Modeling Groundwater - Surface Water Interaction by coupling MODFLOW with WetSpa

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WetSpa is a GIS based distributed hydrologic model for water and energy transfer between soil, plants and atmosphere. The model is originally developed by Wang et al. (1996) and adopted for flood prediction and water balance simulation by Liu and De Smedt (2004). The hydrologic processes considered in the model are precipitation, interception, evapotranspiration, runoff, soil moisture storage, interflow, percolation, groundwater storage and discharge. MODFLOW is a program that numerically solves the three-dimensional groundwater flow equation for a porous medium by using a finite difference method. MODFLOW was originally developed by McDonald and Harbaugh (1984) and underwent several updates until the recent version MODFLOW-2000 by Harbaugh et al. (2000). It is designed with a modular structure, each package deals with a specific feature of the hydrologic system.

This paper describes a two way loose coupling of WetSpa and MODFLOW with the aim of facilitating groundwater-surface water interaction and replacing the linear reservoir baseflow estimation method of WetSpa. In this approach, the spatially distributed recharge determined by WetSpa is used as input for groundwater discharge estimation of MODFLOW, which in turn is used as input for WetSpa. Surface water and groundwater models using WetSpa and MODFLOW were developed for a study area located in Nete catchment, Belgium. The applicability of the coupled model as a hydrologic tool was demonstrated successfully. It shows advantages, such as improved simulation of system non-linearity and feedback mechanisms, in situations where surface and groundwater flow systems have mutual interaction compared to the individual groundwater and surface water models.