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Modeling of surface runoff in a low-mountain catchment in SW Hungary

L. Balatonyi (1), S. Czigány (2), and E. Pirkhoffer (3)

(1) Institute of Environmental Sciences, University of Pécs, Pécs Hungary, Hungary (balatonyi.laszlo@gmail.com), (2) Institute of Environmental Sciences, University of Pécs, Pécs Hungary, Hungary (sczigany@gamma.ttk.pte.hu), (3) Institute of Environmental Sciences, University of Pécs, Pécs Hungary, Hungary (pirkhoff@gamma.ttk.pte.hu)

The temporal frequency of extreme weather phenomena have been steadily increasing over the past decades in the Carpathian Basin. In Hungary, an operational numeric model-based flash flood guidance (FFG) system is under development by the flash flood research group of University of Pécs.

However, to provide an accurate and sufficient number of input parameters for runoff models and to adapt any runoff model to low-mountain environments in Hungary, several pedological and hydrometeorological parameters need to be studied. During a long-time monitoring (10-minute measurement intervals), we measured soil moisture, precipitation, air temperature and relative humidity in a 1.7 km^2 low-mountain forested watershed in SW Hungary. Soil depth was also determined using Vertical Electric Resistance (VES) methods, borehole drillings and dynamic probing. Stream water level was also measured at the outflow point of the watershed.

In the current study we used the HEC-HMS runoff model to analyze the impact of (a) precipitation, (b) soil moisture content (c) canopy storage and (d) soil depth on surface runoff. We also analyzed the impact of (i) rainfall totals, (ii) rainfall intensities and (iii) percentage of canopy cover on interception and soil moisture content at a canopy covered (CS) and a clear-cut site (UCS).

Our results indicate that the average soil moisture content was about two times higher in the uncovered site than under canopy cover. Ground precipitation was significantly higher at the UCS than at the CS, equaling to about 27 percent rainfall retention rate. Our findings indicate that a close relationship exists between canopy cover ratio and interception rate. Maximum rainfall intensity and interception rate showed a relatively high-degree correlation, while poor correlation was found between rainfall totals and interception rate. The correlation between average rainfall intensities and rate of interception was also relatively low. Ground precipitation, as a crucial input data for runoff models, can also be calculated with higher accuracy when maximum rainfall intensities and canopy cover ratios or leaf area indices are known.

HEC-HMS model runs indicated higher output accuracy when correlations between the flood-influencing environmental parameters were used to refine model input data. Model runs also showed a pronounced influence of soil moisture on surface runoff, while the affects of soil depth exceeding about 0.5 meter and canopy storage were insignificant.