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Assessment of the spatial distribution of pesticide soil residues as a mean to constrain and upscale pesticide leaching predictions

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Studies of pesticide fate under field condition usually concentrate on the time period directly following application [1] as the beginning of the falling limb of soil pesticide concentration is the most important to estimate in-situ degradation parameters necessary for prediction. Although attention has turned recently to residual pesticides such as atrazine, whose widespread persistence in soils and groundwater still raises serious issues years after its use was abandoned [2], scientific focus was rather placed on assessing pesticide bioavailability and mobility. The historical information still contained by the pesticide residues and its potential usefulness for constraining pesticide fate predictions and for guiding future management practices is however seldom investigated.
We analyzed a dataset comprising measurements of pesticide soil residues in hundred and fifty soil samples taken on thirty contiguous fields five years after the last atrazine application. Two fields were sampled densely (twenty-five sample per field) while the other fields had between one and three observation points each. The soil was predominantly a loamy sand, with some sandy loam areas. The influence of soil type and farming practice were still clearly recognizable above background noise. Application frequencies derived from crop rotation data and soil type were significant explanatory variables of the atrazine soil concentration, while the organic matter content (Corg) was not. This can be explained on the one hand by the transient behaviour of Corg, so that the snap-shot observations available were not necessarily representative of the average organic matter content, and on the other hand by dominating transport processes over sorption processes, as proposed in [3] and supported by the lower atrazine concentrations measured in the sandy soils compared to the loamy soils. The measured soil residue concentrations were higher than predicted by a lumped first order degradation rate and reasonable half-life values, indicating that the degradation of persistent residues either takes place at a lower rate or obeys a different decay law [4]. Lastly, atrazine desethyl correlated positively and seemingly linearly with atrazine. Such a linear relationship can be derived from the convection-dispersion equation under certain simplifying assumptions, with a slope equal to the product of three terms: the molar fraction of atrazine transformed to atrazine desethyl, the ratio of the molar masses and the ratio of the half-lives.
In conclusion, a soil survey can help to verify the relative importance of pesticide transport and pesticide sorption and to identify areas with different soil hydraulic behaviour and application frequencies. This qualitative information can then flow into the upscaling of a calibrated one dimensional physically-based leaching model by assigning to the different soil and application frequency classes the corresponding predicted leaching values. Quantitatively, estimation of the compound's half-life from the soil residue concentration is however seriously limited for historical pesticides such as atrazine by the inherent noise in the data and the departure of soil residue dissipation from the traditional first order kinetic model.

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