

Publication

A systematic review of land use regression models for volatile organic compounds

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Various aspects of land use regression (LUR) models for volatile organic compounds (VOCs) were systematically reviewed. Sixteen studies were identified published between 2002 and 2017. Of these, six were conducted in Canada, five in the USA, two in Spain, and one each in Germany, Italy, and Iran. They were developed for 14 different individual VOCs or groupings: benzene; toluene; ethylbenzene; m-xylene; p-xylene; (m/p)-xylene; o-xylene; total BTEX; 1,3-butadiene; formaldehyde; n-hexane; total hydrocarbons; styrene; and acrolein. The models were based on measurements ranging from 22 sites in El Paso (USA) to 179 sites in Tehran (Iran). Only four studies in Rome (Italy), Sabadell (Spain), Tehran, and Windsor (Canada) met the Cocheo's criterion of having at least one passive sampler per 3.4 km² of study area. The range of R² values across all models was from 0.26 for 1,3-butadiene in Dallas (USA) to 0.93 for benzene in El Paso. The average R² values among two or more studies of the same VOCs were as follows: benzene (0.70); toluene (0.60); ethylbenzene (0.66); (m/p)-xylene (0.65); o-xylene (0.61); total BTEX (0.66); 1,3-butadiene (0.46); and formaldehyde (0.56). The common spatial predictors of studied VOC concentrations were dominated by traffic-related variables, but they also included proximity to ports in the USA, number of chimneys in Canada, altitude in Spain, northern latitudes in Italy, and proximity to sewage treatment plants and to gas filling stores in Iran. For the traffic-related variables, the review suggests that large buffers, up to 5,000 m, should be considered in large cities. Although most studies reported logical directions of association for predictors, some reported inconsistent results. Some studies included log transformed predictors while others divided one variable by another. Only six studies provided the p-values of predictors. Future work may incorporate chemistry-transport models, satellite observations, meteorological variables, particularly temperature, consider specific sources of aromatic vs aliphatic compounds, or may develop hybrid models. Currently, only one national model has been developed for Canada, and there are no global LUR models for VOCs. Overall, studies from outside North America and Europe are critically needed to describe the wide range of exposures experienced by different populations.

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