Complex Network Theory and Multi-criteria Analysis applied to risk assessment in water distribution systems

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Abstract

Water Distribution Networks (WDNs) are susceptible to various failures, such as pipe bursts, leaks, or contaminant intrusions. These failures can disrupt operations or, in severe cases, lead to health problems (Viñas et al., 2022). To ensure that maintenance prioritizes critical pipes whose failure would cause operational issues, some studies in the literature employ hydraulic simulation to assess the risks associated with the failure of specific pipes. However, this process can be time-consuming for large models, making it challenging to apply to real-world systems. Recently, Complex Network Theory has been applied to analyze WDNs. Centrality metrics derived from this theory are used to evaluate specific features of the hydraulic system. In this work, we propose applying Complex Network Theory (Dastgir et al., 2023) to rank pipes based on the severity of potential failures. Closeness, Betweenness, and Source-Node Betweenness Centrality are used to assess scenarios of pipe leaks, and contaminant intrusions. Based on these three criteria and the different scenarios, the TOPSIS algorithm is applied to rank the elements of the water system, considering both scenarios and criteria (Carpitella et al., 2019). The results of this work can be used to prioritize pipes for maintenance based on the risks associated with their failure.

References

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