Stochastic Rainfall for Planning of Flood Retention Facilities in Urban Areas

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Urbanized areas are exposed to elevated risks of flood damage because of the increased volume of direct runoff, short flow travel times and the high density of the population. The installation of storm water detention facilities, especially reservoirs, provides one important means of managing storm water. The design of storm water reservoirs can be carried out using flow simulation models which are based either on design storms or on continuous precipitation time series. The latter has advantages especially for the planning of whole reservoir systems providing not only the design storm but the complete probability distribution of flood runoff at different points in the system. However, prerequisite for such long-term simulation studies is the availability of adequate precipitation time series, which is usually poor for many cities in the world. As alternative to observed precipitation stochastic precipitation series can be generated as input for the rainfall-runoff models. This study presents a method for the synthesis of long-term 5 minute time increment precipitation series using a simple stochastic model. The proposed model is of a hybrid type with a parametric "Alternating Renewal" framework to describe the external wet-dry spell structure, a resampling scheme to refine seasonal and spatial characteristics as well as a parameter-free design of the internal storms. A case study for the upper Emscher river basin, which is a heavily urbanized area in western Germany, has been carried out. Precipitation series are generated for several locations and long-term simulations are carried out with a hydrological rainfall-runoff model. The results are evaluated based on a comparison of characteristics between observed and synthetic precipitation and on a comparison of simulated flows using observed and synthetic precipitation data as input for the hydrological model.