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Measuring the recovery behavior and effects of disruptions on water networks

Nazli Yonca Aydin (1) and Hans Heinimann (2)

(1) ETH Zurich, Future Resilient Systems, Singapore-ETH Centre, Singapore, Singapore (nazli.aydin@frs.ethz.ch), (2) ETH Zurich, Future Resilient Systems, Singapore-ETH Centre, Singapore, Singapore (hans.heinimann@env.ethz.ch)

Societies highly depend on critical infrastructure systems such as water, power, communication, and transportation networks, which become more and more interconnected and depend on each other as a result of increasing urbanization and technological innovations. Accordingly, if there is any disruption due to man-made or natural disasters, it will likely cascade through the various networks and will result in more severe impacts. For water infrastructure systems, new methodologies and novel approaches are emerging to limit these impacts. Resilience assessment is one such approach and an essential decision support mechanism to cope with those unexpected disruptions, reduce the consequences and increase the quality of life. However, the problem with the resilience assessment methods is that the lack of clear guidelines to evaluate the dynamic and time-dependent properties, specifically for water networks. Some specific questions that need to be addressed to tackle this problem such as “What are the acceptable level of degradation?”, “What is a system’s ability to re-stabilize its key functions?”, “How can we improve the system’s capability to cope with unexpected disruptions?”. These questions can be used as guidelines to characterize the system’s resilience and understand the current or expected issues. Since, clearly, the resilience of water supply will become an issue due to the increasing water stress around the world. In this research, a dynamic resilience assessment methodology is proposed for water distribution systems under several disruptions, such as increased demand due to fire flow and pipe closure. A measure of performance is developed, which is a combination of the acceptable level of nodal pressures and satisfied demand for water networks, to observe the system’s recovery behavior over an extended period of time in the status quo. In addition, several strategies such as increasing reserve capacity, demand conservation measures are also investigated to improve the water system’s capability to cope with these disruptions. The results will provide an insight for designing resilient water infrastructure in the future.