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A robust algorithm for identification of spatial interaction zones and simulation of water balance and nutrient dynamics within floodplains

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The identification and consistent classification of model boundaries are fundamental demands for correct and unique solution of the descriptive equations of any model. For an adequate reflection of water balance and nutrient dynamic processes the spatial extend of the model area, the model geometry as well as the conditions on the model boundaries have to be known. The application of common hydrological models for simulating water balance and nutrient dynamics in lowland wetlands or floodplains do often cause serious problems due to the improper definition of spatial extends of processes and the inaccurate definition of catchments boundaries as well as boundary characteristics. Watershed delineation based on automatic digital terrain analysis algorithms is often not applicable because it requires a minimal extend of topographical heterogeneity. Furthermore, water balance of wetlands is effected by vertical processes of the unsaturated zone as well as by the mainly lateral groundwater dynamics and by the interactions between groundwater and surface water. Mostly the extend of the delineated surface watershed does not fit with the groundwater catchment boundaries. An additional problem is caused by the spatial interaction between river and floodplain and the impossibility to root the runoff which is generated within a subcatchment of the floodplain to a single outlet point into the river. The IWAN model for integrated modelling of water balance and groundwater dynamics of floodplains enables to simulate specific hydrological characteristics of floodplains and to reflect water balance and groundwater processes adequately. It also includes interaction processes between the groundwater of the floodplain and the surface water. A robust algorithm is introduced which enables to delineate the direct catchment of lowland rivers in floodplains. The direct catchment is defined by the spatially discrete part of the connected floodplain in which wetland water balance is affected by the surface

water dynamics of the adjacent river. The delineation algorithm is based on transfer functions which were adapted by local simulation results with the integrated water balance and nutrient dynamics model IWAN. The transfer functions are determined by simulated groundwater depths and mean annual groundwater variability. They are furthermore proved by simulation results of the maximal transversal extend of surface water influences on groundwater stages. The regionalisation approach, which transfers the delineation algorithm, leads to the longitudinal specification of the maximal extent of groundwater - surface water - interaction processes along the riverline. By application of this approach to the Havel river basin located within the lowlands of Northeaster Germany it was possible to select a ca 100000 ha part of the floodplain which is directly connected with the surface waters. This part of the floodplain was specified as the direct catchment of the Havel river. The IWAN model was applied for simulation of water balance of the floodplain as well as of nutrient dynamics within the groundwater. The simulation results proof the tight interaction between river and floodplain. The spatially and temporally variable influences of the connected floodplain on the river discharge were quantified as only important during low discharge seasons at summer. The importance of the floodplain for nutrient retention is shown by the simulation of nitrogen metabolism within the groundwater. Nutrient loads and exchanges between the surface and the groundwater have been quantified.