Land use regression as method to model air pollution. Previous results for Gothenburg/Sweden

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ABSTRACT

INTRODUCTION**:** Air pollution is a concern to public health and requires actions to reduce its levels, mainly in urban areas. As consequence of this concern several methods to assess spatial variations in air pollution have been developed.

Land use regression (LUR) modeling has emerged as a promising approach because it estimates air pollution variations at specifically areas, based on characteristics related *a priori* to concentration and dispersion of pollutants. It adopts measurements of pollution using samplers as dependent variable and land use, traffic intensity and geographic characteristics in buffers as predictor variables of measured concentrations.

OBJECTIVES**:** The main objective of this study is to develop a LUR model to predict the concentration of NO_2 in a Swedish medium-sized city.

METHODS**:** This research was conducted in Gothenburg, west coast of Sweden, based on measurements of 25 passive samplers in the period comprehending 7th–20th May/2001 from GÖTE Campaign.

The cartographic database with elevation, land use and roads were obtained on Lantmäteriets geodata. The land use data, by allotment, had 09 classifications of use, by type of use (urban buildings low and high, industrial, arable, forests and water), building patterns (low, high, recreational), type of use (open, rural or urban areas. The roads database contained information about the type of road (highways, roads, cycling route, shipping lane etc.).

All independent variables of land use, demographic and roads were estimated by geographic information system (GIS) in buffers of 50 m, 100 m, 150 m, 250 m and 500 m-radiuses around sampler's sites.

The association between every independent variables and NO_2 was tested through univariate linear regression (α=5%) and the variables with p-value ≤0.2 in univariate analysis were selected to multivariate analysis. The collinearity of the variables was calculated by Pearson correlation test and if they were collinear the variable most robust remained (lower p-value).
The final model was obtained by multivariate linear regression, using bootstrap method. The multivariate analysis was redone excluding variables without statistical significance. This step was repeated until obtain the variables with p-value ≤0.05.
Finally, the final formula obtained by multivariate regression was applied in a map of regular points of Gothenburg to estimate NO_2 in each point through GIS techniques. The NO_2 map (in µg/m³) was elaborated using Kriging interpolation.
RESULTS**:** The average of the measurements was 23.5 µg/m³ (± 6.8 µg/m³). For each location we obtained 116 independent variables. Seven variables remained in the multivariate regression model. The final model explained 71.8% of the NO_2 variance with presence of elevation ($p < 0.001$), high buildings within 150 m ($p < 0.001$), recreational buildings within 500 m ($p = 0.015$) and highway > 7 m within 100 m ($p = 0.035$) from the sampler sites as predictor variables. The average of NO_2 predicted by the LUR model was 24.4 µg/m³ (DP = 39.8 µg/m³) and the application of Kriging in these points generated the map of the concentration of this pollutant in Gothenburg (Supplementary Figure 1).
The correlation between measured and modeled levels of NO_2 was high with $r = 0.847$ ($p < 0.001$).
CONCLUSIONS**:** The LUR model performed in this study included 04 independent variables (elevation, high buildings within 150 m, recreational buildings within 500 m and highways within 100 m) and it explained almost 72% of NO_2 variability in Gothenburg. The final model can be applied to access retrospective exposure to air pollution with reasonable accuracy (e.g. residence of subjects) in epidemiologic studies. However, the quality of cartographic data may influence the reliability of the model. Furthermore it is important the inclusion of traffic counts, meteorological and demographic data to improve the modeling.

KEYWORDS: Air pollution, Nitrogen Dioxide, Exposure modeling, Geographic information system.