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Spatial Simulation of Air Pollutants Based on Regression Models Between the PM2.5 Concentrations and Urban Land Use: A Case Study of Nanjing

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China's rapid economic growth in the past 30 years has resulted in an unprecedented improvement in material wealth and people's living standard. The urban population proportion in China has increased from 18% in 1978 to 53% in 2014, and is projected to 65% (i.e., approximately one billion people will live in cities) by 2030. However, the haze phenomenon of Chinese cities intensified in recent years. Percentages for cities in China meeting quality standard of $PM_{2.5}$, PM_{10}, NO_2 and SO_2 in 2013 were only 4.1%, 14.9%, 39.2% and 86.5%, respectively. Air quality of cities has drawn worldwide concern.

Traditional monitoring is expensive, covering too limited area and too low spatial density to analyze spatiotemporal patterns of $PM_{2.5}$ pollution. Model simulation method is common now at home and abroad, including spatial interpolation model, remote sensing inversion method, atmospheric diffusion model and land use regression model (LUR). In most cases, data required in LUR model can be obtained by conventional air quality monitoring and GIS techniques without extra monitoring and data collection. The time and human cost is relatively low(D. Briggs et al., 2008). Studies have demonstrated that the $PM_{2.5}$ concentrations achieved by the model simulation and satellite remote sensing inversion of many regions in China, especially in the urban center area, were significantly higher than other countries around the world(Wei Huang et al., 2009). Therefore, This study tried to solve this problem taking the Nanjing city as the empirical object.

Firstly we got the land use status data and the $PM_{2.5}$ concentrations of eight national air quality monitoring sites located in the study area, establishing the spatial database by ArcGIS platform. Secondly, we use tools of spatial overlay, buffer and spatial statistical analysis to extract land use classification configuration data in certain range of each space monitoring data, establish the multivariate regression models between the $PM_{2.5}$ concentrations and various land use spatial factors. Furthermore, we took the equation obtained through above model back to the grid data of the study area and interpolated the $PM_{2.5}$ concentration for each grid point to simulate the spatial distribution of atmospheric concentrations thoughout the study area. Finally, we evaluated the spatial pattern of air pollutants in the study area.

This study derived a multiple linear regression model that explained the variance in $PM_{2.5}$ with the main predictors being industrial areas, green space areas, public services area, residential areas. Results showed a continuous distribution of high $PM_{2.5}$ concentrations in Nanjing of region into, rendering ring purple dumbbell-like distribution from Hexi -the main city area- Xianlin. Area with

high $PM_{2.5}$ concentrations has been significantly reduced by the implementation of urban land use planning of 2020, especially for the improvement of the main city area and Xianlin campus city, but air quality for the Hexi district surrounding the Olympic center has not been significantly improved, but deteriorated.
This study introduced land use regression model and analyzed the influence of urban planning made on the air quality. Our study will contribute to providing spatial information of city air quality for urban planning, to improving the scientificity of urban planning decisions on the city scale, and to promoting the perfection of urban land layout planning as well as the update of urban planning technical methods.
References
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Synopsis The haze phenomenon of Chinese cities intensified in recent years. Air quality of cities has drawn worldwide concern. This study derived a multiple linear regression model that explained the variance in PM2.5 with the main predictors being industrial areas, green space areas, public services area, residential areas.
Keyword Urban sprawl
Keyword Air pollution
Keyword Exposure assessment
PM2.5

Additional information