

Editorial

Preface: Special Issue on Air Quality Assessment for Environmental Policy Support: Sources, Emissions, Exposures, and Health Impacts

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1. Introduction

The increased occurrence of serious health effects, mortality, and morbidity, as well as shortened life expectancy have been related to exposure to ambient air pollution. Studies have revealed acute health effects associated with exposure to ambient air pollutants (including increased rates of heart attack, stroke, respiratory symptoms, and overall mortality). Long-term exposure to airborne pollutants has also been associated with various immunological, hematological, and reproductive outcomes; in this regard, susceptible sub-populations (elderly, children, and individuals with underlying illness) appear to be at particular risk [1,2].

Air pollutants can originate as primary pollutants (i.e., those directly emitted into the air by pollution sources) or as secondary pollutants (i.e., formed in the atmosphere, largely from reaction from the primary pollutants). The primary pollutants include particulate matter (PM), which also includes ultrafine particles (UFP) and gaseous pollutants, which include sulfur oxides (such as sulfur dioxide, SO₂), nitrogen oxides (such as nitric oxide, NO, and nitrogen dioxide, NO₂), and carbon oxides (such as carbon monoxide, CO, and carbon dioxide, CO₂). Secondary air pollutants include gaseous ozone (a major component of photochemical smog) formed from nitrogen oxides and hydrocarbons, and particulate sulfate (e.g., sulfuric acid) and nitrate (e.g., ammonium nitrate) aerosols created in the atmosphere from sulfur and nitrogen oxide gases, respectively [1,2].

Different sources may also emit pollutants in indoor environments [3–5]. Furthermore, due to the presence of this number of sources and the confined air volume, the indoor air concentrations in some environments, such as homes, offices, schools, and public buildings, can be higher than in the outdoor air [6]. Obviously, the issue of air quality is also relevant in terms of occupational exposure: in occupational settings—such as industrial or productive work environments (characterized by the presence of specific pollutants sources), as well as environments in which the professional use of chemicals occurs—the inhalation exposure is generally considered the prevalent route of exposure.

Overall, air quality may affect health, comfort, and well-being [1,2,7]. Therefore, a careful assessment and management of air quality is important for the protection of human health and comfort. In this context, source identification and control has been increasingly recognized as the prioritized strategy for improving air quality and reducing the combined health risks associated with exposure. Air quality policies, such as the definition of air quality standards, vary greatly among countries and these regulatory discrepancies amplify the differences in air quality and related health effects around

the globe. To reduce air pollution and improve air quality, robust, evidence-based, and effective environmental policies are needed. The thorough study of the pollutants' sources and emissions, of the population exposure, and of the exposure-related impacts on health represents the basis for the development of air quality policies and the assessment of their effectiveness. In the last few years, thanks to environmental regulatory programs most closely based on accurate measurements of human exposure, great progress has been achieved in improving public health. It is well known that exposure analysis is one of the most important topics in environmental sciences. Only by accurately determining the pollutants sources could exposure be reduced. In this regard, it should be remembered that airborne pollutants could be emitted and formed both outdoors and indoors, resulting in personal exposures that can be greatly different from levels measured by routine air measurements made at central-site ambient outdoor air monitoring stations. Thus, a proper assessment of human exposure to air pollution (obtained from accurate and robust environmental monitoring or exposure estimation) is a fundamental part of the more general process of health risk assessment, which is the process by which risk for human health deriving from exposure to chemicals can be estimated [1,2].

This Special Issue of *Environments* provides innovative insights and case studies concerning air quality assessment in different contexts.

2. Highlights

Two studies in this Special Issue of *Environments* concerned the study of $PM_{2.5}$ also deepening its chemical characterization, in order to understand if and how the composition of the particulate could determine a different impact on health and possibly suggest a common source. In particular, Zhang et al. [8] performed the chemical characterization of $PM_{2.5}$ in Nanjing (China) and evaluated its toxicological properties in three human cell lines. Authors collected two seasonal $PM_{2.5}$ samples (summer and winter) and investigated their chemical compositions (heavy metals, water-soluble ions, organic carbon (OC), and elemental carbon (EC)). Human lung epithelial carcinoma cells (A549), human hepatocellular liver carcinoma cells (HepG2), and human neuroblastoma cells (Sh-Sy5y) were then employed to evaluate the toxicological properties of the collected $PM_{2.5}$. The results showed that the average mass concentrations of $PM_{2.5}$ were lower in summer than those in winter. However, the mass fractions of heavy metals, OC, and EC exhibited an opposite seasonal difference. Among all tested fractions, water-soluble ions were the major compositions of particles in both summer and winter, especially the secondary ions. Besides, the ratio of OC/EC in $PM_{2.5}$ was greater than two, indicating serious secondary pollution in this area. The toxicological results showed that $PM_{2.5}$ in the summer and winter significantly inhibited cell viability and induced intracellular reactive oxygen species production. Moreover, the viability inhibition in the tested cell lines was more prominent in summer, especially at high $PM_{2.5}$, and the induction of reactive oxygen species in A549 and Sh-Sy5y cells was also more evident in summer. The authors suggested that such seasonal differences might be related to the variations in $PM_{2.5}$ components.

Wang et al. [9] collected $PM_{2.5}$ samples in Changchun (China), with the aim to investigate the distribution characteristics of OC and EC in $PM_{2.5}$. The results showed that the annual OC/EC ratio range was 8.08–15.44, with an average of 11.70. OC and EC concentrations in spring were the lowest, whereas higher levels of both OC and EC were found in winter. Significant correlations between OC and EC were found in the non-heating period, indicating that there was a consistent or similar source, whereas OC was non-significantly correlated with EC in the heating period, suggesting that contributions of OC were from unrelated combustion sources.

