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Simulation of surface runoff and soil erosion in small watersheds in Northern Ethiopia – application and verification of the SWAT model

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Degradation of arable land is a major issue in the Ethiopian Highlands. Deforestation leads to ongoing soil erosion during the rainy season and thus the hydrology of a watershed changes as high erosion rates and dense gully networks cause a direct drainage of rain water usable for crop production. The application of hydrological models can provide a link between local watershed characteristics and the generation of runoff and sediment loss in the watershed. Furthermore, they enable the impact assessment of soil conservation measures on these processes.
Objective of this study was to apply the SWAT model to two small agricultural used watersheds in Northern Ethiopia to assess the impact of soil conservation measures on surface runoff and soil erosion. The watersheds are two small sub-watersheds of the Gumara-Maksegnit watershed. They are located close to each other with an area of 31 and 41 ha, respectively. 80% of the area is steeper than 10%. In one watershed soil conservation measures (stone bunds and trenches) were implemented in 2011 whereas the other watershed is untreated. Mean annual preciptation is about 1200 mm from which 90% rains between June and September. Soil textures range from clay loam to clay. Land use of both watersheds is similar with appr. 70% of agricultural land and 30% of grassland and open shrubland. Main crops grown are sorghum, teff, faba bean, barley, wheat and chickpea.
Since 2011, an automatic weather station as well as weirs are installed in both watersheds to measure runoff. For each erosive event manual samples are taken in addition to a turbidity sensor to monitor sediment yield. Soil and land survey was carried out to derive a soil map and a digital elevation model. A site specific crop rotation was assumed.
The SWAT model calibration was performed with measured data from 2012. The results for runoff as well as sediment yield show acceptable to satisfying performance. The Nash-Sutcliffe efficiency for surface runoff is 0.54 for the untreated and 0.24 for the treated watershed.