Introduction to Special Issue on Hydrology of a Small Basin

Well instrumented experimental and representative basins are important for hydrological and environmental research. The regular conferences on hydrology of small basins have already gained a long tradition both on European and Czech scales. In the framework of The Euromediterranean Network of Experimental and Representative Basins (ERB), that represents an open association of 20 European countries, the biennial conferences have been organised since 1986. From 1986 up to 2008, altogether 12 conferences were held in 11 European countries. In the Czech Republic, the periodical meetings of Czech and Slovak researchers have been organised by the Institute of Hydrodynamics of the Academy of Science of the Czech Republic since 2003. The first conference on "Soil Hydrology of a Small Basin" was held in Prague in 2003, the second conference on "Hydrology of a Small Basin" was arranged in Prague in 2005.

This special issue brings 15 papers presented at the 3rd conference on "Hydrology of a Small Basin" held in Prague in 2008. The published papers refer to Soil physics (3 papers), Transpiration and evapotranspiration (3 papers), Catchment hydrology (4 papers), Runoff modelling (3 papers), and Contaminant hydrology (2 papers).

Soil physics

Sněhota *et al.* analysed the retention curves of soil from the Liz catchment (the Šumava Mts, Czech Republic) obtained by three methods. The sand table and pressure extractor methods were used to obtain a 13-point retention curve for undisturbed soil samples taken from 6 depths. The data points of the individual retention curves were fitted in with the analytical expression and the reference retention curves were calculated for each depth by scaling. For the same soil, the retention curves were estimated by the artificial neural network method and the use of the empirical Pedotransfer function. The numerical experiment, which represented the infiltration and redistribution processes, was conducted using all three sets of retention curves. The simulated water storages and pressure fields obtained using two sets of the estimated parameters produced similar results, however, they did not approximate well the modelling results obtained with the use of the reference parameter set measured.

Štekauerová and Mikulec analysed the variability of saturated hydraulic conductivities in the agriculturally cultivated soils on the locality Most pri Bratislave (Slovak Republic) in the vegetation period of 2003. In total, 244 samples of the saturated hydraulic conductivity values were evaluated. It was found that the K_{labor} normal values indicated a slightly rising trend for the whole soil profile 0–115 cm in the course of the vegetation period. The lower K_{labor} values, observed at the beginning of the vegetation period even in the upper soil layer 0–22 cm, were due to the soil compacting caused by the transport of the agricultural machinery at that time of the year, and also to the not yet fully developed root system of the cultivated vegetation on the experimental plot (maize). The later increase of the K_{labor} values in the course of the vegetation period was caused by the plant root development, and also by the activities of the animals living in the soil of the locality in question. The highest temporal variability of the K_{labor} mean values was also observed in the same layer 0–22 cm of the soil profile.

Dušek *et al.* discussed the numerical analysis of a ponded infiltration experiment under different experimental conditions. In this study, five important factors were analysed determining the infiltration rate and the water flow regime during the ponded infiltration experiments as well as the subsequent evaluation of the surface hydraulic properties. The soil characteristics were based on the soil samples taken from the soil profile of Dystric Cambisol in the Volyňka river watershed, the

Šumava Mts (Czech Republic). The factors included: (1) the diameter of the infiltration ring, (2) the depth of water in the ring, (3) the depth of the ring insertion under the soil surface, (4) the size and shape of the finite-element mesh near the ring wall, and (5) the double-ring vs. single ring setup of the experiment.

Transpiration and evapotranspiration

Kantor *et al.* studied the vaporisation process from young stands of Norway Spruce and European Beech after snow breakage in the Orlické hory Mts (Czech Republic). The extreme disturbance of the forest environment in the young experimental spruce stand after the snow breakage disaster in the winter of 2005/2006 became the impulse for the present study. 98% spruce trees were affected, the stand density decreased from 1550 to 950 trees per ha, the needle foliage of the stand was reduced to about 40%, and the stand canopy was markedly disturbed. ET totals (evaporation from the soil surface and ground vegetation Es + transpiration of trees T) were comparable in both stands (200 to 235 mm during the growing season). Until 2006, ET was about 10% higher in the spruce stand, whereas in 2007, ET was 10% higher in the beech stand. An extremely high increase of the soil surface evaporation (Es) was observed in a gappy spruce stand. Immediately after the disaster, maximum daily totals of evaporation ranged from 1.5 to 2.0 mm in the spring and summer of 2006 while in the beechstand, they reached half these values. In the following year 2007, with gradual weeds infestation of the stand gaps, whose cover extended to 80% in the summer and autumn, the values of Es in the spruce stand reached up to 3 mm per day, on warm summer days being on the level of the weed-infested clear felled area. In the same days, the evaporation in a fully closed beech stand was usually 3 to 4 times lower. The evaporation from the soil surface and ground vegetation evidently substituted the reduced transpiration of the spruce broken canopy, if ET total did not change significantly.

