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Predicting spatial patterns of catchment erosion and estimation of erosion risk using simple modeling approach applicable in data-scarce conditions

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Addressing several issues like sedimentation, water quality, conservation measures, environmental and geomorphologic studies etc, needs the prediction of erosion patterns and source areas within the catchment. Several modeling alternatives exist, all with certain potential and limitations. The physically-based distributed erosion models are very much data-hungry. It makes them of limited use in data-poor developing world context where the erosion problem is severer. In addition, owing to the problems like, large spatial and temporal variability of soil erosion phenomena and the uncertainty associated with the input parameter it is clear that accurate erosion prediction is still difficult and the problem will not be solved by constructing even more complete and complex models. USLE and its derivatives is the simple but still most widely used erosion model. Its adequate capability for predicting gross erosion has been proved in innumerable cases. However, the prediction capability has, so far, been assessed based on their ability to correctly predict lumped hydrograph and sedigraph at watershed outlet.

The aim of this work is, at first, to investigate the reliability of predicting spatial patterns of catchment erosion using the simple USLE-based erosion model when fed with better hydrology using a physically based spatially distributed rainfall-runoff model (WaSiM-ETH). A small agricultural catchment (Ganspoel), located in central Belgium has been chosen for the investigation. The runoff and sediment yield at catchment outlet and the spatially distributed gross erosion

within the catchment for the seven selected events with different characteristics (http://www.kuleuven.be/geography/frg/data/index.htm) have been simulated. Several results, mainly from, SCS CN and WaSiM-ETH for runoff-component computation; rainfall alone, runoff alone and rainfall-runoff combined for erosivity factors computation; single flow, multiple flow and flux decomposition algorithms for topographical factors computation and three different algorithms for sediment delivery ratio (SDR) have been compared. Besides the predictions at outlet, the simulated spatially distributed erosion patterns and the source areas have agreed reasonably well with the observed ones and also with the results from another physically-based more complex and data-intensive erosion model (MEFIDIS).

Secondly, this acceptable capabilities of predicting spatial patterns of catchment erosion is extended further to devise an approach for determining spatially and temporally (monthly) distributed erosion risk in terms of probabilities. The spatial and temporal distribution of rainfall is estimated from radar data, rain gauge data and rainfall simulations with NiedSim (IWS- Uni. Stuttgart), runoff probabilities are estimated from long-term (16 years) simulation with WaSiM-ETH, crop cover distribution is obtained from series of MODIS NDVI and the soil and topographical features, obtained from soil map and DEM, are considered to be temporally constant. The temporal variability hence captured through the intersection of the maps of Hydrologically Sensitive Areas, HSAs (from runoff simulations) and Erosion Susceptible Areas, ESAs (from USLE factors) yields dynamics of the erosion risk areas categorized as Critical Source Areas (CSAs). The dynamic behavior in hydrological sensitivity and erosion risk, estimated in such a simple approach, potentially lessens landuse restrictions on landowners as the arable and agricultural fields could be prioritized for management practices by their degree of hydrological and erosive sensitivity.