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Editorial

Advances in Air Quality Monitoring and Assessment

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1. Introduction

Air quality monitoring is a long-term assessment of pollutant levels that helps to assess the extent of pollution and provide information about air quality trends. Furthermore, an air quality monitoring system (AQMS) supports research by providing the information necessary for scientists to perform long-term studies of population exposure to various atmospheric substances and generally estimate the health effects of air pollution. In addition, an advanced AQMS could make useful information available to policy makers and planners in order to help make informed decisions about managing and improving air quality by better understanding the sources of air pollution. The purpose of this Special Issue is to provide an overview of recent advances in environmental monitoring and assessment, which includes the design, development and application of advanced monitoring systems based on cutting edge scientific knowledge.

2. Current and Future Challenges in Air Quality Monitoring

In this Special Issue, 23 papers were submitted and 13 were accepted for publication (57% acceptance rate). Forty-six percent of the published studies originated from Asian countries, 31% of them were conducted in European countries and 23% were done in the USA and South America. Various topics were addressed in the contributed articles, which can be distinguished into two main groups: (i) development of emerging AQ monitoring systems and methodologies and (ii) evaluation and modeling of AQMN data in terms of AQ and health impact assessment. A quite smaller group included studies on the improvement of methodological approaches to analyzing AQ data.

In the first group, Paralikis et al. [1] developed Al-doped NiO films which can potentially be used as a sensing element for ozone gas sensors. The gas-sensing performance of the film for ozone was studied at different operating temperatures and was able to detect ozone at an ultra-low concentration of 10 ppb. Davidović et al. [2] evaluated the changes in air pollution in Serbia due to the COVID-19 pandemic using data from permanently operating air quality monitoring stations as well as by deploying low-cost particulate matter (PM) sensors. Beyond the useful outcomes for the improvement of air quality due to the reduction of transport and industrial activities, the study confirmed the low-cost PM sensors' usefulness in air quality assessment, as they increase spatial resolution. It also pointed out the necessity to calibrate them and follow the QA/QC protocols in order to verify their reliability. Following a similar methodological approach, Yiniva Camargo-Caicedo et al. [3] observed the changes in air quality using data from an air quality network and from the Ozone Monitoring Instrument (OMI) satellite in order to estimate improvements in air quality in Colombia due to COVID-19 pandemic lockdown. Furthermore, emissions from road transportation of four groups of pollutants (greenhouse gases, ozone precursor gases, aerosols and acidifying gases) before and during the lockdown were estimated and compared. The results could serve decision makers in adopting strategies to improve air quality related to the transportation sector. Regarding this sector, Li et al. [4] presented and analyzed data from four portable emissions measurement system (PEMS) tests of heavy-duty vehicles. More specifically, they analyzed the NOx emission of urban, rural and

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motorway sections and calculated the moving averaging window (MAW) NOx emission under the required boundary conditions. Finally, they explored the proper methods to evaluate real-world NOx emission based on the MAW method. It is worth noting that the study pointed out the insufficiency of the current evaluation method for real-world NOx emission of heavy-duty vehicles, indicating where the research community should focus future studies. It is obvious from the previous studies that an air quality monitoring network (AQMN) plays an important role in air pollution management. However, setting up an initial network in a city often lacks the necessary information, such as historical pollution and geographical data, which makes establishing an effective network challenging. Meanwhile, cities with an existing one do not adequately represent spatial coverage of air pollution issues or face rapid urbanization, where additional stations are needed. To resolve the two cases, Athita Onuean et al. [5] proposed four methods for finding stations and constructing a network. They introduced and applied a coverage percentage and weighted coverage degree for evaluating the results from the proposed methods that will be implemented as a guide for establishing a new network and can be a tool for improving spatial coverage of an existing network for future expansions in air monitoring.

In the second group, Afifa Aslam et al. [6] investigated the concentration level of PM2.5 and PM10 as well as their carbonaceous fraction, including organic carbon (OC), elemental carbon (EC) and total carbon (TC) from samples collected from five different sectors in Pakistan. It is well-known that studying the chemical composition of particulate matter (PM) provides an opportunity to conduct additional studies on source identification, impact assessment and trend analysis. Furthermore, Cho et al. [7] have shown that quantitative assessments of chemical and biological properties of ambient PM2.5 and VOCs can be used effectively to characterize, compare and contrast air pollution across different geographical regions (Los Angeles basin) to account for effects of atmospheric modifications on air mass and to evaluate exposure proximity to an emission source. Observational data from city AQ monitoring stations are usually analyzed and used for numerical simulations in order to evaluate the impact of emission control scenarios. To that end, Zhan et al. [8] analyzed the air quality observational data of major air pollutants in 2015 and during pollution episodes in Haizhu district, China, and the impacts of emission control scenarios on air quality by the year 2020 were evaluated using a WRF-Chem numerical simulation. In the same direction, Li et al. [9] investigated the pollution characteristics, transport pathways and potential sources of PM2.5 based on PM2.5 monitoring data from 2015 to 2016 in Weifang, China. For that purpose, they used three methods: Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT), the potential source contribution function (PSCF) and concentration weighted trajectory (CWT). Nowadays, fine dust data acquired by various personal monitoring devices is of great value as training data for predicting future fine dust concentrations and innovatively alerting people of potential danger. However, most of the fine dust data obtained from these devices include either missing or abnormal data caused by various factors such as sensor malfunction, transmission errors or storage errors. Park et al. [10] presented methods for interpolating the missing data and detecting anomalies in PM2.5 time series data. These methods are expected to contribute greatly to improving the reliability of data.

Air pollution data obtained from various monitoring campaigns are usually used for health impact assessment. Stamatelopoulou et al. [11] examined the concentrations and sources of PAHs and trace metals in indoor dust and, more specifically, focused on residences with infants and young children. Exposure to toxicants contained in house-settled dust is of paramount concern, especially in the case of young children, due to their particular behavioral characteristics. In this context, extracts of sieved vacuum cleaner dust from 20 residences with young children in Athens, Greece were examined for the presence of PAHs and trace metals. Outdoor environment and, more specifically, industrialized areas also play a significant role in citizens' health. To that end, Koukoulakis et al. [12] simultaneously monitored PAHs, PCDD/Fs, dlPCBs and indPCBs bonded to particulate matter (PM10) for the estimation of their health risks to nearby citizens. SPSS statistical package was employed for statistical analysis and source apportionment purposes. Cancer risk was also estimated from total persistent organic pollutants (POPs) dataset according to the available literature. Specific attention should be given to studies on the health impacts of air pollution where regression analysis is used. The complexity of count data regression models can lead to false inference and overfitting. Joseph et al. [13] presented a simple histogram of predicted and observed count values (POCH) which, while rarely found in the environmental literature but presented in authoritative statistical texts, can dramatically reduce the risk of accepting untrue hypotheses.

3. Conclusions

In conclusion, the papers in this Special Issue have highlighted two thematic areas of AQ monitoring that researchers currently focus on: (i) the improvement of AQ monitoring methods and (ii) the use of AQ data in order to better assess the impact of air pollution to the environment and health. While this Special Issue has been closed, further research towards these directions is expected shortly, as there are still several challenging research questions to be answered.

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