Pivec and Brant studied the actual consumption of water by selected cultivated and weed species of plants and the actual values of evapotranspiration of the stands as determined under the field conditions. The field measurements were carried out at the localities Červený Újezd (Czech Republic) in the years 2005 to 2008. On the basis of the measurements carried out, the average daily values of the sap flow of the evaluated plants ranged from 0.016 to 0.193 kg/day of water per plant. The maximum daily values ranged from 0.025 to 0.309 kg/day of water per plant. The average daily value of the evapotranspiration flow in *Hordeum vulgare* during the period under observation amounted to 2.9 mm, while the daily values ranged from 1.2 to 4.6 mm H_2O/day. In other evaluated plants, the daily values of evapotranspiration ranged from 0.9 mm to 5.9 mm/day of water, on average 3.4 mm/day of water (*Beta vulgaris*), and from 1.7 mm to 5.2 mm/day of water, on average 3.2 mm/day of water (*Brassica napus*).

Brom *et al.* evaluated the functional properties of various types of the vegetation cover in the Mlýnský and Horský catchments (the Šumava Mts, Czech Republic). The analyses of satellite images showed that different types of vegetation exhibited different microclimatic characteristics as a consequence of their diverse use of solar energy. In the mountain area studied, the mowed meadows with their lowest humidity showed the highest surface temperature and a sensible heat flux whereas the forests with the highest abundance of moisture, in spite of their highest net radiation, had the lowest surface temperature because they dissipated higher amounts of solar energy through the latent heat flux. This indicates that the landscape management may substantially influence the local climate through changing the distribution of the vegetation types.

Catchment hydrology

Bíba *et al.* evaluated the long-term effect of forest renewal on the water regime in the watersheds Červík-A and Červík-B in the Beskydy Mts (Czech Republic). The measurement of the precipitation – outflow (rainfall – runoff) process showed, that the annual effect of the forest logging on the water balance cannot be proved. More significant changes were measured in the intensively felled and immediately renewed CE-A sub-watershed. The changes were observed mainly in the warm

period of the year. This result, however, should be verified by a long-term measuring, also in other small watersheds, under the given conditions. The results of this research in the CE watershed and its parts CE-A and CE-B are to be considered carefully; they cannot be recommended for application in the forest hydrological plans without a further verification, either in the Beskydy Mts region, or in other regions.

Pavlásek *et al.* presented the results of the monitoring of two experimental micro-scale catchments Modrava 1 (0.1 km^2) and Modrava 2 (0.17 km^2) in upper parts of the Šumava Mts (Czech Republic) in the hydrological year 2007. These catchments differ mainly in the vegetation cover – a dead forest with very young trees (Modrava 1) and primary forest clearings with 10 to 15-year-old young forest (Modrava 2). The average hourly rainfall and runoff data were analysed. During the winter season, snow water equivalents were measured and the maximum value was added to the rainfall amount measured during the vegetation season for the estimation of total year precipitation on each catchment. It follows from the comparison of the time series that the rainfall time distribution was similar during the year on both catchments, with a higher total year precipitation and hour intensities on the catchment Modrava 2. The time distribution and total runoff depth were similar on both catchments. On Modrava 1, a faster recession of hydrographs could be seen which might relate to a lower retention capacity. The value of the water conductivity on the catchment Modrava 1 depended more on the changes of the runoff depth. The maximal values occurred during the peak discharges or at the time of hydrographs rising. This fact can be the result of a lower stability of the soil profile in the catchment with dead forest cover.

Procházka *et al.* made the comparison of water and matter flows from three small catchments in the Šumava Mts (Czech Republic) starting in 1999. The Mlýnský stream catchment was artificially drained, the areas of the catchment retaining the character of drained, semi-intensive pasture. The Horský stream catchment is covered with a forest, mowed meadows, and locations with natural succession (wetlands). The Bukový stream catchment is covered with a forest, mostly with spruce monoculture. The highest amount of water was discharged from the drained Mlýnský catchment whereas the amounts of water discharged from the Horský and Bukový catchments were lower. The runoff maxima in the hydrologic year of 2002 were recorded in the Mlýnský stream catchment in August – at the time of the catastrophic floods. On the other hand, the maximum discharges in the Horský and Bukový stream catchments in August 2002 were comparable with those that had occurred in the spring during the snow melt. In comparison, the water chemistry showed relationships between trends and features and the results of water runoff. The comparison of the runoff and matter flows in the catchments studied confirmed the influence of the land cover and management in both normal and extreme rainfall-runoff conditions.

Šanda *et al.* studied the hydrological processes in the subsurface investigated by means of water isotopes and silica in the small mountainous headwater catchment Uhlířská in the Jizerské hory Mts (Czech Republic). The hillslope soil profile is formed by paleozoic crystalline bedrock overlaid by shallow highly permeable shallow Cambisol, and by thick saturated glacial deposits in the valley, overlaid by Histosol. A quick communication of the vadose zone with the granitic bedrock via preferential subsurface flowpaths is hypothesised, in agreement with the observation of storm-caused instant water transformation to outflow through the permeable Cambisol. A quick response of a high magnitude outflow occurs regularly, although the surface runoff is very rare. Standard climatic and hydrological monitoring in the Uhlířská catchment is supplemented by the measurements of the soil moisture, soil pore water suction, subsurface hillslope stormflow in the vadose zone, and water table fluctuation in the saturated subsurface, and is accompanied by water sampling for the analyses of the contents of the isotopes ^{18}O and ^{2}H and geochemical tracer silica in the form of SiO_2. The episode based isotopic data serve for the separation of the outflow hydrograph to determine the contributions of the event and pre-event water in the hypodermic hillslope outflow and in the catchment outflow. The variation of silica content in the water cycle components was examined to assess the contributions from the soil profile and the aquifer. Up to 75% of the event catchment runoff was assigned to pre-event water, of which about 50% had been stored in the shallow soil subsurface on the hillslopes. The hypothesis

