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On Statistical Modeling of Extreme Rainfall Processes for Urban Water Infrastructure Design in the Context of Climate Change

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There exists an urgent need to assess the possible impacts of climate change on the Intensity-Duration-Frequency (IDF) relations in general and on the design storm in particular for improving the design of urban water infrastructure in the context of a changing climate. At present, the derivation of IDF relations in the context of climate change at a location of interest has been recognized as one of the most challenging tasks in current engineering practices. The main challenge is how to establish the linkages between the climate projections given by Global Climate Models (GCMs) at the global scale and the observed extreme rainfalls at a given local site. If these linkages could be established, then the projected climate change conditions given by GCMs could be used to predict the resulting changes of local extreme rainfalls and related runoff characteristics. Consequently, innovative downscaling approaches are needed in the modeling extreme rainfall (ER) processes over a wide range of temporal and spatial scales for climate change impact and adaptation studies in urban areas. Therefore, the overall objective of the present paper is to provide an overview of some recent progress in the modeling of extreme rainfall processes in a changing climate from both theoretical and practical viewpoints. In particular, the main focus of this paper is on recently developed statistical downscaling (SD) methods for linking GCM climate predictors to the observed daily and sub-daily rainfall extremes at a single site as well as at many sites concurrently. In addition, new SD procedures are presented for describing the linkages between GCM outputs and rainfall characteristics at a given location where the rainfall data are limited or unavailable, a common and crucial challenge in engineering practice.