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Comprehensive Analysis of $PM_{2.5}$ Sources and Contributions in Seoul, South Korea: Insights from Intensive Ground-Based Monitoring

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Air pollution, particularly fine particulate matter ($PM_{2.5}$), presents serious public health challenges in urban areas like Seoul, South Korea. This study investigates the source apportionment of $PM_{2.5}$ concentrations in Seoul for the period from 2015 to 2022 using EPA Positive Matrix Factorization (PMF 5.0). Days were classified based on AirKorea criteria into good condition ($PM_{2.5}$ below 16 $\mu g/m^3$) and bad condition ($PM_{2.5}$ above 35 $\mu g/m^3$) categories. In Seoul, approximately 25% of the days fall under the good condition category, with $PM_{2.5}$ concentrations below 16 $\mu g/m^3$. On these good condition days, the lowest contributing source was aged sea salt/marine aerosol, while the highest contributors were organic aerosol/motor vehicles, secondary nitrate, and secondary sulfate. Conversely, about 22% of the days in Seoul were classified as bad condition days, with $PM_{2.5}$ concentrations above 35 $\mu g/m^3$. On these bad condition days, burning-related sources were the least significant contributors, and the most dominant sources were secondary nitrate, organic aerosol/motor vehicles, and secondary sulfate. This focused analysis of $PM_{2.5}$ pollution sources in Seoul highlights the critical role of motor vehicle emissions and secondary aerosols in both good and bad air quality periods. The findings provide valuable insights for air quality management and policy interventions aimed at reducing $PM_{2.5}$ levels and associated health risks in the city.

Key words: positive matrix factorization (PMF), Seoul, South Korea, $PM_{2.5}$, Source Apportionment