Enhancing $PM_{2.5}$ Estimations Through Spatiotemporal Analysis of Land Use and Land Cover Changes in Greater Kuala Lumpur Area

Nurul Asyiqin Mohamad Fadzil

Tropical Map Research Group, Faculty of Built Environment & Surveying, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia, Malaysia

Author list (excluding presenting author)

Kasturi Devi Kanniah, Nurul Amalin Fatihah Kamarul Zaman

Abstract

$PM_{2.5}$, a crucial air quality indicator in Malaysia, is influenced by urban development and anthropogenic activities, especially in rapidly developing areas like Greater Kuala Lumpur (GKL). Malaysia faces significant air pollution issues due to heavy transportation, industrial activities, and transboundary pollution, leading to health and economic impacts. Land use and land cover (LULC) changes significantly impact air pollution, with urbanization and industrialization increasing pollution from vehicles and industries, while deforestation reduces vegetation that absorbs pollutants. Despite this, few studies have explored their effect on $PM_{2.5}$. Urban land use is a significant $PM_{2.5}$ source, and this study aims to analyze the spatiotemporal relationship of LULC changes with $PM_{2.5}$. Utilizing satellite data like Sentinel-2 alongside atmospheric and meteorological parameters and gas pollutants from Sentinel-5P, the Geographical Weighted Regression (GWR) model provides more accurate $PM_{2.5}$ estimations, considering spatial variability. The Sentinel-2 data have been processed using Random Forest technique to produce seven LULC classes (agriculture, bare land, built up, forest, grass, mangrove and water body) covering GKL for 2018 and 2022. This data with 86% accuracy will be integrated with atmospheric parameters such as aerosol optical depth from Himawari-8 and Multi-Angle Implementation of Atmospheric Correction, as well as meteorological variables (e.g., relative humidity, temperature, wind speed, wind direction, precipitation, planetary boundary layer height) from ECMWF Reanalysis version 5, and Modern-Era Retrospective Analysis version 2 (MERRA2), and gas pollutants (CO, O_3, NO_2, SO_2) from Sentinel-5P. By integrating multi-source data and advanced analytical techniques, this research uncovers how land use patterns influence $PM_{2.5}$ levels over time and space in GKL. Overall, this study offers a comprehensive understanding of urban $PM_{2.5}$ pollution dynamics, aiding policymakers in developing effective air quality improvement strategies.

Early Career Scientist

YES, I am an early career scientist.

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group