Geophysical Research Abstracts
Vol. 21, EGU2019-6520, 2019
EGU General Assembly 2019

Linear flow paths in soil erosion modelling - Results of a case study in Eastern Austria

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In digital elevation models (DEM) that are based on airborne laser scanning data, linear features influencing runoff often remain undetected and therefore need to be identified manually with field inspection. Within this case study, a methodology was developed, that combines outdoor mapping of linear features and sewage networks with GIS tools for indoor post-processing. A clear distinction is made between linear features, such as open ditches and troughs that are too small to be detected at the given DEM resolution on the one hand, and sewage networks that are composed of in- and outlets (e.g. culverts) on the other hand. The procedure includes the lowering of raster cells along the linear features (=”burning”) directly into the DEM, while incorporating the sewage network into flow direction and flow accumulation layers. Sewage inlets serve as sinks for the surrounding raster cells and their flow accumulation, whereas sewage outlets represent sources from which the flow accumulation re-emerges. The developed procedure was implemented in a pilot area of about 25 km^2 to assess the effect of field inspection on runoff and soil erosion. Two basic approaches were undertaken, in each case comparing the results of using the conditioned (=DEM including mapped features after field inspection) and unconditioned (=DEM without field inspection) input data.

Changes in the topology and composition of the drainage network (flow accumulation > 5000 m^2) included changes in individual catchment areas. This consisted either in shifting of the catchment area itself or the pour point into the river network, and changing land use or geomorphic parameters (flow length distribution, drainage density) within the catchments. The identification of certain areas experiencing virtually no changes might allow the reduction of the mapping effort without significantly reducing the quality of the output.

A modified version of the MMF (Morgan-Morgan-Finney) erosion model was used with both versions of the input data. Modifications were concerning the way surface runoff and sediment routing along the mapped features is considered. Also calculations of flow lengths and estimated flow times have been added to the model to provide direct estimations of the influence of the mapped features on runoff and sediment transport within the study area.

In most of the inspected sub-catchments, a reduction of the longest flow length by some 20% can be observed, as well as an increase in the share of shorter flow lengths. Also, the median catchment area of sub-catchments of a certain river reach show a decrease of about 30% - this is actually contrary to our expectations, which assumed the linear features to have the tendency to link sub-catchments together, leading to increased sub-catchment areas.

Further work will now focus on the causes for the occurrence of the man-made features (specific land use in the catchment, linear objects like roads) as well as possibilities of transferring these results from the study area to other catchments.