Geophysical Research Abstracts
Vol. 18, EGU2016-17270, 2016
EGU General Assembly 2016

Topological Analysis of Urban Drainage Networks

Soohyun Yang (1,2), Kyungrock Paik (2), Gavan McGrath (3), and Suresh Rao (1)

(1) Lyles School of Civil Engineering, Purdue University, West Lafayette, United States, (2) School of Civil, Environmental, and Architectural Engineering, Korea University, Seoul, South Korea, (3) School of Earth and Environment, The University of Western Australia, Perth, Australia

Urban drainage networks are an essential component of infrastructure, and comprise the aggregation of underground pipe networks carrying storm water and domestic waste water for eventual discharge to natural stream networks. Growing urbanization has contributed to rapid expansion of sewer networks, vastly increasing their complexity and scale. Importance of sewer networks has been well studied from an engineering perspective, including resilient management, optimal design, and malfunctioning impact. Yet, analysis of the urban drainage networks using complex networks approach are lacking.

Urban drainage networks consist of manholes and conduits, which correspond to nodes and edges, analogous to junctions and streams in river networks. Converging water flows in these two networks are driven by elevation gradient. In this sense, engineered urban drainage networks share several attributes of flows in river networks. These similarities between the two directed, converging flow networks serve the basis for us to hypothesize that the functional topology of sewer networks, like river networks, is scale-invariant.

We analyzed the exceedance probability distribution of upstream area for practical sewer networks in South Korea. We found that the exceedance probability distributions of upstream area follow power-law, implying that the sewer networks exhibit topological self-similarity. The power-law exponents for the sewer networks were similar, and within the range reported from analysis of natural river networks. Thus, in line with our hypothesis, these results suggest that engineered urban drainage networks share functional topological attributes regardless of their structural dissimilarity or different underlying network evolution processes (natural vs. engineered). Implications of these findings for optimal design of sewer networks and for modeling sewer flows will be discussed.