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A Stochastic Rainfall Generator Suitable for Modeling Future Compound Disasters Associated with Heavy Rainfall

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Disasters associated with heavy rainfall such as urban floods, riverine floods, and landslides often simultaneously occur while each of them sensitively reacts to rainfall variabilities at distinct ranges of time scales. Therefore, a stochastic rainfall model suitable for modeling compounding of disasters must be good at reproducing the rainfall variability across all timescales relevant to all types of disasters. This study proposes a point stochastic rainfall generator that can reproduce various rainfall characteristics at timescales between 5 minutes and one decade. The model generates the fine-scale rainfall time series using a randomized Bartlett-Lewis Rectangular Pulse (RBLRP) model. Then the rainstorms are shuffled such that the correlation structure between the consecutive storms is preserved. Finally, the time series is rearranged again at the monthly timescale based on the result of the separate coarse-scale monthly rainfall model. The method was tested using the 69 years of 5-minute rainfall data recorded at Bochum, Germany. The mean, variance, covariance, skewness, and rainfall intermittency were well reproduced at the timescales from 5 minutes to a decade without any systematic bias. The extreme values were also well reproduced at timescales from 5 minutes to 3 days. The past-7-day rainfall before an extreme rainfall event, which is highly associated with the extreme riverine flow and landslide was reproduced well too. Then, the model was extended to integrate the influence of climate change. For this, the model was re-parameterised in terms of parameters representing average magnitude and temporal structure of the rainfall time series. Then, the relationship between these new parameters and the covariates (e.g. monthly, weekly, daily temperature) were investigated. Lastly, the derived regression relationships were applied to adjust the duration and the magnitude of rain storms and cells that were generated by the stationary RBLRP model.

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