

RESILIENCE OF UK WATER AND WASTEWATER SERVICES - WHY WE NEED TO GET WISE BEFORE WE GET SMART

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1. THE UK WATER SECTOR'S JOURNEY TO RESILIENCE

Confidence in key institutions and public services can be easily damaged and difficult to restore and events like the financial crisis of 2007-08, natural disasters, terrorist acts can all have a cumulative and corrosive effect on public confidence. That is why resilience has become such a focus of public policy in the UK, particularly in the water and utilities sector. Significant momentum was imparted to the resilience agenda following major disruption to people's lives, due to natural hazards such as flooding or freezing conditions in the early 2000's.

In the winter of 2010-11 sustained sub-zero temperatures in the UK lead to multiple water mains bursts and ruptures of domestic and commercial plumbing systems leading to such dramatic increases in water demand that many areas were at risk of losing public water supply. A few years earlier, widespread flooding in the summer of 2007 caused extensive disruption, including the loss of water supplies to over 350,000 people for up to 17 days when Mythe Water Treatment Works in Gloucestershire was inundated by floodwater. The same event left 42,000 people without electricity for 24 hours, when the Castle Meads substation was shut down as a preventative measure, as flood water threatened to overtop temporary flood barriers erected around the site. At one stage 10,000 people were trapped in their vehicles on the M5 motorway. The incident was considered to be the biggest, peace-time civil emergency ever faced in the UK.

The UK Government commissioned a review, led by Sir Michael Pitt ¹ looking at all aspects of flood risk management in England. It contained 92 recommendations and identified issues beyond flood risk management, including raising the possibility that the drive for economic efficiency in regulated UK utilities may have been achieved at the loss of some resilience. Whilst the report found no explicit evidence of a decline in resilience, it nevertheless concluded that given the vulnerabilities exposed by the floods of 2007, there was a need to improve the resilience of utilities to low probability, high consequence events and that the utilities should be incentivised to do so through the regulatory frameworks. It is also unsurprising that no evidence of a decline in resilience was found given that there were few, if any consistent resilience metrics in place from which such an assessment could be made.

The Pitt Review also drew attention to the absence of common national standards for resilience, which it felt were a pre-requisite for underpinning investment decisions. It proposed that government should lead cross-sector action to reduce the risks of service disruption by setting

proportionate standards within and across critical infrastructure sectors that the utilities should then plan to achieve. The report articulated many key principles of resilience planning which have widespread application beyond the specific issue of flooding. A key issue identified with respect to public water supply was that Mythe WTW was effectively a stand-alone works, whose customers could not be supplied from elsewhere. It noted that the same water company had five such potential single points of failure (one of which supplied 1.2 million customers). The report concluded that the UK Government should “*provide particular weighting for such single points of failure and identify them for priority action to increase resilience*”.

In March 2010, in response to the Pitt Review, the Government published: a Strategic Framework and Policy Statement ² which set out the process, timescale and expectations for a Critical Infrastructure Resilience Programme; including the development of regularly updated (5-yearly) sector resilience plans; and Interim guidance to the economic regulated sectors.

The following year the Cabinet Office produced the first national guidance on resilience for critical infrastructure service providers, in the document “*Keeping the Country Running: Natural Hazards and Infrastructure*” ³. The document provided cross-sectoral guidance, including resilience definitions, guiding principles and practical approaches to assessing and building resilience. The sectors covered in the guidance were those deemed essential to daily life in the UK and comprised; food, energy, water, communications, transport, health, emergency services, government, and finance. Within these areas the government identified certain assets as being of strategic national importance, the Critical National Infrastructure (CNI), the loss or significant compromise of which would potentially cause disruption at a national scale.

The guidance defined resilience as “the ability of assets, networks and systems to anticipate, absorb, adapt to and / or rapidly recover from a disruptive event”. It also recognised that in its broadest sense resilience encompassed an organisations adaptive capacity, gained from an understanding of the risks and uncertainties in which it operates. Resilience was recognised as a multi-faceted organisational capability, which could be delivered through a combination of activities or components which were characterised as the “4Rs” of resilience: -

- **Resistance** – protection measures to prevent external threats from impacting on the infrastructure;
- **Reliability** – the ability of asset systems to continue to function under a wide range of operating conditions
- **Redundancy** – the availability of back-up facilities or spare capacity
- **Response & Recovery** – the capability to mitigate the impact on services through operational response and to restore normal service swiftly following disruption

This simple model was intended to encourage organisations to think beyond asset protection measures such as flood barriers (resistance) to consider at a system level how the resilience of the service provided by that system could be enhanced and assured by measures in any of the four areas identified.

Although the report was focused primarily on natural hazards, one of the benefits of the 4Rs mindset was that it encouraged development of a wider resilience thinking which would address other potential disruptive events. Whereas flood barriers around a critical asset can provide protection against one threat, providing system redundancy through alternative supply options can mitigate multiple failure modes including ones which may never have been contemplated.

