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A Spatially Distributed Leaching Model to assess pesticide leaching for exposure assessment at the European level

Maarten Braakhekke[1], **Pavan Cornelissen**[1], Louise Wipfler[1], Aaldrik Tiktak[2], Anton Poot[3], Bernhard Jene[4], Gerco Hoogeweg[5], Abdul Ghafoor[6], Judith Klein[7], Michael Stemmer[8], Amy Ritter[9], Robin Sur[10], Gregor Spickermann[11], Gerard Heuvelink[12], Gregory Hughes[13], Stephan Marahrens[14], Stefan Reichenberger[15], Nicoleta Suciu[16], and Michelle Morris[17]

[1]Wageningen University & Research, Wageningen, The Netherlands
[2]PBL, Den Haag, The Netherlands
[3]CTGB, Ede, The Netherlands
[4]BASF SE, Limburgerhof, Germany
[5]Corteva, United States
[6]KEMI, Sundbyberg, Sweden
[7]Fraunhofer IME, Schmallenberg, Germany
[8]AGES, Vienna, Austria
[9]Waterborne Environmental, Leesburg, VA, USA
[10]Bayer AG, Monheim, Germany
[11]Adama, Baden-Württemberg, Germany
[12]ISRIC – World Soil Information, Wageningen, The Netherlands
[13]Geospatial Analytics Ltd, United Kingdom
[14]Umweltbundesamt, Dessau-Roßlau, Germany
[15]Knoell France SAS, Lyon, France
[16]Università Cattolica del Sacro Cuore, Piacenza, Italy
[17]Health & Safety Executive Chemicals Regulation Division

Assessment of the leaching potential of pesticides and their metabolites is an important part of the authorization procedure for pesticides in Europe. To protect groundwater quality,

it must be demonstrated that concentrations of active substances in the upper groundwater do not exceed 0.1 µg/L before a pesticide can be approved for use. For the purpose of exposure assessment, this concentration limit is imposed on the water leaching downward at 1 m depth in the soil profile. For a given substance and application pattern, this leaching concentration can vary in space by several orders of magnitude, due to variation in site conditions, most importantly soil properties and climate. Spatially distributed leaching modelling (SDLM) is a methodology for exposure assessment over large spatial extents, dealing with this spatial variability in a comprehensive way. It involves performing simulations for many parametrizations representative for a spatial region and can be used to generate maps or calculate spatio-temporal percentiles of leaching concentrations. While such tools are already used in exposure assessment at national level in several EU member states, no generally accepted SDLM tool is available at the European level. In 2020, a working group of Society of Environmental Toxicology and Chemistry (SETAC) was formed with the purpose to develop a harmonized framework for SDLM across Europe (EU27 + UK).

A first version of an SDLM—referred to as GeoPEARL-EU—was built around the pesticide leaching model PEARL, a field-scale model of pesticide fate in the soil-plant system. PEARL mechanistically simulates pesticide behaviour in a 1D soil column based on explicit descriptions of transport in the liquid and gas phases, sorption to the solid phase, degradation, volatilisation, and plant-uptake. Soil moisture content and fluxes are provided by the SWAP hydrological model. PEARL is used in regulatory exposure assessment for groundwater and soil. Furthermore, a spatially distributed tool based on PEARL (GeoPEARL) is used for exposure assessment in the Netherlands.

To apply PEARL to Europe, pan-European gridded datasets were collected for several variables, including soil texture, pH, soil organic carbon, weather, irrigation patterns and crop area. These datasets were used to develop a set of parametrizations covering the variability of climate and soil conditions in Europe. To this end, all 1x1 km grid cells for the EU27 + UK were partitioned into approximately 10,000 clusters using *k*-means clustering, based on several soil- and climate-related variables relevant for leaching vulnerability. Subsequently, a representative grid cell was selected for each cluster, which was used to obtain the data required to parameterize PEARL from the spatial data sets. Pedotransfer functions were used to derive soil hydraulic parameters.

We will present results from GeoPEARL-EU for several test cases with specific attention to the effect of the spatial aggregation approach on the model predictions. Moreover, we discuss how the tool could be used in the tiered approach of the regulatory exposure assessment for groundwater in the EU.

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