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Identification and contribution of water sources to the extent of floods

Tomasz Berezowski (1,2), Daniel Partington (3), Jarosław Chormański (2), Okke Batelaan (1,3)

(1) Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium, (2) Department of Hydraulic Structures, Warsaw University of Life Sciences, Nowoursynowska 166, 02-787 Warsaw, Poland (t.berezowski@levis.sggw.pl), (3) National Centre for Groundwater Research and Training, School of the Environment, Flinders University, Adelaide, SA 5001, Australia

The extent of floods is the result of the discharge of various water sources in the floodplain. These water sources originate from upstream river discharge, direct rainfall on the floodplain, snowmelt or groundwater discharge. The differentiation between these water sources, including the spatial delineation of their contributing areas is an important issue for flood protection, ecohydrology and hydrological modelling. So far the most reliable method for differentiation and spatial delineation of the water sources in the overall flood extent is extensive hydrochemical analysis involving numerous sampling points. In this study we compare results from such an analysis with a coupled groundwater-surface water simulation approach. The comparison is performed for the Lower Biebrza Basin, north-eastern Poland (453 km2). This study area is a natural wetland river valley dominated by peat soils with extensive agriculture. Floods in this area occur yearly and are considered of major importance for the ecology of the basin. The hydrochemical analysis was conducted for the 2002 spring flood and consisted of sampling 538 points for 19 parameters (pH, electrical conductivity, organic carbon and concentration of 16 ions). The identification of spatial water sources was further conducted by means of dimensionality reduction and cluster analysis. The hydrological modelling of different water sources was conducted with a HydroGeoSphere (HGS) model for the whole Biebrza catchment (7000 km2). HGS is a finite element, fully integrated physically based hydrological model, which simulates unsaturated/saturated groundwater flow, surface flow, evapotranspiration, snowmelt, etc. Hence, it offers coupled groundwater-surface water interaction and an important new feature that allows to calculate the composition of different water sources in each computational node of the model. Results of this mixing-cell methodology are compared with the hydrochemical analysis and show good agreement for the differentiation of zones directly flooded by river water and for the zones dominated by other water sources. However, the zones with a mixture of snowmelt, rainfall and groundwater were delineated slightly different in both analyses.