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Criticality index for resilience analysis of water distribution networks in a context of mechanical failures

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ABSTRACT

Water distribution networks (WDNs) are one of the most important urban complex infrastructures, which provide an essential resource for life. Therefore, ensuring resilience and safety for WDNs are big concerns for water utilities. WDNs are characterized by multiple components that are usually represented by a graph, i.e. a set of interconnected nodes or demand points and links or pipes. Node importance for a WDN depends on various factors such as population sensitivities, the location in the graph, and the system performance. Whilst pipe importance is related to measuring both risk of system isolation and insufficient pressures.

This work attempts to explore consequences of pipe failures into the system's performance. Three failure scenarios are proposed: 1) single pipe break, 2) isolation of the broken pipe (single failure), and 3) isolation of the surrounding area to the broken pipe as the event may lead to multiple failures. The impact into the network performance of each of these scenarios is assessed through a resilience criticality index specifically tailored to WDNs and also compared to normal operating conditions regarding the satisfaction rate of nodes. The water distribution computations are approached by a pressure depending model (PDM) [1, 2], as in case of pipe failures it provides better description of the system conditions than the classical demand-driven formulations [3]. So, the overall proposal quantifies how resilient the system is and supports the decision-making process to eventually reduce the occurrence of failure events and to minimize their potential consequences. A set of further potential scenarios is also described and analysed to test the success of the method for assessing pipe criticality and network resilience.

REFERENCES

[1] O. Piller, S. Elhay, J. Deuerlein, and A. Simpson, "Local sensitivity of pressure-driven modeling and demand-driven modeling steady-state to variations in parameters", *J. Water. Resour. Plann. Manage*, **(in press)**, 1-12 (2016).

[2] S. Elhay, O. Piller, J. Deuerlein, and A. Simpson, "A robust, rapidly convergent method that solves the water distribution equations for pressure-dependent models", *J. Water Resour. Plann. Manage*. **142**, 1-12 (2015).

[3] E. Creaco, M. Franchini, and E. Todini, "Generalized resilience and failure indices for use with pressure-driven modeling and leakage", *J. Water Resour. Plann. Manage.* **142**, 1-10 (2016).