The regulatory framework for the water sector in England and Wales includes a five-yearly price review process, through which the economic regulator, the Water Services Regulation Authority (or Ofwat), sets objectives for the private sector water companies and requires them to submit business plans and associated spending commitments on the basis of which Ofwat determines the prices the companies can charge their customers for the next 5 years. The guidance which Ofwat published for the 2014 price review (PR14) which would set price limits for the 2015 to 2020 period, included 6 references to resilience. Roll forward 5 years to the current PR19 price review and resilience was made one of the four key themes of the price review and is mentioned over 400 times in the main PR19 guidance document.

One of the main reasons for this heightened emphasis on resilience was the introduction, through legislation (the 2014 Water Act), of a new primary duty for Ofwat to “further the resilience objective”.

The ‘resilience objective’ was defined as, securing that water companies took steps enabling them to meet the long-term need for water supply and sewerage services to customers, in the face of environmental pressures, population growth and changes in customer behaviour, through appropriate planning and investment and measures to increase efficiency in water use and reduced demand to alleviate pressure on water resources. Ofwat stressed that they expected water companies to think beyond the structure and functioning of individual assets, to consider whole systems and services and to work to deliver resilience in all areas of their activity.

Whilst long-term planning processes were not a novel concept in the sector, particularly in the area of water resource management, there was a consensus within the industry that the broad requirements contained within the ‘resilience objective’ required some clarity and definition in order for companies to build the objective into their planning processes. It was in this spirit that in 2015, Ofwat commissioned an independent ‘Task and Finish’ group help inform and challenge the sector on resilience and advise and inform Ofwat’s own policy development.

The group’s report ⁴ was published by Ofwat in December 2015 and included a specific definition of resilience and a number of recommendations for regulators and water companies.

The definition of resilience adopted by the group and by Ofwat was: -

“Resilience is the ability to cope with, and recover from, disruption, and anticipate trends and variability in order to maintain services for people and protect the natural environment now and in the future”.

Other recommendations included the need to bring similar rigour to long term planning for wastewater, sewerage and drainage services (as was the norm in water supply and demand planning); to improve understanding of risk and failure; to develop benchmarking, standards and metrics and to ensure that existing plans are stress-tested. The report also echoed the concern expressed in the Pitt report back in 2008, that the economic regulatory model, with its emphasis on efficiency, might be preventing legitimate investment in resilience from being proposed or approved.

In the run up to the PR19 price review, further guidance to the water companies emerged. The UK Government Department for the Environment Food and Rural Affairs (DEFRA), the sponsoring department for Ofwat gave strong guidance to the regulator requiring that

*“Ofwat should ensure that companies assess the resilience of their systems and infrastructure against **the full range of potential hazards and threats** and take proportionate steps where required.”*

Ofwat in turn, in their guidance documents for the PR19 process, informed the water companies that their plans would be tested on the basis that the companies could evidence that they had

undertaken a “*robust, objective, comprehensive and quantitative assessment of the principal risks they see to the resilience and delivery of their services.*” They further stated that they expected companies’ approaches to be in line with global best practice.

To this growing corpus of resilience guidance Ofwat added further guidance document in 2017⁵ which developed the concept of ‘Resilience in the Round’ which emphasised that a resilient water company had to be demonstrably resilient in each of the following areas.

- **Corporate resilience:** the effectiveness of governance and assurance processes in helping to avoid, cope with and recover from, disruption
- **Financial resilience:** an organisations ability to reliably secure the finances necessary to maintain its services
- **Operational resilience:** having reliable infrastructure, and the skills to run that infrastructure, and recover from disruption.

‘Resilience in the Round’ also stressed the need for companies to adopt ‘systems-based’ approaches to resilience, stressing the need for a holistic approach which recognised the dependency of water services on other third-party systems and the vulnerabilities which that created with respect to potential for cascading failures originating outside the companies’ own asset bases. The report presented some case studies which it considered to be exemplars, including the Rockefeller 100 Resilient Cities initiative (<http://100resilientcities.org>) and the work in the UK of the Infrastructure Transitions Research Consortium (<http://www.itrc.org.uk>) which developed an integrated strategic model of UK infrastructure (energy, transport, water, waste and ICT) to support a national assessment of future infrastructure needs. How or whether these approaches could be translated into water company planning processes was not discussed but nevertheless the expectation that companies would adopt systems-based approaches to resilience within their PR19 planning processes was clearly signalled.

The English and Welsh water companies business plans were submitted to Ofwat in September 2018 (and published via the companies’ websites) and it was immediately apparent that a wide range of approaches to resilience had been adopted. Many claimed to have adopted the 4 Rs (see earlier reference to Cabinet Office guidance) and most claimed that their approach delivered ‘resilience in the round’. There were a variety of approaches including strategic frameworks, asset system reviews, examples of resilience scorecards and reviews of business process maturity, often using the BS6500 standard for Organisational Resilience, as their framework. But despite some examples of good practice few demonstrated or effectively articulated that these disparate activities were part of a fully integrated systems-based approach to ensuring the resilience of their services.

