Source apportionment of $PM_{2.5}$ in the pre-pandemic versus pandemic period in an area near Lisbon: Lessons for air quality management

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The lockdowns held due to the COVID-19 pandemic caused changes in air quality worldwide, allowing important lessons to be drawn on how to abate pollution (Querol et al., 2021).

Seixal, a densely populated area near Lisbon, comprising heavy industry (e.g. steelworks) and highways with intense commuting traffic, has suffered from poor air quality in the last decades. The present study aims to address this problem, by identifying $PM_{2.5}$ emission sources and determining their contribution.

$PM_{2.5}$ samples were collected in 128 days, in winter (December 2019-March 2020), summer (June-August 2020) and autumn (September-November 2020), spanning from pre-pandemic to pandemic context. The composition of $PM_{2.5}$ was assessed for 24 elements (by Particle Induced X-Ray Emission, PIXE), secondary inorganic ions (by ion chromatography) and black carbon (BC, by multi-wavelength absorption). The Positive Matrix Factorization receptor model PMF 5.0 was used to perform source apportionment (Gamelas et al., 2023).

The $PM_{2.5}$ and PM_{10} mean concentrations were 13±11 $\mu g.m^{-3}$ and 24±13 $\mu g.m^{-3}$, respectively, bellow the annual limits of Directive 2008/50/EC, but above the WHO annual guideline values (WHO, 2021). The daily WHO guideline values for $PM_{2.5}$ and for PM_{10}, not to be exceeded more than 3-4 days per year, have been exceeded 33 and 8 times, respectively, in the 128 days.

The most abundant species in $PM_{2.5}$ were BC (19.9%), SO_4^{2-} (15.4%), NO_3^- (11.6%) (with mean concentrations >1 $\mu g.m^{-3}$) and NH_4^+, Na, Cl, K, Ca, Si and Fe (>100 $ng.m^{-3}$).

From the pre- to the post-confinement, there was a reduction of 46.1 % in $PM_{2.5}$, and a significant reduction ($p<0.050$) of all the $PM_{2.5}$ components, except for Al, Ba, Ca, Si and SO_4^{2-}.

PMF identified seven sources, whose contributions at the receptor were greatly influenced by the restrictions imposed by the COVID-19 pandemic (Figure 1). Fuel-oil combustion and vehicle exhaust factors were significantly higher in the pre- than in the post-confinement ($p<0.050$), with vehicle exhaust presenting the most pronounced decrease (80.1%). These results confirm the relevance of traffic and

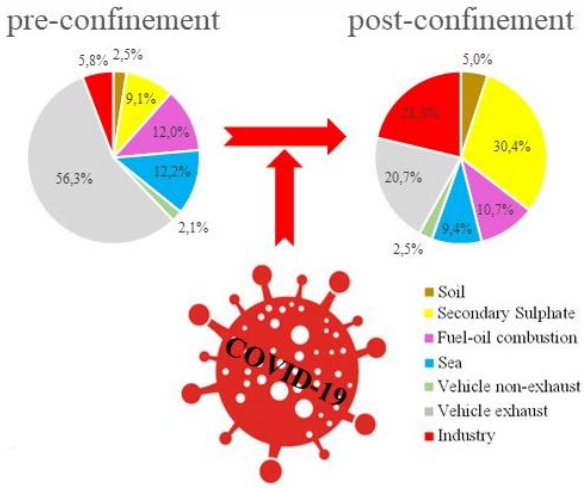

Figure 1. Source contributions for $PM_{2.5}$ mass, for the selected PMF solution.

associated secondary aerosol in $PM_{2.5}$ in the study area and reveal that the decrease in the $PM_{2.5}$ concentrations was due, to a large extent, to the reduction of vehicle traffic, caused by the COVID-19 confinement.

On the other hand, secondary sulphate was the main contributor in post-confinement (Figure 1), due to increased photochemical activity in summer; followed by industry, since the steelworks did not stop to operate during the confinement and due to increased resuspension in the dry season.

Besides the restrictions imposed by COVID-19 and the seasonality, the source contributions at the receptor were also affected by the types of air mass trajectories.

In conclusion, the pandemic confinement created a unique opportunity for assessing the effect of anthropogenic activities on air pollutants in the study area and targeted mitigation measures to improve air quality are presented based on this assessment.

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Gamelas et al. (2023) *Urban Clim.*, *49*, 101446.
Querol et al. (2021) *Sci. Total Environ.*, *779*.
WHO (2021) *WHO global air quality guidelines*.