Geophysical Research Abstracts
Vol. 17, EGU2015-8938, 2015
EGU General Assembly 2015

Evaluating the effect of human activity patterns on air pollution exposure using an integrated field-based and agent-based modelling framework

Oliver Schmitz (1), Rob M. J. Beelen (2), Merijn P. de Bakker (1), and Derek Karssenberg (1)

(1) Department of Physical Geography, Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands (o.schmitz@uu.nl), (2) Institute for Risk Assessment Sciences (IRAS), Utrecht University, Utrecht, The Netherlands

Constructing spatio-temporal numerical models to support risk assessment, such as assessing the exposure of humans to air pollution, often requires the integration of field-based and agent-based modelling approaches. Continuous environmental variables such as air pollution are best represented using the field-based approach which considers phenomena as continuous fields having attribute values at all locations. When calculating human exposure to such pollutants it is, however, preferable to consider the population as a set of individuals each with a particular activity pattern. This would allow to account for the spatio-temporal variation in a pollutant along the space-time paths travelled by individuals, determined, for example, by home and work locations, road network, and travel times. Modelling this activity pattern requires an agent-based or individual based modelling approach. In general, field- and agent-based models are constructed with the help of separate software tools, while both approaches should play together in an interacting way and preferably should be combined into one modelling framework, which would allow for efficient and effective implementation of models by domain specialists.

To overcome this lack in integrated modelling frameworks, we aim at the development of concepts and software for an integrated field-based and agent-based modelling framework. Concepts merging field- and agent-based modelling were implemented by extending PCRaster (http://www.pcraster.eu), a field-based modelling library implemented in C++, with components for 1) representation of discrete, mobile, agents, 2) spatial networks and algorithms by integrating the NetworkX library (http://networkx.github.io), allowing therefore to calculate e.g. shortest routes or total transport costs between locations, and 3) functions for field-network interactions, allowing to assign field-based attribute values to networks (i.e. as edge weights), such as aggregated or averaged concentration values.

We demonstrate the approach by using six land use regression (LUR) models developed in the ESCAPE (European Study of Cohorts for Air Pollution Effects) project. These models calculate several air pollutants (e.g. NO_2, NO_x, $PM_{2.5}$) for the entire Netherlands at a high (5 m) resolution. Using these air pollution maps, we compare exposure of individuals calculated at their x, y location of their home, their work place, and aggregated over the close surroundings of these locations. In addition, total exposure is accumulated over daily activity patterns, summing exposure at home, at the work place, and while travelling between home and workplace, by routing individuals over the Dutch road network, using the shortest route. Finally, we illustrate how routes can be calculated with the minimum total exposure (instead of shortest distance).