

Increasing resilience by engaging infrastructure interdependencies in urban water systems

1. Urban Water Systems

At a simplistic level explained as:

Water: Source ⇒ Treatment ⇒ User

Wastewater: Drain ⇒ Treatment ⇒ Water Body

However, urban water systems are complex and this simplification fails to represent the multiple and varying layers of direct and indirect infrastructure interdependencies.

The core components of a wastewater sub-system are:

1. **Networks:** Drains ⇒ Sewers ⇒ CSO ⇒ Pumping Station ⇒ Rising Mains ⇒ Inlet Pipework
2. **Treatment:** Screening ⇒ Storm Tanks ⇒ Primary, Secondary & Tertiary Treatment ⇒ Final Effluent
3. **Sludge:** Pipework ⇒ Sludge Storage ⇒ Sludge Treatment ⇒ Power Generation / Sludge to Land

Figure 1 shows how wastewater depends on a range of external systems, for example:

- Power Supply
- Manual / Remote Monitoring
- Supply Chain

The temporary or long term loss of any of these can be significant.

In addition to dependencies these systems operate within the wider context of society further increasing their vulnerability to risks (e.g. pipes under rail lines).

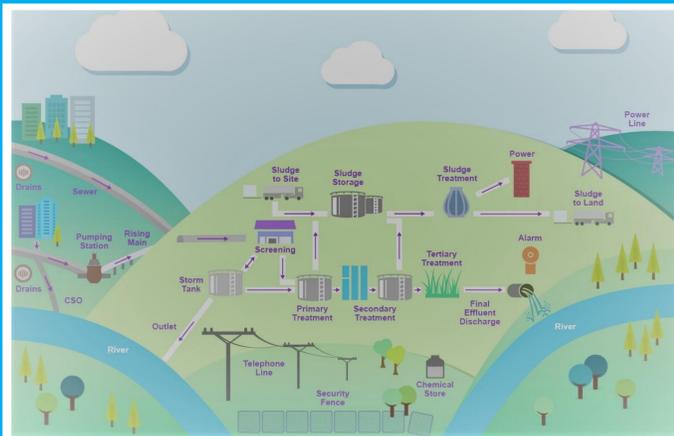


Figure 1: Urban water system interdependencies

2. Infrastructure resilience

Infrastructure resilience is generally defined as the ability of an asset to resist, respond and adapt to disturbances. In the water sector, the responsibility resides on Ofwat and the water companies, which to design a framework that is standard, yet flexible enough to measure and compare resilience across the sector

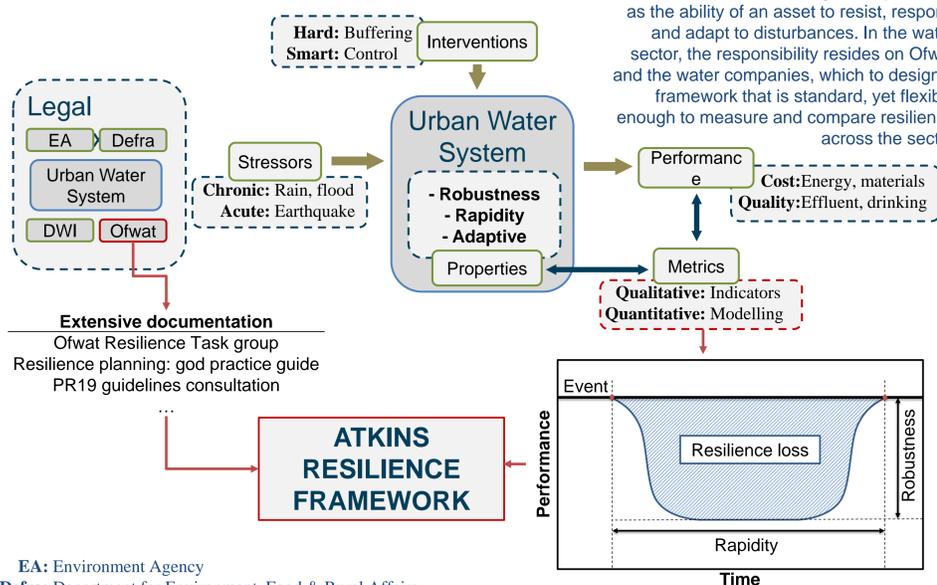


Figure 2: Resilience quantitative assessment
*Adapted from Juan-Garcia et al. (2017)

EA: Environment Agency
Defra: Department for Environment, Food & Rural Affairs
DWI: Drinking Water Inspectorate
Ofwat: Economic regulator in England and Wales

3. Resilience: Legislation to Implementation

Legislation: Water Act 2014 placed a requirement on Ofwat to ensure the long-term resilience of the water and wastewater systems, which has been captured as a priority for the Price Review 2019 (PR19). Complementary, Water and wastewater providers -as Category 2 Responders under the Civil Contingencies Act 2004- are required to Cooperate and Share Information with other resilience and emergency response organisations.

