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Simulation of hydrological impact of dumped sediment structures in the artificial Chicken Creek catchment, Germany

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Revealing the hydrological impact of sediment structures promises a better understanding of the influence of the spatial variability of sediment properties on the hydrological patterns and processes at the catchment scale. To improve the knowledge of structure-process interactions in initial ecosystems, the 6-ha artificial Chicken Creek Catchment in Germany was investigated by the Transregional Collaborative Research Centre 38 (SFB/TRR 38). Sediment structures called pour-ribs, which are dumped by stackers during the construction process, lead to differently compacted sediment zones, which increase the spatial variability of sediments' hydraulic properties. Although levelled afterwards by caterpillars, the majority of these structures remain in the subsurface. To analyse the effects of pour-ribs on the hydrological catchment's behaviour, the process-based spatially distributed Water balance Simulation Model (WaSiM-ETH) was applied. The results show that the consideration of pour-ribs improves the runoff simulation and significantly affects the simulated soil moisture patterns and, thereby, the initial stage of the ecosystem development. Compacted zones act as hydraulic barriers and inhibit subsurface lateral water flow, whereas non-compacted zones constitute areas with increased water storage capacity. Both effects cause reduced catchment runoff. Moreover, disregarding of the pour-ribs was identified as a source of model uncertainty in previous studies. A further outcome of this study is the importance of a global sensitivity analysis as a tool for model improvement. Finally, the results stress the importance of considering the variability of sediment properties for hydrological modelling at the catchment scale.