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Soil maps as data input for soil erosion models: errors related to map scales

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Soil erosion rates depend in many ways on soil and soil surface characteristics which vary in space and in time. To account for spatial variations of soil features, most distributed soil erosion models require data input derived from soil maps. Ideally, the level of spatial detail contained in the applied soil map should correspond to the objective of the modelling study. However, often the model user has only one soil map available which is then applied without questioning its suitability. The present study seeks to determine in how far soil map scale can be a source of error in erosion model output.

The study was conducted on two different spatial scales, with for each of them a convenient soil erosion model: a) the catchment scale using the physically-based Limbourg Soil Erosion Model (LISEM), and b) the regional scale using the decision-tree expert model MESALES. The suitability of the applied soil map was evaluated with respect to an imaginary though realistic study objective for both models: the definition of erosion control measures at strategic locations at the catchment scale; the identification of target areas for the definition of control measures strategies at the regional scale.

Two catchments were selected to test the sensitivity of LISEM to the spatial detail contained in soil maps: one catchment with relatively little contrast in soil texture, dominated by loess-derived soil (south of the Alsace), and one catchment with strongly contrasted soils at the limit between the Alsatian piedmont and the loess-covered hills of the Kochersberg. LISEM was run for both catchments using different soil maps ranging in scale from 1/25 000 to 1/100 000 to derive soil related input parameters. The comparison of the output differences was used to quantify the map scale impact on the quality of the model output. The sensitivity of MESALES was tested on the Haut-Rhin county for which two soil maps are available for comparison: 1/50 000 and 1/100 000. The order of resulting target areas (communes) was compared to evaluate the error induced by using the coarser soil data at 1/100 000.

Results shows that both models are sensitive to the soil map scale used for model data input. A low sensitivity was found for the catchment with relatively homogeneous soil textures and the use of 1/100 000 soil maps seems allowed. The results for the catchment with strong soil texture variations showed significant differences depending on soil map scale on 75% of the catchment area. Here, the use of 1/100 000 soil map will indeed lead to wrong erosion diagnostics and will hamper the definition of a sound erosion control strategy. The regional scale model MESALES proved to be very sensitive to soil information. The two soil related model parameters (crusting sensitivity, and soil erodibility) reacted very often in the same direction therewith amplifying the change in the final erosion hazard class. The 1/100 000 soil map yielded different results on 40% of the sloping area compared to the 1/50 000 map. Significant differences in the order of target areas were found as well.

The present study shows that the degree of sensitivity of the model output to soil map scale is rather variable and depends partly on the spatial variability of soil texture within the study area. Soil (textural) diversity needs to be accounted for to assure a fruitful use of soil erosion models. In some situations this might imply that additional soil data need to be collected in the field to refine the available soil map.