Guidance: To support legislation, guidance documents have been provided, such as: Ofwat "Towards Resilience", the JESIP Joint Doctrine and Keeping the Country Running.

Standards: Further information and standardisation to approaches can be found through ISO 55000 Asset Management and ISO 22301 Business Continuity.

Overall: A common thread is the importance of context and the need of understanding system

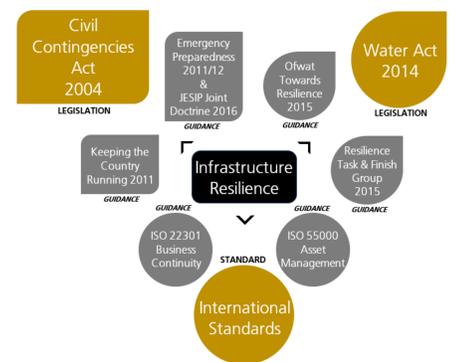


Figure 3: Legislation, International Standards & Guidance for Infrastructure Resilience

Resilience Assessment: Atkins work with clients for PR19 looking to explore priority areas for resilience investment has highlighted the importance of opportunities for increased engagement with multi-agency partners (e.g. within transportation, power and telecommunications). Improvements to business continuity planning enhanced our understanding of interdependencies, and identified areas to enhance resilience measures through collaborative and mutually beneficial working.

Resilience Components: Our work has identified key components to resilience (Figure 4), which link to the three types of resilience presented by Ofwat; financial, corporate and operational.

Metrics: Atkins supported UKWIR in a review of requirements for resilience metrics. This assessed the complexities and opportunities of different indicators that linked outcomes and incentives. A key consideration was that metrics should describe how the system or aspects of the system respond to disruptive events, whilst providing a baseline context for normal service. Metrics should be quantifiable, repeatable and comparable to show evidence of continuous improvement through investment.



Figure 4: Key Components to Infrastructure Resilience

4. Future challenges

The future of infrastructure is expected to become more interconnected (Figure 5) and can be considered as a lens looking into the future.

The biggest challenge looking into the future is the uncertainty of impacts associated with system stressors such as climate change, customer usage and behaviour and urbanisation. Future mitigations to these are likely to be embedded in innovation through big data, the Internet and technological advancements although these bring new risks from threats such as cyber attack.

Drivers for improvement will be influenced by government, investors and stakeholders. There is currently uncertainty as to whether new legislation will enhance investment in resilience as a win-win or impose it on regulators.

Enhancing stakeholder engagement will be key to sharing learning on the challenges and maximising opportunities from big data and collaborative working to minimise risks.

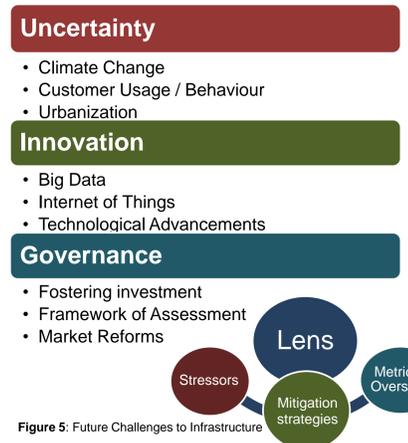


Figure 5: Future Challenges to Infrastructure

5. Take home messages

- Urban water and wastewater systems are complex and have a wide range of internal and external interdependencies that could lead to a disruption
- Ofwat through the Water Act 2014 and Price Review 2019 are increasingly focused on resilience within water and wastewater systems
- Prioritising engagement between all forms of critical infrastructure and the wider supply chain is a key opportunity to collaboratively respond to future challenges
- Increased understanding of interdependencies will help establish useful metrics and evidence the continuous improvement through investment

Acknowledgments

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