

<https://doi.org/10.7250/CONNECT.2026.030>

INTEGRATING METEOROLOGY AND HEALTH MODELLING: APPLICATION OF GAM AND DLNM APPROACHES TO PM_{2.5} POLLUTION IN SOUTH AND SOUTHEAST ASIA

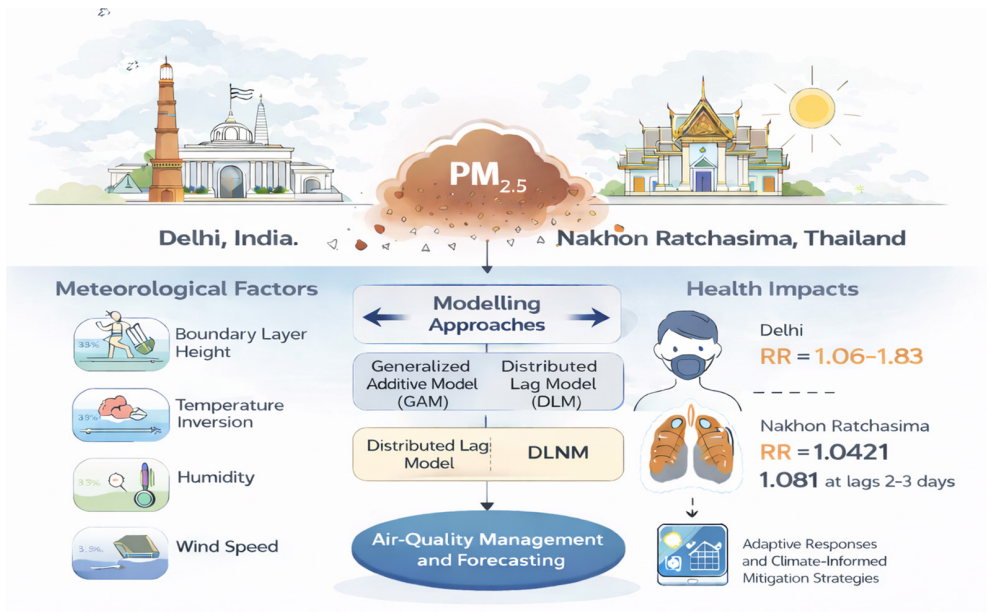
Abhishek DUTTA^{1*}, Wanida JINSART²

^{1,2} *Department of Environmental Science, Faculty of Science, Chulalongkorn University, 254 Phayathai Road, Pathumwan, Bangkok 10330, Thailand*

* *Corresponding author. Email address: abhishek.d@chula.ac.th*

Abstract – Meteorology has a decisive influence on the dispersion, transformation and health effects of air pollutants. In this research, the interaction between meteorological variability and air-pollution dynamics is examined by making a comparative study on two Asian cities, Delhi (India) and Nakhon Ratchasima (Thailand), that represent a different climatological regime. The analysis combines observational data and statistical modelling by means of Generalized Additive Models (GAM), Distributed Lag Models (DLM) and the Distributed Lag Nonlinear Models (DLNM) to quantify the short-term associations between the meteorological parameters, the particulate matter (PM_{2.5}) and respiratory morbidity. Results show that meteorological factors such as boundary layer height, temperature inversions, humidity, and wind speed are a critical factor in the regulation of pollutant accumulation and exposure levels. In Delhi, winter boundary layers are shallow and in stagnation condition which further magnifies the PM_{2.5} concentration and leads to acute health response (RR = 1.06–1.83). On the contrary, the more moderate pollutant persistence by monsoonal meteorology of Nakhon Ratchasima results in smaller but longer lagged health effects (RR = 1.042–1.081 at lags 2–3 days). The DLNM approach was the best model fit and the approach included both non-linear exposure-response and delayed health impacts. In addition to emphasizing the importance of integrating meteorological variability into health-related studies, the paper also highlights the dynamic nature of meteorological variability as a determinant of air-quality episodes and health outcomes. Meteorological forecasting can be an important addition to air-quality management and health early-warning systems, which may significantly improve adaptive responses. The results can provide an empirical basis for the development of climate-informed mitigation of air pollution throughout tropical and continental Asia.

Keywords – Air pollution; Distributed Lag Nonlinear Model (DLNM); meteorology; PM_{2.5}



Meteorology-PM_{2.5}-health interactions