# Coupled Engineering and Natural Drainage Networks: Data-Model Synthesis in Urbanized River Basins
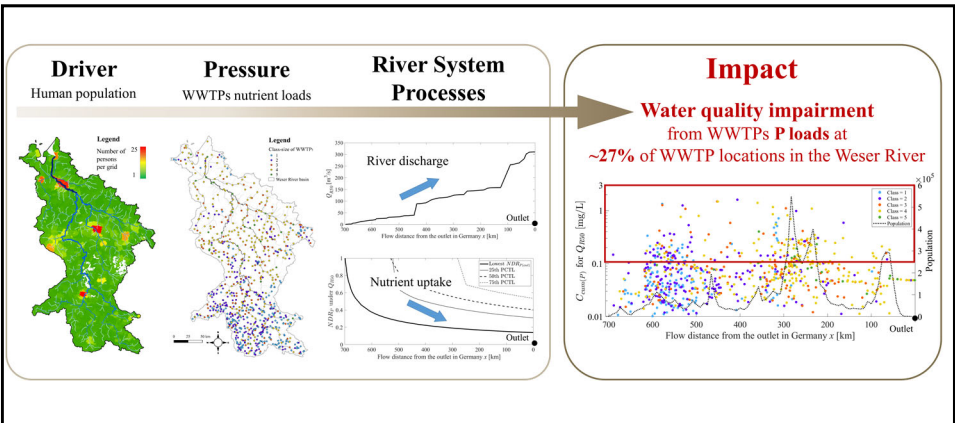
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## ABSTRACT

In urbanized river basins, sanitary wastewater and urban runoff from urban agglomerations drain to complex engineered networks, are treated at centralized wastewater treatment plants (WWTPs), and discharged to river networks. Discharge from multiple WWTPs contributes to adverse impairments on river water-quality and aquatic ecosystem integrity. Economic and engineering constraints determine the combination of wastewater treatment technologies used to meet required environmental regulatory standards for treated wastewater discharged to river networks. Thus, it necessary to understand the coupled natural-human-engineered systems (CNHES), to characterize their coupled relations, and to generate concomitant phenomena. My PhD works involve data-model synthesis, using publicly available data and application of well-established network analysis/modeling synthesis approaches. Main inter-related three topics are: (1) the similarities and differences in scaling and topology of engineered urban drainage networks in two cities, and further UDN evolution over decades; (2) the scaling and spatial organization of humans, population equivalents, and WWTPs using geo-referenced data for WWTPs in three large urbanized basins in Germany; and (3) hydrological and water-quality impacts from WWTP discharges in the Weser River basin. The quantitative measures and the basin-scale network model presented in my PhD project could be applicable to other large urbanized basins for better understanding the spatial distribution patterns of the CNHES and the resultant impacts on river water-quality impairment and further algal blooms.