Geophysical Research Abstracts
Vol. 13, EGU2011-3501, 2011
EGU General Assembly 2011

Impact of field scale variability of soil organic carbon in pesticide leaching modelling (case study of the Molignée catchment, Belgium)

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Current pesticide registration practices in Europe aim, amongst others, to limit pesticide leaching risks to groundwater and hence to reduce the contamination pressure on groundwater bodies (COM372final, 2006). Pesticide leaching risk can be assessed by means of PEC (Predicted Environmental Concentration) models. Yet, local and regional scale PEC models are known to be very sensitive to the parameterization of soil organic carbon (SOC). The main objective of this study was to evaluate different parameterization schemes of SOC for assessing PEC by means of the MetaPEARL model (Tiktak et al., 2009). In particular, the impact of the field scale variability of SOC on PEC was assessed.

First, we generated a field scale SOC data base for three different cultivated fields in Belgium. Within each field, 360 geo-referenced surface horizon (0-30 cm) soil samples were taken using a «random stratified » sampling design. The random stratification was based on secondary information about the soil topography and soil electrical conductivity as assessed by means of a preliminary EM38 campaign. Each soil sample was analysed for SOC content using two different techniques: the Walkley and Black technique (Walkley and Black, 1934), and the dry combustion technique. Subsequently, we preprocessed the field scale SOC data base in three different ways. Adopting a deterministic approach, we calculated the mean of SOC for each field which subsequently was used for a PEC calculation. Using a non-georeferenced stochastic approach, we calculated a non-parametric distribution of field scale SOC which subsequently was processed for PEC calculation using a classical Monte Carlo method. Using a georeferenced stochastic approach, we interpolated the field scale SOC measurements by means of BMEkriging and generated SOC maps which subsequently was linked to the Metapearl model.

We observed that SOC spatial variability can be significant at the field scale, with a variation coefficient ranging from 5 to 18% on the three studied plots. The variability can be explained by topography, with significant higher values of SOC content on colluvial positions. Moreover, this spatial variability and its patterns can be quite well described by soil electrical conductivity measurements. When comparing this spatial variability at field scale with variability at landscape and regional scale (based on the Belgium regional data base CARBOSOL), we observed a linear and growing trend of SOC with scales. This growth of the SOC variability coefficient is less important when considering soil types one by one.

As far as the PEC calculation is concerned, it is shown that the stochastic approaches (geo-referenced and non-georeferenced) add significant value to the PEC calculation and the commonly used deterministic approach can induce a significant underestimation of the field scale mean calculated PEC. This can be explained by the strong non-linearity of the PEC model for SOC. Moreover, given the linear and growing trend of the CV of SOC with a larger scale, we also highlighted the importance of characterising SOC variability at short distance (field scale) for regional scale PEC assessments.