Spatial proximity of air pollution exposure for benzene and its potential risk in the vicinity of petrochemical industrial complex

○Wissawa Malakan [1)], Sarawut Thepanondh [1)], Akira Kondo [2)], Hikari Shimadera [2)]
[1)]Department of Sanitary Engineering, Faculty of Public Health, Mahidol University, Bangkok 10400, Thailand,
[2)]Graduate School of Engineering, Osaka University, Osaka 565-0871, Japan

【Introduction】With the development of economic growth and acceleration of industrialization under the eastern seaboard development program in Maptaphut, Thailand, benzene (C_6H_6) concentrations have become problems and complications. However, the measurements are limited to existing measuring stations in their specific area owing to the high costs. Thus, a GIS-based proximity model was applied to assess exposure to air pollution in areas with a low density and distribution of monitoring sites or no measurements and was analyzed using geostatistics and spatial techniques.

【Method】The data set for this work consisted of ambient monthly and yearly concentrations of benzene obtained from 16 ground-based stations in the Maptaphut industrial area. Their concentrations were predicted and spatially interpolated using three interpolation techniques: Inverse distance weighted (IDW), Ordinary kriging (OK), and Spline. The interpolation performance was evaluated by leave-one-out cross-validation to choose the most accurate interpolation method. Interpolated concentrations were divided into nine groups to explore each country's benzene standards, and add smoothness to the visualization of the air pollutant concentrations map according to the global air quality standards. Finally, a benzene concentration map was produced using the most suitable interpolation technique, considering the result from model performance testing. Exposure assessment was determined using a weighted average of the annual benzene concentrations and the population number in each village.

【Results and Discussion】The results showed that the OK interpolation method was the most suitable for spatial proximity in overall statistical results (e.g., RMSE = 2.13 μg/m^3) compared to other techniques (RMSE of IDW and Spline = 2.22 and 2.90 μg/m^3, respectively). As shown in Fig. 1, levels of ambient benzene concentrations were classified into nine classes following multi-scale databases for ambient benzene standards worldwide. Mapping analysis from OK indicated that 86.8% of villagers (without workers) of the population in the study area had exceeded the annual average ambient benzene concentrations (1.7 μg/m^3) of the Thai national ambient air quality standards (NAAQS), as shown in Fig. 2. It is concluded that benzene can impose a relatively high risk to the exposed populations, and thus it cannot regulate effectively now. Therefore, stricter countermeasures should be taken to further control ambient air levels of benzene for vehicle and petrochemical industrial emissions and develop NAAQS for benzene in industrial and residential areas based on international countries, especially in Maptaphut, Thailand. The findings suggested that GIS-based spatial interpolation algorithms could provide a fundamental tool to assess benzene pollution and its potential risk.

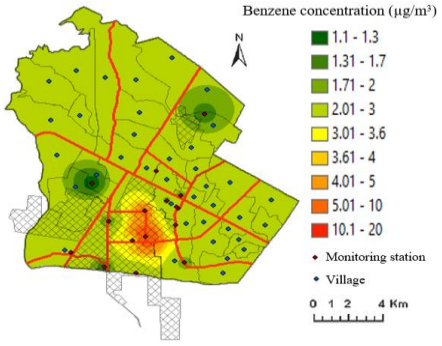

Fig. 1 Multi-scale concentration for C_6H_6 standards

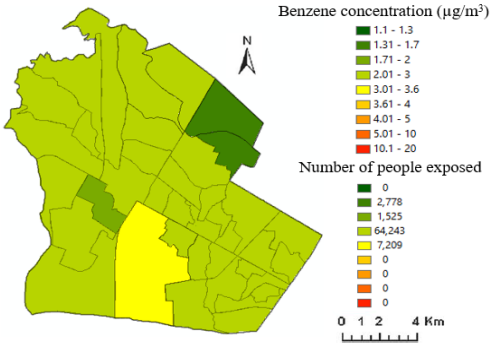

Fig. 2 Spatial distribution of the number of people exposed

【Acknowledgement】The authors greatly appreciate the support with emission and monitoring data from the Pollution Control Department (PCD) and the Industrial Estate Authority of Thailand (IEAT), the community boundaries from Maptaphut Municipality. This research project is supported by National Research Council of Thailand (NRCT) [No. NRCT5-RGJ63012-136]. This study was partially supported for publication by the China Medical Board (CMB), Center of Excellence on Environmental Health and Toxicology (EHT), Faculty of Public Health, Mahidol University, Thailand.