



Synthesis of rainfall time series in a high temporal resolution

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In order to optimize the design and operation of urban drainage systems, long and continuous rain series in a high temporal resolution are essential. As the length of the rainfall records is often short, particularly the data available with the temporal and regional resolutions required for urban hydrology, it is necessary to find some numerical representation of the precipitation phenomenon to generate long synthetic rainfall series.

An Alternating Renewal Model (ARM) is applied for this purpose, which consists of two structures: external and internal. The former is the sequence of wet and dry spells, described by their durations which are simulated stochastically. The internal structure is characterized by the amount of rain corresponding to each wet spell and its distribution within the spell. A multivariate frequency analysis is applied to analyze the internal structure of the wet spells and to generate synthetic events. The stochastic time series must reproduce the statistical characteristics of observed high resolution precipitation measurements used to generate them. The spatio-temporal interdependencies between stations are addressed by resampling the continuous synthetic series based on the Simulated Annealing (SA) procedure.

The state of Lower-Saxony and surrounding areas, located in the north-west of Germany is used to develop the ARM. A total of 26 rainfall stations with high temporal resolution records, i.e. rainfall data every 5 minutes, are used to define the events, find the most suitable probability distributions, calibrate the corresponding parameters, simulate long synthetic series and evaluate the results. The length of the available data ranges from 10 to 20 years. The rainfall series involved in the different steps of calculation are compared using a rainfall-runoff model to simulate the runoff behavior in urban areas. The EPA Storm Water Management Model (SWMM) is applied for this evaluation.

The results show a good representation of the seasonal variability, good performance in reproducing the sample statistics of the rainfall characteristics, whereas the extreme value statistics show some inconsistencies in some of the analyzed cases. The model presented here can be used in ungauged regions through regionalization of the model parameters.

Key words: stochastic rainfall model, rainfall characteristics, copula, continuous simulation