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# A Web-based Uncertainty-enabled Information System for Urban Air Quality Assessment

Lydia E. Gerharz, Benjamin Proß, Christoph Stasch, and Edzer Pebesma
Institute for Geoinformatics, University of Münster, Germany (lydia.gerharz@uni-muenster.de, +49 (0) 251 83 39763)

Air quality information on an urban level is necessary to identify individual hazards and exposure levels that can cause negative health effects. Modelling air quality using emission dispersion models enables the estimation of the concentration at unsampled locations if continuous measurements are not available at a high spatial density. Although such models and measurement data are often publicly available, the application of those models currently requires considerable expert knowledge and computing environments especially when uncertainties of resulting predictions need to be assessed. As modelling of air quality information on an urban level introduces a number of simplifications and errors leading to uncertainties in the model results these need to be quantified and communicated to the users. The 7th FP project UncertWeb generalizes the model web concept as promoted by the Group on earth observation (GEO) to an uncertainty enabled model web where web services can process and communicate uncertain model inputs and outputs. Based on approaches currently developed in the UncertWeb project we present a prototypical system using a pre-configured web service chain for estimating and presenting PM10 concentration on an urban level. The system is able to model PM10 concentrations with uncertainties for point locations, e.g. tracked via GPS. Currently, data can be retrieved by non-expert users for the urban area of Münster, Germany, with data from July 2008 to June 2010.
The PM10 concentration is estimated using a two-stage approach: background concentration fields are interpolated using rural and urban background measurements of PM10 over Germany. These observations origin from the German Federal Environmental Agency (Umweltbundesamt – UBA) and are provided via a Sensor Observation Service (SOS) interface. The interpolation is performed by the INTAMAP interpolation service which is implemented as an OGC Web Processing Service (WPS), and uses for our case Ordinary Kriging (OK) for interpolation. The additional PM10 concentrations, which are produced by local urban emissions like traffic are modelled using the Lagrangian dispersion model AUSTAL2000. The AUSTAL2000 model is also accessed through a Web Processing Service. Input data for AUSTAL2000 like emissions, meteorology and land use are currently local sources included in the WPS interface to simplify execution of the model.
Uncertainties are quantified in the inputs and the modelling processes. Input uncertainties for the UBA observations are currently not known. Input uncertainties for the local AUSTAL2000 model are quantified in the emissions using sample measurements and in the meteorology using a comparison measurement and expert judgment. AUSTAL2000 is run for a small number of ensemble iterations (due to the model run time), to estimate the uncertainty propagation from the input to the model output. Model uncertainty for AUSTAL2000 is partially provided as the statistical uncertainty depending on the number of particles used by the software. Interpolation error of the background concentration is given by the Kriging variance. Uncertain background and urban concentration layers are combined in an overlay service using Monte Carlo simulation which provides an uncertainty distribution of the total concentration outputs. The resolution of the final layer is 250 x 250 $m^2$ cell size over the urban area of Münster as provided by the AUSTAL2000 model. A client application enables the user to easily execute the workflow and visualise the uncertain results, e.g. by examining confidence intervals.
The presented approach enables non-expert users to assess their exposure to air pollution automatically through a web based system by explicitly communicating the uncertainty of the results. This can improve decision making based on assessment at the level of individuals.