Spatial distribution of wastewater treatment plants in diverse river basins over the contiguous United States

Soohyun Yang*, Olaf Buettner**, Yuqi Liu***, Dietrich Borchardt****

Abstract

Humans inevitably and continuously produce wastewater in daily life worldwide. To decrease the degradation of river water bodies and aquatic ecosystem therein, humans have built systems at different scales to collect, drain, and treat household-produced wastewater. Particularly, municipal wastewater treatment plants (WWTPs) with centralized controls have played a key role in reducing loads of nutrients in domestic wastewater for the last few decades. Notwithstanding such contributions, impaired rivers regarding water quality and habitat integrity still exist at the whole river basin scale. It is highly attributable to the absence of dilution capacity of receiving streams and/or the accumulation of the pollutant loads along flow paths.

To improve the perspective for individual WWTPs assessment, the first crucial step is to achieve systematic understanding on spatial distribution characteristics of all WWTPs together in a given river basin. By taking the initiative, our former study showed spatial hierarchical distributions of WWTPs in three large urbanized river basins in Germany. In this study, we uncover how municipal WWTPs in the contiguous United States are distributed along river networks in a give river basin. The extended spatial scope allows to deal with wide ranges in geomorphological attributes, hydro-climatic conditions, and socio-economic status. Furthermore, we identify the relation of the findings with multiple factors related to human activities, such as the spatial distribution of human settlements, the degree of economy development, and the fraction of communities served by WWTPs. Generalizable patterns found in this study are expected to contribute to establishing viable management plans for recent water-environmental challenges caused by WWTP-discharges to river water bodies.

Keywords : Spatial organization, Data-driven analysis, Fractal river networks, Scaling ratios

Acknowledgment

This study was supported by the New Faculty Startup Fund from Seoul National University.

* Member · Assistant Professor, Department of Civil and Environmental Engineering, Seoul National University · E-mail : soohyunyang@snu.ac.kr

** Scientist, Department of Aquatic Ecosystem Analysis, Helmholtz Centre for Environmental Research - UFZ · E-mail : olaf.buettner@ufz.de

*** Post-master intern, Department of Aquatic Ecosystem Analysis, Helmholtz Centre for Environmental Research - UFZ · E-mail : yuqi.liu@ufz.de

**** Professor, Department of Aquatic Ecosystem Analysis, Helmholtz Centre for Environmental Research - UFZ · E-mail : dietrich.borchardt@ufz.de