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Editorial: Crucial air quality, atmospheric environment, and climate change in low- and middle-income countries

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Editorial on the Research Topic
Crucial air quality, atmospheric environment, and climate change in low- and middle-income countries

The management of air pollution and climate change is an urgent issue that requires tackling both problems simultaneously. It was addressed to be a significant milestone in the meeting of Conference of the Parties (COP). Most countries have agreed to transition away from fossil fuels (Arora, 2024). The relationship between air quality and climate change is complex. Pollutants emitted into the atmosphere not only reduce air quality but also exacerbate global warming by increasing greenhouse gas concentrations. Reducing emissions like carbon dioxide and particulate matter is crucial for both improving air quality and mitigating the impact of climate change (Im et al., 2022). Many developing countries in South Asia and Southeast Asia have faced severe air pollution problems, particularly with particulate matter with diameter less than 2.5 microns ($PM_{2.5}$) exceeding the World Health Organization (WHO) air quality guideline value in Asian cities (Sooktawee et al., 2023; Verma et al., 2023; Jawaa et al., 2024). They have also experienced climate change impacts, both extreme and slow-onset events such as warm days and nights, intense heat waves, unpredictable floods, sea-level rise, and saltwater intrusion (Hussain et al., 2020; Limsakul et al., 2023).

This Research Topic aims to collect original research papers on air quality, the atmospheric environment, and climate change that focus on low- to upper-middle-income economy countries. The content of this Research Topic is mostly research related to air pollution, $PM_{2.5}$, bio-particle, remote sensing, and their relationship with climatic factors. Seven articles are published in this Research Topic with contributions from 35 authors. We briefly selected their findings and highlights from each paper summarized as follows:

Ratanavalachai and Trivitayanurak carried out air quality dispersion modeling to reveal source contributions of $PM_{2.5}$ in the central business area in Bangkok, Thailand. Emission inventory of mobile sources in this study was developed in hourly variation. Interestingly, $PM_{2.5}$ from outside the study domain was used as an input and declared as advected-in $PM_{2.5}$. At five receptor points, they found advected-in $PM_{2.5}$ contribution that ranged from 64% to 99%, dominating emissions within the study area. Upgrading fuel standards to EURO6 emerged as the effective countermeasure scenario. This work could be valuable for policymakers in urban air quality management.

Karimi et al. assessed bioaerosols and the presence of bacteria and fungi in $PM_{2.5}$ in the air of Isfahan, Iran. They found that $PM_{2.5}$ concentrations frequently exceed WHO guidelines during the summer and autumn seasons. Dust events and thermal inversion are causes of the rise in concentration. Nevertheless, concentrations of bacteria and fungi in $PM_{2.5}$ were low, possibly related to the warm and arid climate. This study suggested fewer health risks associated with $PM_{2.5}$ pollution in terms of bacterial and fungal bioaerosols.

Hongthong and Nakapan simulated the distribution of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and $PM_{2.5}$ from point source emission using a dispersion model. They further compared the spatial distribution of $PM_{2.5}$ obtained from the model simulation with prediction using remote sensing data (MAIAC-AOD). Within the area of 10 km^2 from the source, correlations between them were 0.65–0.76. This study suggested the possibility of using remote sensing for air quality monitoring and validating pollutant dispersion from point sources.

Punpukdee et al. conducted an extensive analysis of data from satellites, ground-based observations, and modeling data to produce a high spatial resolution 1×1 km^2 map of $PM_{2.5}$ concentrations with hourly dynamic across Thailand. Their results captured significant increases in $PM_{2.5}$, particularly in the northern region during the dry season. Compared to monitoring station data, higher estimated $PM_{2.5}$ concentrations were found, especially from March to April. Contributing factors include open burning of agricultural residues and increased ambient temperatures. Despite limitations such as reliance on AOD data for $PM_{2.5}$ estimation and challenges with algorithms, this study provides valuable insights into $PM_{2.5}$ concentrations at a finer spatiotemporal scale for the community.

Zhang et al. utilized remote sensing data from OMI and TROPOMI satellites for NO_2 analysis across China from 2009 to 2021. Their results revealed pollution control measures with related factors including industrial activities, transportation, and COVID-19 lockdown. Interestingly, the analysis showed that economic growth since 2012 has not been correlated with NO_2 levels, likely due to the implementation of desulfurization and denitrification measures in key industries. In addition, the COVID-19 lockdown reveals a significant reduction in NO_2 in early 2020. However, this study did not consider meteorologic and soil emission factors, suggesting a need for further investigation.

Understanding air pollution in the face of changing climatic conditions and land use patterns is indispensable for planning effective strategies and measures. Dilawar et al. presented air pollution trends across Pakistan from 2004 to 2021, focusing on the impacts of land use and land cover change (LULCC) and climatic factors. The trend shows the most prominent increase in PM concentrations, with the highest levels observed in grasslands and barren lands. NO_2 and SO_2 concentrations, particularly in central and southern regions, also increased. The largest increases in PM, NO_2, and SO_2 were associated with the conversion of barren land to croplands, highlighting the significant impact of LULCC on air pollution dynamics. Precipitation has a positive influence on PM concentrations in most areas, whereas the O_3 concentration is influenced by both precipitation and mean temperature maximum (Tmax). This study underlines the complex interplay between air pollution, LULCC, and climate factors in Pakistan.

In terms of management in the government sector, Han et al. presented a positive impact of electronic (E)-government on air quality. Data from SEDAC and EChinagov were used to investigate the impact of E-government on $PM_{2.5}$ in 226 Chinese cities from 2012 to 2016. Their findings revealed a significantly constructive effect: a 1% increase in the E-government score corresponds to a 6.71 percent decrease in $PM_{2.5}$ concentration. The robustness of these results was confirmed using statistical techniques. The mechanism analysis suggested that E-government improvements lead to better air quality primarily by promoting innovation. The study recommends prioritizing E-government policy as a national strategy for air quality improvement. This can be achieved through utilizing digital technology for urban management, monitoring real-time environmental pollution, encouraging eco-friendly production methods, and promoting environmental awareness through education and public participation.

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