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Hydrological modelling of an artificial headwater catchment using the model system WaSiM-ETH

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The hydrological headwater catchment Chicken Creek (6.5 ha) was constructed in a lignite open-cast mine by Cottbus (Germany) to study initial processes of ecosystem development. The catchment has been intensively monitored for more than three years. Thereby, it is well suited to test and develop hydrological models. The construction of a clay layer in the basement simplifies the balancing of the water cycle since lateral inflows and vertical outflows can be neglected.

For modelling purposes all basic input data were given, but neither discharge nor soil moisture measurements were provided. Hence, no high model quality can be feigned by fitting simulated results on observed output data.

To compare the ability of different models and modellers to describe the hydrological behaviour of that catchment, a model competition was declared, on which several international scientists take part, all specialised in hydrological modelling. The contest is conducted in different levels, whereupon the knowledge of modellers concerning the investigated catchment will be increased stepwise. All modellers use the same database and results will be evaluated by an independent observer group. Thereby, the comparability between different model applications is guaranteed.

We applied the process-based distributed Water balance Simulation Model (WaSiM-ETH) by Schulla & Jasper (2007) to simulate the first three years since the catchment construction was finished (Sep. 2005 – Aug. 2008).

For the first modelling exercise important initial conditions (e.g. soil moisture) were unknown. Due to the lack of field experiences, effects of a constructed lake were disregarded. Therefore, the results of the first level were far away from being perfect, e.g. discharge was simulated from the beginning which was not observed because in reality soil water and lake storages were filled up first.

The biggest differences occurred between simulated and observed surface runoff. In reality, surface runoff is the dominant runoff part responsible for approximately 70 % of the total runoff, but only half a percent was simulated. Hence, runoff dynamic and runoff peaks were underestimated. The simulated result is physically vindicated through the given data, because the sandy soils (sand content of 70 – 90 %) leads to high infiltration rates. During a first survey a compact and sealed layer was identified as the reason for high surface runoff, which could not be derived from the given date.

For the second step of the modelling exercise the lake and the improved knowledge about the initial conditions were considered. Now, the simulated discharge shows the same delay as observed. Furthermore, effects of the sealed layer could be considered by a differentiated representation of soil conditions. Thereby, the simulated surface runoff increased up to 60 % of total runoff, which leads to an enforced runoff dynamic with higher peaks.

Now, it is up to the observer group to evaluate whether or not the simulated results of the second modelling level has improved.