Recent Advances in Modeling of Extreme Rainfall Processes for Climate Change Impact and Adaptation Studies in Canada

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ABSTRACT

Information on the variability of extreme rainfall characteristics is essential for planning and design of various urban infrastructures. Furthermore, climate change has been recognized as having a profound impact on these extreme events. Hence, there exists an urgent need to assess the possible impacts of climate change on the extreme rainfalls for improving the design of urban infrastructures in the context of a changing climate. In current engineering practice, Environment and Climate Change Canada (ECC) provides the extreme rainfall data and the intensity-duration-frequency (IDF) relations for approximately 650 stations across the country. Traditionally, these IDF relations were obtained by fitting the two-parameter Gumbel distribution to the annual maximum (AM) rainfall data for each rainfall duration independently using the method of moments (MOM). However, it has been widely known that this Gumbel/MOM traditional approach may not produce accurate extreme rainfall estimates as compared to those given by, for instance, the Generalized Extreme Value (GEV)/L-Moment method. Consequently, there are several recently developed estimation procedures in Canada in an attempt to provide some improvements in the design rainfall estimation. This study presents therefore a critical review of existing methods as well as a regional comparative study to identify the best extreme rainfall estimation procedure for Canada. Historical AM data with at least 50 years of record from 39 stations representing diverse climatic conditions across Canada were used for this study. It was found that there are three distinct IDF patterns for different regions of Canada, including convex, linear, and concave patterns. These patterns are linked to the scale-invariance relationships between the statistical moments of observed rainfall amounts over different rainfall durations. Consequently, it was found that the estimation method based on the scale-invariance GEV distribution can provide the best estimates of extreme design rainfalls for Canada in the context of a changing climate.

Keywords: Extreme rainfalls, downscaling methods, frequency analyses, statistical modeling methods, climate change impact and adaptation.