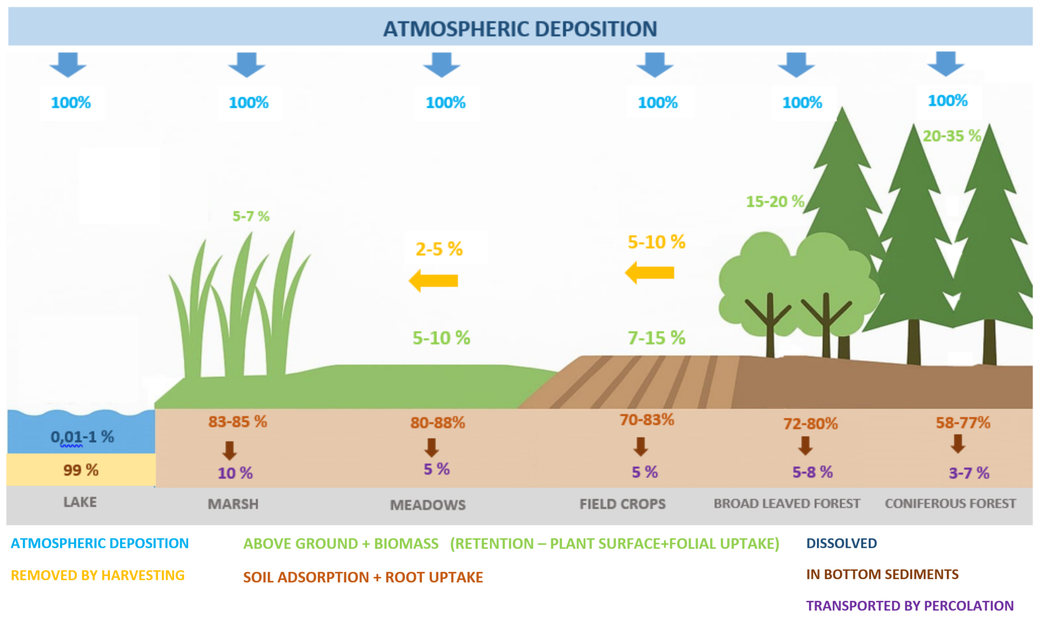
Chemical status of surface water bodies – fluoranthen (left) and benzo[a]pyrene (right) as PAH representatives

49% of surface water bodies in the Czech Republic do not achieve good status according to the Water Framework Directive. PAHs are one of the most common causes, as shown in the figures above. The main source of PAHs is considered to be polluted air and atmospheric deposition. Although the situation has improved significantly over the last 30 years (see EMEP report map below), the unsatisfactory state persists - most notably in the industrial area of the Ostrava region, but also in other areas. The aim of the project was to quantify the PAH substance flow through various environmental pathways.



Modelled annual total deposition fluxes of and benzo[a]pyrene in Baltic Sea region for 1990 (left) and 2020 (right). Source EMEP report: https://emep.int/publ/helcom/2022/F_BSEFS_BaP_dep_v2.pdf

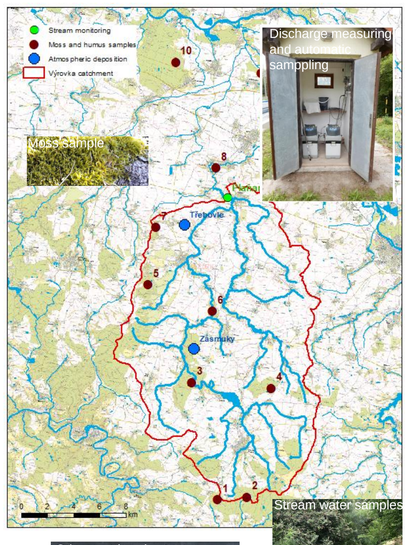
ANNUAL REDISTRIBUTION OF ATMOSPHERIC DEPOSITION LOADS IN NATURAL ENVIRONMENTS



The picture above shows annual redistribution of atmospheric deposition loads in various vegetation covers (logging is not considered). General overview was prepared based on literature and previous measurements, but were confirmed by the project results.

