

Integrating Moss Biomonitoring and GLEMOS Modelling for PAH Distribution and Source Attribution in Europe

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Air pollution poses significant risks to both ecosystems and human health, with polycyclic aromatic hydrocarbons (PAHs) representing a critical group of pollutants due to their persistence, toxicity, and long-range transport. This study integrates moss biomonitoring and the Global EMEP Multimedia Modelling System (GLEMOS) to improve the spatial understanding of PAH distribution in Europe and validate model-based source attribution, offering new insights into exposure pathways, environmental deposition, and potential health risks.

Our analysis incorporates moss biomonitoring data from Norway, including PAH uptake measurements, diagnostic ratios for source identification, and concentration factors to assess ecosystem vulnerability. These empirical findings are contrasted with GLEMOS model outputs, which provide spatial patterns of PAH concentrations and deposition across Europe, revealing transboundary pollution dynamics and source contributions.

The results show strong spatial correlations between PAH concentrations in mosses and GLEMOS-simulated deposition, confirming the model's predictive accuracy. However, PAH levels varied across measurements, indicating that industrial emissions alone cannot fully explain the observed contamination patterns. Nevertheless, modelled source attribution of BaP, BbF, BkF, and IcdP revealed differing sector contributions across sites, including industry, stationary combustion, and road transport. These findings highlight the need for a multi-source approach to understanding PAH pollution, considering both diffuse emissions and long-range atmospheric transport.

By integrating biological monitoring and atmospheric modeling, this study highlights an approach for improving pollutant source attribution and exposure assessment. This research underscores the importance of multi-disciplinary approaches in air quality assessment and informs policy strategies for mitigating PAH pollution at both national and transboundary levels.