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Joint Probability Distribution of Extreme Water Level with Rainfall and Temperature: Trend Analysis of Potential Impacts of Climate Change

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Abstract : Climate change is known to have the potential to impact adversely hydrologic patterns for variables such as rainfall, maximum and minimum temperature and sea level rise. Long-term average of these climate variables could possibly change over time due to climate change impacts. In this study, trend analysis was performed on rainfall, maximum and minimum temperature and water level data of a coastal area in Manhattan, New York City, Central Park and Battery Park stations to investigate if there is a significant change in the data mean. Partial Man-Kendall test was used for trend analysis. Frequency analysis was then performed on data using common probability distribution functions such as Generalized Extreme Value (GEV), normal, log-normal and log-Pearson. Goodness of fit tests such as Kolmogorov-Smirnov are used to determine the most appropriate distributions. In flood frequency analysis, rainfall and water level data are often separately investigated. However, in determining flood zones, simultaneous consideration of rainfall and water level in frequency analysis could have considerable effect on floodplain delineation (flood extent and depth). The present study aims to perform flood frequency analysis considering joint probability distribution for rainfall and storm surge. First, correlation between the considered variables was investigated. Joint probability distribution of extreme water level and temperature was also investigated to examine how global warming could affect sea level flooding impacts. Copula functions were fitted to data and joint probability of water level with rainfall and temperature for different recurrence intervals of 2, 5, 25, 50, 100, 200, 500, 600 and 1000 was determined and compared with the severity of individual events. Results for trend analysis showed increase in long-term average of data that could be attributed to climate change impacts. GEV distribution was found as the most appropriate function to be fitted to the extreme climate variables. The results for joint probability distribution analysis confirmed the necessity for incorporation of both rainfall and water level data in flood frequency analysis.

Keywords : climate change, climate variables, copula, joint probability
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