

Application of a land - use regression model for calculation of the spatial pattern of annual NO_x air concentrations at national scale: a case study for Poland

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Abstract

Land Use Regression (LUR) models are applied to derive spatial information on NO_x air concentration for Poland, with 1km x 1km grid resolution for years 2005 and 2008. The LUR results are cross validated with the leave one out approach and compared with the output of the FRAME atmospheric transport model. The LUR and FRAME modelled spatial patterns of NO_x concentrations are similar, with the grid-to-grid correlation coefficient at 0.89 in 2005 and 0.84 for 2008. The LUR approach showed higher concentrations than FRAME, with a mean grid-to-grid difference of 0.9 and 2.2 µg for year 2005 and 2008. Missing emission sources may be the main reason for the better performance of the LUR models, compared to FRAME. Regression model can response to the gaps in emission inventory by adjusting the regression coefficients, while physical models show lower air concentrations resulting in larger errors. It should also be noticed that the cross validation approach, used for evaluation of the LUR models, and direct model-measurement comparison applied for error assessment in case of FRAME, are not directly comparable, with the latter being more demanding.

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1. Introduction

Spatial data on air concentrations of various atmospheric pollutants, including NO_x, SO₂, PM₁₀ and VOC, is important for the protection of human health and of natural or seminatural ecosystems. Spatial patterns of air pollutant concentrations at regional scale can be derived by various methods, with complex atmospheric transport models (ATM) being the most widely used [1]. ATMs require a significant amount of input data and are computationally demanding, especially if high spatial resolution is needed over a

large study area. Simple and faster methods, supported by GIS, including land use regression models (LUR), might therefore be efficient and useful in calculating spatial information on air pollution concentrations[2]. LUR models are often applied to provide information on atmospheric pollutant concentrations over the cities[3]. However, several authors used the LUR in more regional studies, e.g. over the United Kingdom[4], or Europe[5].

In this paper, LUR models are applied to derive spatial information on NO_x air concentration for Poland, with 1km x 1km grid resolution for years 2005 (58 measuring sites) and 2008 (104). The LUR results are cross validated with the leave one out approach and compared with the output of the Fine Resolution Atmospheric Multi-pollutant Exchange ATM (FRAME).

2. Data and methods

2.1. NO_x air concentration measurements

For year 2005, measurements from 58 sites were used for spatial interpolation of the annual average NO_x air concentration (Fig. 1), for cross-validation of the interpolation results and evaluation of the FRAME model. For year 2008, data from 104 sites were available. All sites were tested for data completeness, and the threshold of acceptance was set at >90%. The spatial distribution of the measuring sites for both selected years had a strong tendency for clustering. This can be described with the average nearest neighbor Z score statistics, which are equal to -2.0 and -4.8 for year 2005 and 2008, respectively. The Z score statistics are statistically significant with p-value <0.05.

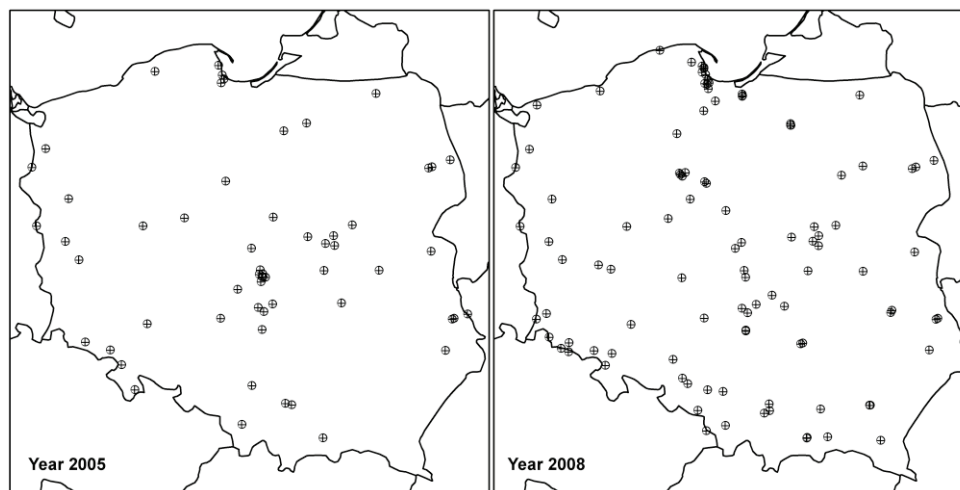


Fig. 1 NO_x air concentration measuring sites used for LUR spatial interpolation, cross-validation and evaluation of the FRAME model.

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