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Integrating Citizen Data in Urban Flood Risk Modeling: Insights from synthetic experiments

Minyoung Kim[1], Hyeonjin Choi[2], Bomi Kim[3], Yaewon Lee[4], Haeseong Lee[5], Junyeong Kum[6], Myungho Lee[7], and Seong Jin Noh[8]

[1]Kumoh National Institute of Technology, Department of Civil Engineering, South Korea(minyy208@gmail.com)
[2]Kumoh National Institute of Technology, Department of Civil Engineering, South Korea(hyeonjinchoi21@gmail.com)
[3]Kumoh National Institute of Technology, Department of Civil Engineering, South Korea(kimbom3835@gmail.com)
[4]Kumoh National Institute of Technology, Department of Civil Engineering, South Korea(yaewon99@kumoh.ac.kr)
[5]Pusan National University, School of Computer Science and Engineering, South Korea(heaseong@pusan.ac.kr)
[6]Pusan National University, School of Computer Science and Engineering, South Korea(junegold12@pusan.ac.kr)
[7]Pusan National University, School of Computer Science and Engineering, South Korea(mlee.academic@gmail.com)
[8]Kumoh National Institute of Technology, Department of Civil Engineering, South Korea(seongjin.noh@gmail.com)

Accurate flood risk assessments are critical for mitigating the impacts of pluvial flooding in densely populated urban areas. However, conventional flood modeling approaches often face limitations due to the lack of measurement information. To address this challenge, we develop, implement, and evaluate a novel framework that integrates crowdsourced data, such as citizen observations, with process-based modeling to enhance the accuracy of urban flood risk assessments. The proposed method utilizes indicator co-kriging techniques to merge citizen-sourced data with auxiliary variables, including inundation maps generated from 1D-2D urban flood models driven by high-resolution radar rainfall estimates. The framework is applied to the Oncheon River catchment in Busan, South Korea, a region highly vulnerable to pluvial flooding due to its urbanization and complex hydrological conditions. To evaluate the method, synthetic citizen observation data were generated based on inundation maps. These synthetic experiments assess the influence of the spatial distribution and quality of citizen observations on urban flood risk predictions. This study examines the integration of citizen observations into urban flood modeling workflows to address uncertainties in models and observations. In particular, we investigate the extent to which distributed citizen observations enhance prediction accuracy and analyze the effects of model bias on the reliability of flood risk assessments. The study quantitatively evaluates the effects of citizen data quality and spatial distribution on the accuracy of urban flood risk mapping. Furthermore, a sensitivity analysis is conducted for co-kriging parameters, focusing on semivariogram model selection and its influence on prediction accuracy.