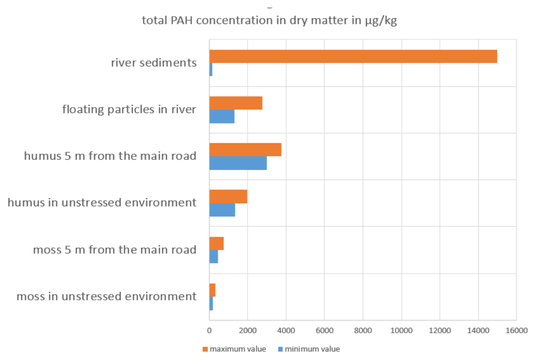
VÝROVKA CATCHMENT AND PROJECT METHODS

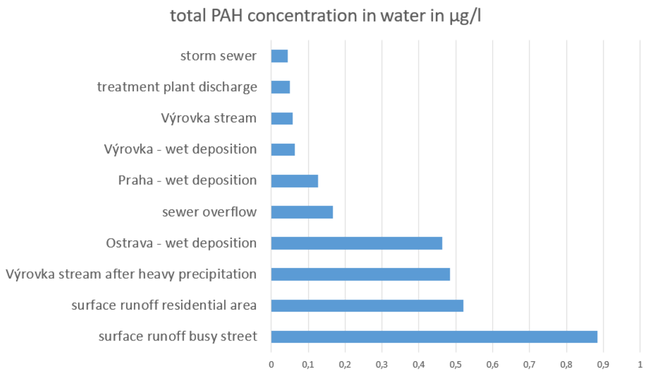
In 2021, two-year monitoring was initiated in the framework of the Water Centre project, which built on the previous results. In the catchment area of Výrovka – leftside tributary of Elbe river several matrices were sampled and compared. The observed matrices were: monthly sampled precipitation at two places, moss (an indicator of deposition over 1-3 years) and humus (an indicator of deposition over a longer period) samples at 10 places without significant presure, moss and humus samples at various distances from a busy highway, monthly point samples of watercourse water, sediments and floating sediments samlples. In a sample settlement the sources were monitored - in particular the potential pollution input from the built-up area (in the form of surface runoff, run-off from WWTPs and storm overflows) and major roads. A single rainfall-runoff event was sampled during heavy rain when the stream contained a significant surface runoff. In each sample a set of 15 different PAH were measured.



PROJECT RESULTS

The graph on the left shows the results of measuring the sum of PAH in solid components of the environment in the model basin. It shows visibly higher pollution around roads, measurable both in moss (1 year of pollution) and in forest humus (approx. 3 years of pollution). The proportion of PAH in suspended matter and river sediment is more variable





The graph on the right shows the results of measurements of the sum of PAHs in water in the stream, runoff from the waste water treatment plant, surface runoff, rainwater discharge, and precipitation in the model catchment area and in precipitation in reference locations in Prague and Ostrava. While the stream and precipitation in the model catchment area often reach concentrations around the detection limit under normal conditions, the highest values were reached by surface runoff, precipitation in the compared industrial location, and also by water in the Výrovka stream during heavy rainfall with a large amount of eroded material. Concentrations in such a situation reached ten times the normal value.

Conclusion

It has been confirmed that atmospheric deposition can be a significant pollutant of surface waters. However, the measured values also show the ability of PAHs to bind to various matrices and remain there until they are released into the watercourse through surface runoff, erosion or sewer overflows.
From these findings, possible measures can be suggested. In addition to measures aimed at improving air quality in general, measures to reduce erosion rates, reduce surface runoff and manage contaminated material (e.g. sewage sludge) may also be recommended.
Monitoring then makes sense to target the potentially higher risk sites (with higher air pollution) and where measures are to be or have been implemented. From a reference - less polluted sites can be considered those with lower air pollution and intact soil horizons and cover.
All methods and results are described in detail in the project summary report available at: https://www.centrum-voda.cz/file/e497353af571cc2d88aeaefc31ed8c79/627/V1%20WP6_souhrnn%C3%A1%20zpr%C3%A1va_12112024.pdf

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