Toxicity score of aerosols in rural and urban areas, with a focus on the Po Valley, Italy

11th International Aerosol Conference

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4-9 September 2022

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Abstract Book

Toxicity score of aerosols in rural and urban areas, with a focus on the Po Valley, Italy.

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Keywords: atmospheric aerosols, particle toxicity, toxicity – weighted concentration, air quality planning
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The study of atmospheric aerosols composition is fundamental to fill the knowledge gap on particulate matter dynamics and fate. Aerosol composition varies significantly depending on the emission sources, the geographic area, and the meteorological conditions. Many studies analysed the composition and source apportionment of particulate matter in urban areas, while studies concerning rural sites are more limited. Different aerosol mixtures have also different toxicity. The characterization of aerosols toxicity is gaining importance, as it could act as a key point for the development of air quality planning policies. To this end, toxicity ranking methods have been recently proposed by researchers.

In this study, the toxicity of $PM_{2.5}$ in different rural sites worldwide was calculated and compared to data of urban areas. Several similar sites in Europe, USA, Hong Kong and China were considered. The $PM_{2.5}$ source apportionment and concentration trend was analysed based on data reported in the literature. To evaluate particle toxicity, the methodology proposed by Park et al. (2018) was applied. This method is based on the analysis of multiple biological and chemical endpoints, that were integrated for various source-specific aerosols to derive toxicity scores for particles originating from different sources. Average $PM_{2.5}$ toxicity of rural and urban sites was thus calculated based on the average chemical composition.

The preliminary results show that, on average, toxicity ranking of rural sites was 1% – 55% lower than that of urban areas. Nevertheless, it was estimated that secondary inorganic aerosols contribute 1 – 10% to the overall PM toxicity. A significant variability was observed among different rural sites.

In the second phase of the study, the analysis was focused on the Po Valley, Italy, a region which is affected by severe pollution episodes during winter, due to presence of multiple emission sources and peculiar geophysical and meteorological conditions. The temporal variability of PM composition and toxicity of the Revello (rural) and Turin (urban) sites was analysed (Piedmont Region, 2018). Time series of toxicity-weighted concentration C_t were defined based on the following equation:

$$C_t = C \cdot t_{ave}^{-1} \cdot t$$

where C is the $PM_{2.5}$ concentration at the considered site, t is the particle toxicity based on the average source apportionment of $PM_{2.5}$ at the considered site, and t_{ave} is the average particle toxicity based on the data available for this area. Figure 1 shows the preliminary results of the toxicity-weighted concentration trend in the Turin and Revello sites in the year 2019, compared with the measured $PM_{2.5}$ mass concentration.

The results reported in this study showed that, although the reduction of traffic and biomass burning remains the primary target, in highly-polluted areas like the Po Valley, reducing the emission of precursors in rural areas is also fundamental to improve air quality in all the region.

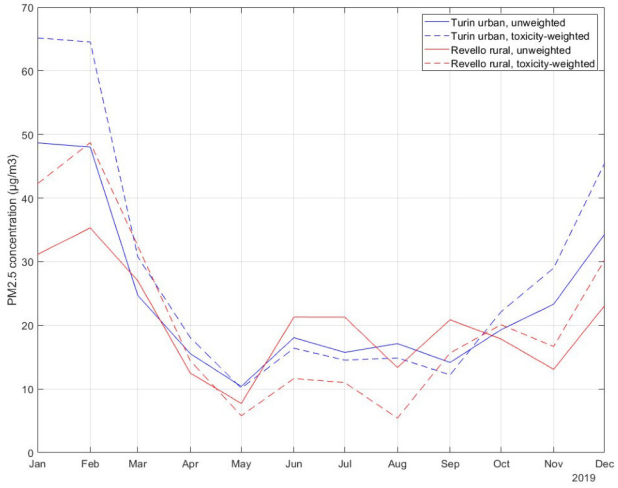

Figure 1. $PM_{2.5}$ total and toxicity-weighted concentration in the Turin and Revello sites.

Part of the data used in this study was produced in the context of the LIFE AIRUSE and LIFE PREPAIR projects. The authors acknowledge the work done in this projects.

Park, M., Joo, H.S., Lee, K., Jang, M., Kim, S.D., Kim, I., Borlaza, L.J.S., Lim, H., Shin, H., Chung, K.H., Choi, Y.-H., Park, S.G., Bae, M.-S., Lee, J., Song, H., Park, K., 2018. Differential toxicities of fine particulate matters from various sources. Sci Rep 8, 17007.

Piedmont Regional Air Quality Plan (PRQA). Available online: http://www.regione.piemonte.it/ambiente/aria/piano_regionale.htm. (In Italian)