Simulating the Effect of Green Infrastructure on Flood Mitigation under Extreme Rainfalls

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Abstract

Urban drainage systems are facing major challenges with rapid urbanization and climate change, especially for developing countries. Green infrastructure (GI) is a natural-based solution expected to reduce flooding and help in water pollution control. Notwithstanding multiple research have discussed the contribution of GI to climate change adaptation. The efficiency of GI to extreme events in the context of the more frequent extreme precipitation events has received limited attention in the literature. This study aims to quantify the impact of historical and future extreme rainfalls on overflow flooding, pollutant transport, and GI's potential in flood control by taking Phnom Penh City, the capital of Cambodia, as a case study. Firstly, we predicted the history of sub-daily extreme rainfall (1986-2005) by disaggregating outputs of various regional climate models based on the Artificial Neural Network (ANN) method. Secondly, we generated the future intensity-duration-frequency (IDF) curves based on sub-daily extreme rainfall (2026-2045) and input the design rainfall time series (based on the scenarios of RCP4.5 and RCP8.5) into a hydrological model (PCSWMM) to investigate the impact of climate change on urban drainage systems, including the flooding and pollution (suspended solids). The model successfully captured the variation of overflow flooding and transport of pollutants. Thirdly, we introduced four mitigation measures of GI and simulated their effectiveness against climate change with different extreme rainfall events. The results indicate that future climate change will increase the risk of overflow flooding and more pollutants diffuse on urban surfaces. The GI is an effective method to mitigate its impact, but the performance decreases with rainfall intensity. The effect of increased rainfall is consistent for different GI. PP is most effective in relieving the pressure of extreme rainfall for total flood, peak flow reduction, and pollutant removal. Although GR performs reasonably well in flood control, it is the least effective in pollutant control. It can be seen that more research is needed in the implementation and optimization of GI.

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