Application of a Semi-Physical Tropical Cyclone Rainfall Model in South Korea to estimate Tropical Cyclone Rainfall Risk

Angelika L. Alcantara*, Kuk-Hyun Ahn **

Abstract

Only employing historical data limits the estimation of the full distribution of probable Tropical Cyclone (TC) risk due to the insufficiency of samples. Addressing this limitation, this study introduces a semi-physical TC rainfall model that produces spatially and temporally resolved TC rainfall data to improve TC risk assessments. The model combines a statistical-based track model based on the Markov renewal process to produce synthetic TC tracks, with a physics-based model that considers the interaction between TC and the atmospheric environment to estimate TC rainfall. The simulated data from the combined model are then fitted to a probability distribution function to compute the spatially heterogeneous risk brought by landfalling TCs. The methodology is employed in South Korea as a case study to be able to implement a country-scale-based vulnerability inspection from damaging TC impacts. Results show that the proposed model can produce TC tracks that do not only follow the spatial distribution of past TCs but also reveal new paths that could be utilized to consider events outside of what has been historically observed. The model is also found to be suitable for properly estimating the total rainfall induced by landfalling TCs across various points of interest within the study area. The simulated TC rainfall data enable us to reliably estimate extreme rainfall from higher return periods that are often overlooked when only the historical data is employed. In addition, the model can properly describe the distribution of rainfall extremes that show a heterogeneous pattern throughout the study area and that vary per return period. Overall, results show that the proposed approach can be a valuable tool in providing sufficient TC rainfall samples that could be an aid in improving TC risk assessment.

Keywords : Tropical Cyclone; Track model; TC Rainfall Model; Rainfall Frequency Analysis

Acknowledgment

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (No. 2019R1C1C1002438).

* Graduate Research Assistant, Department of Civil and Environmental Engineering, Kongju National University, Cheon-an, South Korea; e-mail: alcantaraangelika97@smail.kongju.ac.kr

** Assistant Professor, Department of Civil and Environmental Engineering, Kongju National University, Cheon-an, South Korea; Corresponding author; e-mail: ahnkukhyun@kongju.ac.kr