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Development and Evaluation of a Cellular Automata Model for Simulating Tillage Erosion in the Presence of Obstacles

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The process of tillage translocation is well studied and can be described adequately by different existing models. Nevertheless, in complex environments such as olive orchards, characterized by numerous obstacles, application of such conventional tillage erosion models is not straightforward. However, these obstacles have important effects on the spatial pattern of soil redistribution and on resulting soil properties. In this kind of environment, cellular automata could provide a valuable alternative. This study aims at developing a cellular automata model for tillage translocation (CATT) that can take into account such obstacles and at exploring its possibilities and limitations.
A simple model was developed, which main parameters are tillage direction, speed and depth.
Firstly, the model´s outcome was tested against existing 137Cs inventories for a study site in the Belgian loam belt. The observed spatial soil redistribution patterns could be adequately represented by the CATT model. Secondly, a sensitivity analysis was performed to explore the effect of input uncertainty on several selected model outputs. The variance-based extended FAST method was used to determine first and total order sensitivity indices. Tillage depth was identified as the input parameter that determined most of the output variance, followed respectively by tillage direction and speed. The difference between the total and first-order sensitivity indices, between 0.8 and 2, indicated that, in spite of the simple model structure, the model behaves non-linearly with respect to some of the model output variables. Higher-order interactions were especially important for determining the proportion of eroding and deposition cells.
Finally, simulations were performed to analyse the model behaviour in complex landscapes, applying it to a field with protruding obstacles (e.g. olive trees). The model adequately represented some morphological features observed in the olive orchards, such as mounds around the olive trees and soil banks along terraces or field lines. The results show that cellular automata are an appropriate tool to describe long-term tillage soil redistribution. Future improvements of the model will focus on the consideration of the spatial variability of soil properties and on including water erosion.