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Regional analysis of changes in snow pack in mountainous basins in the central Danube region

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Accurate estimation of the volume of water stored in the snow pack and its rate of release is essential to predict the flow during the snowmelt period. In mountainous drainage basins water stored in the snow pack represents an important component of the water budget.

Two modelling tools are compared. The first, HOLV snowmelt model is developed by the Hungarian National Hydrological Forecasting Service (VITUKI NHFS) for regional assessment of snow accumulation and ablation of the central Danube. The model originates from the early 80's and it is under continuous development, while its recent distributed version over a grid with 0.1 degree resolution is in use. The snowmelt model has a flexible structure; it is able to change its own structure in function of data availability. In case when only precipitation and air temperature data are available temperature index method is used. When also other data are accessible (cloudiness, dew point, wind speed) using of energy balance model is to be preferred. If there are suitable data available for calculation of the energy terms, the energy balance method can be applied.

The second semi-distributed Hron model, developed at the Slovak University of Technology was applied to a smaller sub-basin to represent spatial distribution of snow cover by simulated snow water equivalent. The upper Hron river basin with an area of 1766 km2 is located in central Slovakia. The conceptual semi-distributed tool applied contains three basic storage components with 15 calibrated parameters, as the flow routing component the cascade of linear reservoirs is used as opposed to the original simple triangular routing function. The snow sub-model uses the temperature index (degree-day) method for snow accumulation and snowmelt calculations. Uncertainty of model parameters was reduced by multi-calibration on the mean daily discharges in the basin outlet and measured stations data of snow water equivalent. Changes in the model parameters during the investigated period also were analyses.

The consistency of modelled spatial distribution of snow water equivalent also was checked by the Modis sow satellite data. The results showed a decrease in snow water equivalent and snow depth, and snow duration from the past to the present.

The paper also deals with the analysis of changes in depths, duration and spatial distribution of snow cover. Daily snow cover depth observations and weekly snow water equivalent data were available at 6 climatic stations for the period 1961-2010 for the upper Hron while the last two decade sporadic observations and simulated snow depths and snow water equivalent for the entire central Danube region.

It is concluded that simulated qualitative information on snow pack across the Alpine-Carpathian region can provide more information on appropriate values of melt parameters than quantitative data on snow water equivalent at a single station location. These simulations appear to provide an adequate representation of snow climatology.