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The 'coupling' of surface and subsurface watershed modelling approaches towards a better understanding of lowland hydrology

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Since the last decades in several lowland watersheds of north-east Germany a decreasing runoff combined with temporal hydrological droughts are observed. Because the runoff process takes place in the unsaturated-saturated zone of the subsurface watershed and the near-surface groundwater layer different composite or coupled models are developed and applied. Traditionally, watershed models have been applied to problems of surface water management only, and, similarly, ground water models have been applied without treating surface water in any detail. But for understanding water flow and transport processes in a basin, integrated watershed and groundwater models that attempt to represent the relevant processes in the hydrological system are needed, especially in lowland catchments without any hillslope, but with permeable soils.

Following the theory of REW a possible way to describe thermodynamic quantities, external supplies and rates, is somewhere in between applying deterministic and lumped descriptions of hydrological balances, that means the concept of coupled models.

In the paper two examples of such model coupling are presented. In the first case a composite lumped physically-based model was used to describe runoff processes with special emphasis to the surface-subsurface interaction. Observed hydrographs are well reproduced by the model, showing that the occurrence of hydrological droughts in this area is mainly controlled by base flow, whereas the subsurface watersheds are clearly distinct from the surface ones. Furthermore, it showed that the observed long-term decline of groundwater table has an increasing influence because stream water leakage

could diminish the runoff seriously. In the second example, a fully distributed watershed model was coupled with the groundwater model ASM. The advantage of this approach is the use of readily available data, the handling of watershed heterogeneities (multiple land uses, soil layers, vegetation structures) and the significantly increased flexibility in handling stream-aquifer interactions.

This paper makes the case for a modular organised model approach to integrate surface and subsurface runoff processes in lowland watersheds. The applications demonstrate the practicability and versatility of this relatively simple and conceptual clear approach, making public acceptance of the integrated watershed modelling system much easier.