Geophysical Research Abstracts
Vol. 18, EGU2016-11207, 2016
EGU General Assembly 2016

Power-law scaling in daily rainfall patterns and consequences in urban stream discharges

Jeryang Park (1), Elisabeth H. Krueger (2), Dongkyun Kim (3), and Suresh C. Rao (4)

(1) Hongik University, School of Urban & Civil Engineering, Seoul 04066, South Korea (jeryang@hongik.ac.kr), (2) Purdue University, Lyles School of Civil Engineering, West Lafayette, IN 47907, USA (ElisabethKrueger@purdue.edu), (3) Hongik University, School of Urban & Civil Engineering, Seoul 04066, South Korea (kim.dongkyun@hongik.ac.kr), (4) Purdue University, Lyles School of Civil Engineering and Agronomy Department, West Lafayette, IN 47907, USA (SureshRao@purdue.edu)

Poissonian rainfall has been frequently used for modelling stream discharge in a catchment at the daily scale. Generally, it is assumed that the daily rainfall depth is described by memoryless exponential distribution which is transformed to stream discharge, resulting in an analytical pdf for discharge [Gamma distribution]. While it is true that catchment hydrological filtering processes (censored by constant rate ET losses, and first-order recession) increases “memory”, reflected in 1/f noise in discharge time series. Here, we show that for urban watersheds in South Korea: (1) the observation of daily rainfall depths follow power-law pdfs, and spectral slopes range between $0.2 \sim 0.4$; and (2) the stream discharge pdfs have power-law tails. These observation results suggest that multiple hydro-climatic factors (e.g., non-stationarity of rainfall patterns) and hydrologic filtering (increasing impervious area; more complex urban drainage networks) influence the catchment hydrologic responses. We test the role of such factors using a parsimonious model, using different types of daily rainfall patterns (e.g., power-law distributed rainfall depth with Poisson distribution in its frequency) and urban settings to reproduce patterns similar to those observed in empirical records. Our results indicate that fractality in temporally up-scaled rainfall, and the consequences of large extreme events are preserved as high discharge events in urbanizing catchments. Implications of these results to modeling urban hydrologic responses and impacts on receiving waters are discussed.