DISTRIBUTED HYDROLOGICAL MODELLING AND LANDUSE SCENARIO ANALYSIS IN THREE CARPHATIAN WATERSHEDS USING WETSPA

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In the paper a modelling approach is presented for distributed hydrological modelling of watersheds containing important wetland areas, with special regard to a GIS-based parameterization scheme particularly useful for applying landuse scenario analysis. The hydrological model WetSpa was developed and applied in an integrated catchment modelling system together with hydraulic, water quality and ecologic models with the final aim of revitalizing riparian and oxbow wetlands in the Tisza River basin. The focus of this paper is on the modelling approach and application of WetSpa. WetSpa simulates hydrological processes in a grid-based schematisation of a watershed. Processes considered in the model are precipitation, snow melt, interception, surface runoff, infiltration, evapotranspiration, soil moisture storage, interflow, percolation, groundwater storage and discharge. The main outputs of the model are river flow hydrographs and spatially distributed hydrological characteristics like evapotranspiration, soil moisture, infiltration, surface runoff, groundwater recharge, etc. Model parameter values and catchment characteristics are derived from GIS maps of elevation, landuse and soil type. Generated runoff is routed to the catchment outlet along topographic determined flow paths, using a diffusive wave approximation to simulate both overland and channel flow. Under the assumption that hydraulic characteristics are static in parameters that only depend upon position, the total discharge at any downstream convergence point is obtained by convolution of the flow response from all grid cells.

The modelling approach is applied on hourly or daily time-step to three medium-sized Carpathian catchments of the Lapus, Zagyva and Hornad Rivers (ca. 1880 – 4260 km2). The models are calibrated for the current conditions on the basis of observed discharge data. Good comparisons between predicted and measured hydrographs are achieved resulting from automated parameter estimation with PEST, visual comparison and statistical assessment. Nash-Sutcliffe model efficiencies range from 80 to 85%. Consequently, different landuse scenarios including urbanisation, afforestation and deforestation, are developed and the effects on simulated discharges, water balance and spatial distribution of hydrologic characteristics, e.g. evaporation and groundwater recharge, are investigated.