Atmospheric Response to the Solid Fuel Combustion Ban in Krakow, Poland: Characterisation of Particulate Matter, Oxidative Potential, and Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) and Hydroxy-Polycyclic Aromatic Hydrocarbons (OH-PAHs) with Implications for Human Health. ***(acronym IMPACT-AIR)***

The project "Atmospheric Response to the Solid Fuel Combustion Ban in Krakow, Poland: Characterisation of Particulate Matter, Oxidative Potential, and Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) and Hydroxy-Polycyclic Aromatic Hydrocarbons (OH-PAHs) with Implications for Human Health. *(acronym IMPACT-AIR)* addresses the urgent need to assess the environmental and health related outcomes of air quality policies implemented in highly polluted European cities. This research will evaluate the atmospheric and toxicological implications of the 2019 ban on solid fuel combustion in Kraków, Poland a city historically increased by high concentrations of particulate matter (PM), particularly during winter months. To provide evidence-based answers, the project will apply a multifaceted methodology combining chemical, toxicological, and source apportionment analyses of ambient $PM_{2.5}$ and PM_{10} collected over a full annual cycle (October 2023–September 2024). The study will focus on quantifying the concentrations of polycyclic aromatic hydrocarbons (PAHs) and their hydroxylated derivatives (OH-PAHs), key combustion related toxicants known for their mutagenic and carcinogenic properties. Additionally, the oxidative potential (OP) of PM will be measured using two spectrophotometric assays ascorbic acid (AA) and dithiothreitol (DTT) in a synthetic respiratory tract lining fluid. These redox-based assays offer biologically relevant metrics of PM toxicity, reflecting the potential of airborne particles to generate oxidative stress upon inhalation. Source apportionment will be performed using both Positive Matrix Factorization (PMF) and the advanced Source Finder (SoFi) model. Comparing the results of SoFi and PMF will enhance the resolution of urban emission sources and improve the understanding of toxicologically relevant contributors. The outcomes of this post-ban investigation will be compared to a well characterised pre ban dataset (2017–2019), enabling a rare, policy-relevant temporal assessment of changes in PM composition, source contributions, and health risks. The following research questions will guide the project:

1. How has the ban on solid fuel combustion impacted the levels and seasonal profiles of PAHs and OH-PAHs in $PM_{2.5}$ and PM_{10} in Kraków?
2. What is the oxidative potential of post-ban PM in comparison with pre-ban measurements, and which chemical species are the main redox-active contributors?
3. How do the sources and toxicity of PM evolve in response to policy interventions and changing energy use patterns?
4. To what extent do advance receptor models (PMF vs. SoFi) provide consistent or complementary insights into source attribution in an urban environment?

The project is expected to produce high-impact outcomes across several domains:

- Deliver the first comprehensive post-ban dataset for Kraków detailing oxidative potential (OP), concentrations of PAHs, and OH-PAHs in $PM_{2.5}$ and PM_{10}.
- Validate the effectiveness of local air quality regulations by assessing changes in combustion-related pollutants and their associated health risks.
- Provide high-resolution chemical and source apportionment data using a combination of traditional (PMF) and advanced (SoFi) receptor models.
- Contribute to improved exposure-risk modeling through integration of OP as a biologically relevant metric.
- Facilitate transfer of advanced analytical and source identification techniques from PSI to Polish research institutions.
- Support the development of science-based air quality strategies aligned with EU directives and WHO health guidelines.