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Uncertainty in Urban Flooding Assessment under Climate and Land Use Change

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According to IPCC AR4 projections, the frequency of heavy precipitation events is likely to increase over the Pacific Northwestern (PNW) of USA during the 21st century. Consequently, flood risk is expected to increase in this region. Additionally, the land use change, such as urban development exacerbates the flood risk. We investigate potential changes in urban flood frequency and their uncertainty caused by future climate change and urban development in two urbanizing watersheds, the Fanno and Johnson, located in the PNW. The Fanno creek watershed is highly developed with a 84% urban land use, and the Johnson creek watershed is moderately developed with a 40% urban land use. The urban development of these watersheds will increase in the future with a higher rate of urban development in the Johnson watershed. This study employs three possible land use change scenarios, Conservation, Development, and Plan Trend, developed by the Pacific Northwest Ecosystem Research Consorthium (PNW-ERC). The Precipitation Runoff Modeling System (PRMS) hydrological model developed by U.S. Geological Survey is employed to simulate runoff changes and resulting changes in flood frequency. To consider model parameter uncertainty, Latin Hypercube Sampling is employed to sample the PRMS model parameter space and estimate the acceptable parameter ranges according to the Nash-Sutcliffe efficiency criterion. The U.S. Geological Survey PeakFQ program is also applied to estimate flood frequency with different recurrence intervals. To estimate uncertainties of climate change projection, we use eight GCMs and two emission scenarios (A1B and B1). The results show that change in flood frequency in the Johnson watershed is more significant than in the Fanno watershed because of the higher rate of urban development. The flood frequency changes are most sensitive to uncertainty in the GCM structure and downscaling method but are less affected by uncertainties due to hydrological model parameters and emission scenarios.

Key words
Flood, Uncertainty, Climate change, Urbanization, Oregon