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Assessing the Effect of Climate Change on Design Storm Depth Using Storm Rainfall Simulation

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Many studies related to climate change focused on global, continental or regional scale effect in space and annual or seasonal scale effect in time. However, for practical planning and engineering design, it is necessary to deal with local (spatial) and event (temporal) scales. In this paper we present the development of a continuous stochastic storm-rainfall simulation model (SRSM) which can accommodate the aforementioned scales and provides quantitative assessment of the impact on design storm depth under given scenarios of climate change. The SRSM is a parametric stochastic simulation model which considers random processes of four major storm types – frontal rainfall, Mei-Yu, convective storms and typhoons occurring annually in Taiwan. Random process of a storm rainfall event is characterized by (1) inter-arrival time of storm events, (2) joint probability distribution of storm duration and total rainfall depth and (3) time distribution of the total depth. Occurrences of storm events of a certain storm type can be modeled as a Poisson process and the inter-arrival time is modeled as a random variable with exponential distribution. A bivariate exponential distribution is adopted for joint distribution of storm duration and total rainfall depth. A Gauss-Markov random process is used for disaggregation of total rainfall. Under certain scenarios of climate change, i.e. the average number of typhoons events for the study site increases or decrease, we assess the impact on design storm depth. Changes in the number of typhoon events corresponds to changes in the inter-arrival time, and therefore the SRSM can provide a quantitative assessment of climate change effect on design storm. Our simulation results show that if the annual number of typhoons increases from current average of 4.5 events to 5 events, the 1-hr (24-hr), 100-year design storm depth will increase by 25% (7.7%); whereas the 1-hr (24-hr), 10-year design storm depth will increase by 13% (6.1%).