Water Infrastructure Resilience Evaluation using WNTR

Drinking water distribution systems face multiple challenges, including aging infrastructure, water quality concerns, pipe breaks, uncertainty in supply and demand, natural disasters, environmental emergencies, and terrorist attacks. All of these have the potential to disrupt a large portion of a water network. Increasing resilience to these types of hazards is essential to improving water security. Simulation and analysis tools can help water utilities predict how their system will respond to expected, and unexpected, incidents and help inform decisions to make water distribution networks more resilient over time.

The **Water Network Tool for Resilience (WNTR)** is an open source Python package designed to simulate and analyze resilience of water distribution systems. The United States Environmental Protection Agency, in partnership with Sandia National Laboratories, developed WNTR to integrate critical aspects of resilience modeling for water distribution systems into a single software framework.

The software includes capability to:
- Generate water network models
- Integrate GIS data into models and analysis
- Modify network structure and operations
- Assign fragility and survival curves to network components
- Model disruptive events such as power outages, earthquakes, fires, pipe breaks, and contamination incidents
- Model response and repair strategies
- Simulate hydraulics and water quality
- Evaluate resilience using a wide range of metrics
- Integrate dependency with other critical infrastructure and supply chains
- Analyze results and generate graphics

WNTR can be used to estimate infrastructure damage, evaluate preparedness strategies, prioritize response actions, and identify worse case scenarios and best practices for maintenance and operations. WNTR can be installed through the United States Environmental Protection Agency GitHub site at https://github.com/USEPA/WNTR. Documentation is available at https://usepa.github.io/WNTR/.

For more information or to conduct a case study, contact:
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WNTR
Water Network Tool for Resilience

Simulate and analyze water distribution system resilience

Aging Infrastructure / Asset Management	Power Outage *and* Black Sky Hazards

Earthquakes	Drought / Wildfires	Water Contamination

Flood / Hurricane	Cyber Threats to Critical Sectors

Example application: System resilience following an earthquake

Epicenter

Simulated peak ground acceleration from an earthquake

Fragility curves for tank damage

No Damage

DS1

DS2

DS3

DS4

Probability of exceeding a damage state

Peak Ground Acceleration [g]

Statistical prediction of water service availability

Water Service Availability

For median line
Minimum WSA: 0.54 (1.00 days after earthquake)
Recovery Time: 6.58 days after earthquake

Time (Days)