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Influence of Design Storm Profiles on Flood Peak Discharge in a Small River Catchment

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Estimations of flood peak discharges of low probability of exceedance are required for designing and maintaining hydraulic and road structures (reservoirs, weirs, water intakes, bridges, culverts) as well as for flood protection, including assessment of the risk of flooding. Rainfall-runoff models are usually the only alternative for such estimations in case of small catchments, as there is a lack of sufficient, good quality historic data to be used for applying the traditional i.e. statistical methods. The aim of this study was to check responses of a small agro-forested, lowland catchment located in center of Poland to rainfall of assumed probability of exceedance and of three profiles of intensity (i.e. a/ constant intensity, b/ asymmetric one with highest intensity between 0.3 and 0.5 its duration, c/ symmetric one with single peaked intensity) and various storm duration.

A regional formula, developed by state hydrological service, on relationship of intensity-duration-frequency, applicable also for region of center of Poland, has been used to find rainfall depths of the events with probability of exceedance of 1% (return period of 100 years) and various duration (i.e. D = 6, 12, 18, 24, 30, 36, 42, 48, 60 and 72 h), as input data for runoff hydrograph simulation. As the catchment, which area is 82.4 km^2, has long term monitoring history, the model parameters, as Curve Number of NRCS (Natural Resources Conservation Service), used for extracting the effective rainfall (direct runoff) from total rainfall depth and parameters of Nash model, used for transformation of effective rainfall into direct runoff hydrograph, were estimated from recorded rainfall-runoff events. Over 50-year-continuous discharge record allowed us to estimate the 100 year flood, by applying statistical method for the investigated catchment, as 25,6 m^3/s which form a base for comparison of the results of application of the rainfall-runoff model.

Results of modelling of the of rainfall-runoff process indicate: a/ that critical rainfall duration (producing highest peak discharges) of the three storm profiles were between 24 and 60 hours, and b/ higher peak discharges at critical rainfall durations of the three storm profiles than one of statistical method. The differences (overestimates) were from 1.6% for the constant intensity to 30.0% for the symmetric single peaked intensity.