The monitoring of air pollutant concentration within cities, as well as the understanding of pollutants' spatial and temporal variability, and the estimation of pollutants' origins are crucial for environmental management and public health policies in order to promote sustainable cities.

Several studies on PM levels in large cities have been conducted, while studies related to the source and general estimation of levels of SO_2 over whole years are lacking. Prikaz and collaborators [10] explored the yearly trend in SO_2 in Ulaanbaatar (Mongolia); their results showed a reduction of

around 40% of the annual average concentration of SO₂ from 2016 (53 µg/m³) to 2017 (32.43 µg/m³). Furthermore, the back-trajectory model and the National Oceanic and Atmospheric Administration (NOAA)'s hybrid single particle Lagrangian integrated trajectory model (HYPSPLIT) were used to determine the source of SO₂. Results showed that 78.8% of the total trajectories in Ulaanbaatar came from an area inside Mongolia, and mainly from industrial cities placed in the northwest and north of the country, during the winter season.

Fang et al. [11] studied the temporal and spatial variations of the O₃ concentration and its relationships with meteorological factors by correlation analysis during the period of 2013–2017 in Changchun (China). The results showed the ozone concentration in the periphery of Changchun is higher than that in the city center, and that in the south of the city is higher than that in the north. The maximum ozone concentration increased year by year from 2013 to 2017 with a gentle single-front distribution. In 2015, the daily maximum 8 h average concentration (MDA8) of ozone was the highest (with the greatest number of days exceeding the standard in this year) and the concentration growth rate was the fastest. Furthermore, daily, monthly, and seasonal trends were analyzed. Finally, the correlation of ozone levels with other airborne pollutants concentrations (carbon monoxide, nitrogen oxides, PM_{2.5}, and PM₁₀) and with atmospheric pressure, relative humidity, and air temperature were investigated.

In their study, Alvarez-Mendoza et al. [12] presented an approach to estimate the concentration of PM₁₀ using an empirical land use regression (LUR) model and considered different remote sensing data as the input. The study area was Quito, the capital of Ecuador, and the data were collected between 2013 and 2017. The model predictors were the surface reflectance bands and some environmental indexes. The dependent variable was PM₁₀ levels measured at ground level. Furthermore, this study also aimed to compare three different sources of remote sensing to estimate the PM₁₀ concentration, and three different predictive techniques to build the model. The selected models allowed the generation of PM₁₀ concentration maps from public remote sensing data, constituting an alternative over other techniques to estimate pollutants, especially when few air quality ground stations are available.

Boniardi et al. [13] explored whether an LUR model can predict home-to-school commuting exposure to black carbon (BC). In this study, 43 children walking to school were involved in a personal monitoring campaign measuring exposure to BC and tracking their home-to-school routes. At the same time, a previously developed LUR model for the study area was applied to estimate BC exposure on points along the route. The comparison between the two methods showed good agreement, suggesting that LUR estimates are capable of catching differences between routes and predicting the cleanest route. However, the model tends to underestimate absolute concentrations by 29% on average. Based on the obtained results, the authors suggested that the LUR model can be useful in predicting personal exposure and can help urban planners to build a healthier city for schoolchildren by promoting less polluted home-to-school routes.

Pochwat and collaborators [14] shifted to a different type of problem: their article discussed the process by which malodorous substances arise and may be emitted from sewage-treatment systems, the current legal regulations of relevance to the issue, and discussed methods of odor abatement.

Finally, two articles shifted the attention to the issue of occupational exposure to airborne pollutants, though they dealt with the subject with extremely different methodologies [15,16]. Marcias et al. [15] investigated the occupational exposure to fine and ultrafine particles and noise in aircraft personnel employed in an airport taxiway. The study design consisted of an extremely detailed exposure characterization and provided evidence on the impact of aviation-related emissions on occupational exposure to ultrafine particles and noise exposure of workers operating in an airport taxiway. In fact, main exposure peaks are related to pre-flight operations of engine aircrafts. The authors suggested that although exposure to ultrafine particles and noise appears to not be critical if compared with other occupational scenarios, the coincidence in time of high peaks of exposure to ultrafine particles and noise means that further investigations are warranted in order to assess possible subclinical and clinical adverse health effects in exposed workers, especially for cardiovascular apparatus.

Jensen et al. [16] presented an aerosol dispersion model and validated it by comparing the modelled concentrations with concentrations measured during chamber experiments. More in detail, authors investigated whether a better estimation of concentrations was possible by using different geometrical layouts rather than a typical two-box layout. One-box, two-box, and two three-box layouts were used. The one-box model was found to underestimate the concentrations close to the source, while overestimating the concentrations in the far field. The two-box model layout performed well based on comparisons from the chamber study in systems with a steady source concentration for both slow and fast mixing. The three-box layout was found to better estimate the concentrations and the timing of the peaks for fluctuating concentrations than the one-box or two-box layouts under relatively slow mixing conditions. Based on the obtained results, the authors suggested that industry-relevant scaled volumes should be tested in practice to gain more knowledge about when to use the two-box or the three-box layout schemes for multi-box models.

Overall, the papers published in this Special Issue of Environments presented studies concerning the assessment of sources and emissions of air pollutants, the study of exposure of the general population or of specific categories of subjects, in different environments, including work environments, and the potential health impacts that may result from it.

Conflicts of Interest: The authors declare no conflict of interest.

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