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Development of a Resilience Assessment Methodology for Networked Infrastructure Systems using Stochastic Simulation, with Application to Water Distribution Systems

Leon Francisco Gay Alanis

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Civil Engineering

Sunil K. Sinha, Committee Chair
Pamela M. Murray-Tuite
Annie R. Pearce
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March 29, 2013
Blacksburg, VA

Keywords: Critical Infrastructure Systems, Asset management, Resilience, Water Distribution Systems, Stochastic Simulation

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Development of a Resilience Assessment Methodology for Networked Infrastructure Systems using Stochastic Simulation, with application to Water Distribution Systems

Leon Francisco Gay Alanis

ABSTRACT

Water distribution systems are critical infrastructure systems enabling the social and economic welfare of a community. While normal failures are expected and repaired quickly, low-probability and high consequence disruptive events have potential to cause severe damage to the infrastructure and significantly reduce their performance or even stop their function altogether. Resilient infrastructure is a necessary component towards achieving resilient and sustainable communities. Resilience concepts allow improved decision making in relation with risk assessment and management in water utilities. However, in order to operationalize infrastructure resilience concepts, it is fundamental to develop practical resilience assessment methods such as the methodology and tool proposed in this research, named Effective Resilience Assessment Methodology for Utilities (ERASMUS). ERASMUS utilizes a stochastic simulation model to evaluate the probability of resilient response from a water distribution system in case of disruption. This methodology utilizes a parametric concept of resilience, in which a resilient infrastructure system is defined in terms of a set of performance parameters compared with their socially acceptable values under a variety of disruptive events. The methodology is applied to two actual water distribution networks in the East and West coasts of the US.