Chemical characterization of atmospheric particulate matter and source apportionment in an urban-industrial area of the Lisbon Metropolitan Area, Portugal

C.A. Gamelas[1,2], N. Canha[1,3], A. Vicente[3], C. Alves[3], Z. Kertesz[4], S.M. Almeida[1*]

[1] Centro de Ciências e Tecnologias Nucleares, Instituto Superior Técnico, Universidade de Lisboa, Estrada Nacional 10, 2695-066 Bobadela, Portugal;
[2] ESTSetúbal/IPS and CINEA, IPS Campus, Polytechnic Institute of Setúbal, 2914-508 Setúbal, Portugal
[3] CESAM—Centre for Environmental and Marine Studies, Department of Environment and Planning, University of Aveiro, 3810-193 Aveiro, Portugal
[4] Laboratory for Heritage Science, Institute for Nuclear Research, H-4026 Debrecen, Hungary
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Presenting author email: carla.gamelas@ctn.tecnico.ulisboa.pt

In Seixal, an urban-industrial area with the influence of steelworks, crossed by highways with high density traffic, occasional settled dust events have increased the population's concerns regarding the impacts of the air pollution on their health. Therefore, the need to pinpoint the sources of these events and to study the local air quality, has emerged among local authorities (Abecasis, 2022). The present study aims to answer this problem, by the assessment of particulate matter levels by reference methods, allowing the analysis of the issue based on national and European legislation.

$PM_{2.5}$ and PM_{10} samples were collected in 128 sampling days, in three sampling campaigns: Winter (December 2019 to March 2020), Summer (June to August 2020) and Autumn (September to November 2020), spanning from pre-pandemic to pandemic context. $PM_{2.5}$ was analyzed for a total of 24 elements by Particle Induced X-ray Emission (PIXE) and the concentrations of water-soluble ions were determined by Ion Chromatography. Mass concentrations of black carbon (BC) were determined, using a multi-wavelength absorption instrument, allowing the distinction of BC due to fossil fuel combustion (BC_{ff}) and biomass burning (BC_{bb}) (Manohar, 2021). The Positive Matrix Factorization receptor model PMF 5.0 was used to perform source apportionment.

The $PM_{2.5}$ and PM_{10} mean concentrations were 13±11 μg.m^{-3} and 24±13 μg.m^{-3}, respectively, bellow the annual limits of the Directive 2008/50/EC. However, the daily WHO guideline for $PM_{2.5}$ (15 μg.m^{-3}, not to be exceeded more than 3-4 days per year (WHO, 2021)) has been exceeded 33 times in the 128 sampling days. Twelve of these days were affected by Sahara dust events, as ascertained by the back-trajectories ending at the sampling point, simulated using the NOAA/ARL Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model.

There was a reduction of 46.1% and 35.9% in $PM_{2.5}$ and PM_{10}, respectively, from the pre-pandemic to the pandemic period, and a reduction relative to the last six years. This is certainly due to the confinement measures imposed to halt the SARS-COV-2 pandemic, which led to a decrease in anthropogenic activities and emissions worldwide (Chauhan, 2020). The change in the emission patterns caused by the pandemic was also felt in the PM chemical composition (Figure 1). In fact, NO_3^- concentrations were significantly higher ($p<0.001$) in the pre-pandemic (2.69±3.06 μg.m^{-3}) than in the pandemic period (0.63±0.58 μg.m^{-3}) and the same happened with BC concentrations (3448±2539 and 1860±776 ng.m^{-3}, $p<0.001$).

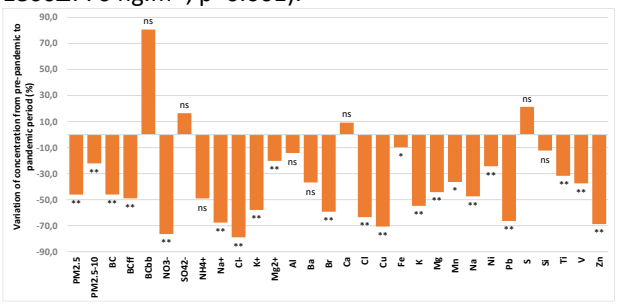

Figure 1. Variation of concentrations from the pre-pandemic to pandemic period. Significantly different *at $p<0.05$ and **at $p<0.01$, ns - not significant.

Source apportionment results showed that mitigation actions should focus on traffic and industrial fugitive emissions. This was the first study that investigated the sources of $PM_{2.5}$ in Seixal, providing the authorities with important information to target measures to improve local air quality. Furthermore, the SARS-COV-2 pandemic context offered a unique opportunity to examine the effects of human-related activities on air quality in the study area.

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