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A semi-probabilistic approach for the design of detention storage facilities

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Traditional methods for detention storage design are based on the concept of the design hydrograph derived from Intensity-Duration-Frequency (IDF) curves. This means that first the temporal profile of the precipitation (design hyetograph) is derived from IDF curves for a fixed return period, then the design hydrograph is obtained by routing the hyetograph through a mathematical rainfall-runoff model. This approach is widely used in the Italian engineering practice, but it does not correctly quantify the hydrological uncertainty of the computed storage. For this reason a semi-probabilistic procedure is introduced, which relies on quite simple assumptions and allows an estimate of the uncertainty. The precipitation event is represented as a stochastic process, where the rainfall volume, the event duration and the inter-storm time are independent exponentially distributed variables. The probability distribution functions (CDF) of the storm runoff and of the peak-flood are obtained by application of the 'derived distribution' theory and of a simplified rainfall-runoff model. The procedure was applied to the case study of the Brescia time series of rainfall observations, assuming an hypothetic basin area of 100 ha. Results obtained through the semi-probabilistic approach are compared to those obtained through traditional methods and are found to be overall in agreement, even if the new approach seems to overestimate a bit the needed detention capacity. On the other hand the stochastic rainfall scheme allows also a sensitivity study to a change of climate, by changing the rainfall model parameter values by a given quantity, in accordance to the expected change in the local climate. Therefore four different climate change scenarios were defined and the results obtained are compared and discussed.