was confirmed that the hillslope soil layers control the distribution of the flow into the groundwater recharge and/or the shallow subsurface flow during the rainfall-runoff episode.

Runoff modelling

Buchtele *et al.* examined the variability of the water regime in the forested experimental catchments Liz, Lenora, Modrava, Husinec in the Šumava Mts, Lysina and Pluhův Bor in the Slavkovský les, and Červík and Malá Ráztoka in the Beskydy Mts (Czech Republic), using the SAC-SMA and BROOK models. The intention was to decrease the uncertainties due to the annual cycle of climatic conditions in the evaluation of appearing natural and/or artificial changes of the runoff. The results suggested that an improvement of the runoff simulation could be reached by a more precise evaluation of the evapotranspiration demands as the variability of the water regime in the catchments studied is influenced by the changes of the vegetation cover in the annual cycle, but also by its development in the span of decades. The simulations of the rainfall-runoff process are useful for pursuing the possible role of this land use. The differences between the observed and simulated flows in the available period can be considered as a proper tool for the assessment of changes.

Máca and Torfs examined the influence of the temporal rainfall distribution in the flood runoff modelling using the SEBRM model. The ensemble hydrograph simulation was used in order to compare the flood event extremities. The ensemble hydrograph simulation and evaluation were performed during the evaluation of two large flood events in the small Morávka basin (Czech Republic). The results showed that the rainfall volume plays a significant role in the flood event extremity and confirm the suitability of the application of both simulation techniques tested. The proposed methodology is open for adding other hydrological components, making an improvement towards more physically based process description of the main runoff response components.

Košková and Němečková studied the evapotranspiration simulations in the Malše basin (Czech Republic) using the SWIM model. The primary interest in this analysis was to assess the ability of the hydrological model to simulate the actual evapotranspiration on larger scales and to evaluate its dependence on the landscape characteristics such as the vegetation cover, soil type, and average precipitation amount during the simulation. The annual actual evapotranspiration in each hydrotope was evaluated in the simulation period of 1985–1998. The credibility was quantified using Nash Sutcliffe efficiency which was more than 0.7. The main trends of the simulated actual evapotranspiration were evaluated and assessed as satisfactory. The differences in the soil types did not seem significant for the evapotranspiration variation, the monthly average values among the soil types differing by ± 10% except histosol. On the other hand the differences in the land-use categories strongly influenced the amount of evapotranspiration (–30; +50%). It appears that the model SWIM overestimates the actual evapotranspiration in the spring and, on the other hand, underestimates it in the autumn, according to the comparison with the only data available in the entire Climate Atlas of the Czech Republic.

Contaminant hydrology

Fišák *et al.* referred to the measurement of soluble and insoluble pollutants in fog and rime water samples. Fog and rime water samples were collected at the meteorological observatory Milešovka (Czech Republic) in February and June 2006. In the samples, the soluble and insoluble pollutant concentrations were evaluated separately and the differences between the fog and rime water samples were studied. The comparison of the fog and rime water samples indicates that the mean soluble components concentrations in the air appear to be higher during the rime events than during the fog events at Milešovka. We recorded a larger mean particle size of the insoluble compounds in the fog water samples than of those in rime water. Some elements contained in the insoluble particles like Ca, Cl, C, Cu, Ag, were present largely in fog while others, like Fe, Al, Si, Ti, prevailed in rime. In addition to the overall evaluation, the backward air trajectories were determined for each fog/rime event and the concentrations are presented as depending on the direction of the air particle transfer.

Nováková and Nágel analysed the influence of irrigation on nitrates movement in soil and the risk of subsoil contamination at the Experimental Station Most pri Bratislave (Slovak Republic). The results of the nitrates movement monitoring under the conditions of field experiment, with different fertilisers doses applications, with and without irrigation and for different crops have been presented. The soil at the site is mainly clay loam with a high retention capacity and a relatively low hydraulic conductivity. The results of the nitrates measurements in the soil profile during the vegetation period and those of lysimetric water analysis have shown that the movements of nitrates in irrigated and non-irrigated fields differed significantly from each other during the early stages of the vegetation period, however, at the end of this period the differences between the irrigated/non-irrigated and fertilised/non-fertilised soils were small, probably due to an increased uptake of water and nutrients during the vegetation period at the irrigated field. Properly applied irrigation was not the reason for nitrates penetration beneath the root zone under the soil and meteorological conditions of the Most pri Bratislave site.

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