In January 2019 Ofwat provided a first response to the companies plans in the form of its Initial Assessment of Plans (IAP). Plans were graded A to D in ten test areas, one of which was the approach to securing long-term resilience. Of all the tests applied by the regulator, resilience was the area where the industry as a whole was deemed to have performed the poorest. Out of 17 plans, the two highest-graded only secured a B, ten companies received a C grade with five being graded D.

All but one of the companies has now been asked to present the regulator with an action plan (by August of 2019) setting out how they will implement systems-based approaches to resilience, which ensure that the company’s operations and future plans are underpinned by an

integrated resilience framework with clear line of sight between risk to service, their planned mitigations, the service outcomes to be delivered for customers set within an overall corporate governance framework.

The water companies in England and Wales either individually or collectively must now determine how to respond to this challenge; to understand what a fully integrated, systems-based approach to resilience might look like; to ascertain the gaps between their current approaches and that future model and identify a roadmap which will move them towards that goal. The key questions that this poses for the sector are:

- Are their suitable, mature examples of such systems in operation outside the UK water sector which could be adapted to address the need?
- If not, what emergent thinking, practices and approaches, including those within the academic research arena, might provide a basis for developing new systems and processes?
- Is the industry ready to move to such a level of complexity in its planning and operating processes, in terms of organisational capacity / capability and requisite data to support such an approach?

Received wisdom in the sector often suggests that the UK water industry is in a ‘data-rich, information-poor’ state and that with better data analytics, it could make much better use of the rich sources of data to inform improved operating decisions or asset investment plans. In the context of resilience, it is arguable that we are actually in a ‘data-poor, information-poor’ condition. We know very little about the condition and integrity of much of our below ground asset systems. At a corporate level there is often a lack of visibility about the serviceability and operational readiness of critical plant and equipment. Declining raw water quality and or treatment process performance may be masked as operators compensate for that deterioration by reducing output in order to maintain water quality compliance, carrying the risk of being unable to meet future peaks in demand. Operational ‘near-misses’, those events that could have tipped over into a major disruption but were narrowly averted, are rarely captured and trended. In the world of health and safety such near misses are the key lead indicator to ensure that serious injuries or fatalities are avoided. There are also many ‘hidden’ vulnerabilities such as obsolete hardware and software used in critical operating systems; unsuspected localised single points of failure; lack of testing of contingency plans and over-dependency on the expertise of individual staff members.

The result of this situation is that few water companies have genuine insight into the level of risk of service disruption at which they operate on a day-to-day basis or how this position changes as a result of operational activities or asset investment choices they have taken. The companies would not know that they had breached thresholds of risk tolerability which, had they more complete situational awareness, they, their customers and regulators would deem unacceptable. Should a major service disruption event occur in that context, companies may find themselves in a very uncomfortable position and may suffer long-term damage to their reputation and the trust and confidence of their customers for having tolerated that situation, however unwittingly.

There is little doubt that in the wider economy and society the digital revolution is transforming many aspects of work and life. In the UK water sector with its aging asset base and regulatory pressure to see stable or reducing customer bills, the lure of digital transformation, smart networks, big data and Internet of Things to extend the life of those assets, manage capacity and demand and deliver operating efficiencies is very compelling. But it is also important to

recognise that embracing such technologies brings new vulnerabilities, not just in relation to cyber-security but in relation to the skills requirement to operate and maintain those new systems, the increased dependency on power and communications networks and the potential inability to operate those systems ‘in hand’ if the digital control systems fail. Any digital transformation strategy needs to account for those new vulnerabilities and also seek to address the latent vulnerabilities and lack of understanding of our existing ‘dumb’ asset base.

Coming back to the challenge for the water companies in England and Wales, to develop integrated systems-based approaches to resilience, there are examples emerging from the work undertaken by the Infrastructure Transitions Research Consortium, on behalf of the National Infrastructure Commission which applied complex adaptive systems theory to explore strategic planning of multiple infrastructure sectors, developing national infrastructure system-of-systems models which include long-term planning and analysis of risk and vulnerability of critical national infrastructure. The approach is described in a paper ⁶ from the Environmental Change Institute, University of Oxford, which reflects that “*while some policy makers have been keen to adopt the narrative of complexity, the application of complexity-based methods in public policy decision-making has been restricted by the lack of innovation in associated methodologies and tools*”. This chimes strongly with the current situation in the UK water sector.

If adaptable to the context of an individual water company, the system-of systems models referred to above may be one way of meeting the aspirations contained in the Ofwat challenge and begin to provide the kind of tools which can address the unavoidable complexity of our increasingly interconnected world. As we embark on such potential developments, we need to make sure that we are building them on a sound foundation, addressing the current gaps in our knowledge and understanding of our asset systems and bringing those hidden vulnerabilities into the spotlight.

Keywords: Action plan, Flood risk, Water industry

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