Resilience assessment of water distribution systems: A framework for supporting adaptative planning under uncertainty

Summary

Drinking water distribution systems are increasingly exposed to uncertainty due to climate change, ageing infrastructure, demand variability, and extreme events. These challenges call for robust, adaptive tools to support long-term planning and operational resilience.

This doctoral research develops and demonstrates a comprehensive and integrated methodology for assessing the resilience of water distribution systems. The methodology supports water utilities in identifying system vulnerabilities and defining context-specific resilience improvement measures. It combines a scenario-building technique, used to represent a wide range of future internal and external conditions, including disaster events, with a resilience assessment framework that evaluates multiple resilience aspects, such as robustness, autonomy, preparedness, recovery, reliability, and flexibility.

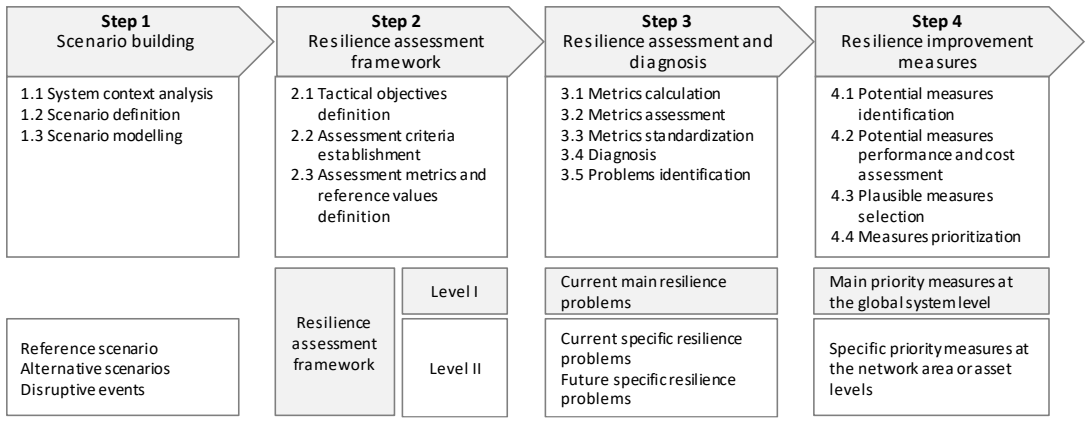
The framework operates across two assessment levels: Level I provides a preliminary, system-wide screening using limited data to identify priority areas, while Level II allows for detailed analysis of specific vulnerabilities through more data-intensive modelling. The assessment is supported by numerical hydraulic and water quality simulations, incorporating both established performance and energy-based indicators, and proposing new metrics. This integrated structure enables a flexible application of the methodology across systems with varying data availability and complexity.

The methodology was applied to real-world systems for demonstration purposes, and the insights gained contributed to the refinement of the framework and the formulation of general recommendations for improving resilience in diverse operational contexts.

Overall, this integrated methodology enhances water utilities' capacity to assess resilience systematically and implement context-specific, effective improvements, contributing to the sustainable management of water distribution systems under uncertainty.

Keywords

Resilience Assessment; Water Distribution Systems; Scenario-Building; Adaptative Planning; Urban Water Management.



Integrated methodology to assess water distribution systems resilience.

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