Investigating relationships between PM₁₀ and Climatic Parameters using PCA Model in the three largest urban areas in North Macedonia

This study applies Principal Component Analysis (PCA) to evaluate how meteorological factors influence PM10 pollution in Skopje, Kumanovo and Bitola from 2012 to 2020. PCA reduces data complexity while identifying key weather variables that impact air pollution levels.

Findings indicate that temperature and wind speed have the strongest negative correlation with PM10 concentrations, meaning lower temperatures and weaker winds are linked to higher pollution levels. These conditions limit pollutant dispersion, leading to worse air quality. Humidity and precipitation have mixed effects—humidity can promote both the removal and formation of pollutants, while precipitation aids in PM10 reduction through wet season, depending on intensity and duration.

The extracted principal components explain a significant portion of pollution variability, highlighting the dominant meteorological influences on air quality trends. By clarifying these relationships, PCA enhances the understanding of air pollution dynamics in the three largest urban areas in North Macedonia.

This analysis provides valuable insights for air quality management in North Macedonia. By identifying the key meteorological drivers of pollution, policymakers can develop more targeted and effective strategies to mitigate PM10 levels and improve public health.

Keywords: Principal Component Analysis, PM10, meteorological factors, North Macedonia.