



100 Resilient Cities
RESILIENCE POINT OF VIEW SERIES

Water and Sanitation



During its five years of operations, the 100 Resilient Cities program supported the participating city governments to prepare city-wide resilience strategies for each city. During these strategy development efforts, city governments and their stakeholders considered and prioritized a full range of urban risks and vulnerabilities, which spanned each city's diverse communities, places, economic sectors, and operations.

As the strategy processes established each city's resilience priorities and action areas, 100RC staff, together with 100RC's 115 Platform Partners and scores of Subject Matter Advisors, provided further domain specific support to the cities' relevant technical and managerial counterparts and stakeholders. These focused efforts led to the preparation of domain specific resilience frameworks and approaches. These approaches are now being summarized in this 100RC *Resilience Point of View* series.

The Water Resilience Challenge

Access to Water and Sanitation Services

Flowing through every part of the economy, water is a fundamental for cities and their residents. Access to safely managed water and sanitation and sound management of freshwater ecosystems are essential to economic prosperity, health and development outcomes, and to environmental sustainability. Yet cities are not managing water well, due above all to failures of policies, governance, leadership, and markets. The existing challenges include inadequate access, poorly managed risks, and increasing competition for water resources. Climate change will amplify all these challenges. Already, 4.5 billion people, about two-thirds of the world's population, rely on sanitation that puts their own or their neighbors' health at risk from water borne diseases, and 2.1 billion people live without readily available, safe water supplies at home. Today, more than half the world's population, roughly 4.3 billion people, live in areas where demand for water resources outstrips sustainable supplies for at least part of the year. With 60% of the world's population anticipated to be living in cities in 2030 (over two billion new urban residents) cities will not be able to meet the challenges of the 21st century, such as food and energy security, liveability, and climate change, without improving how they manage their water resources and allow people access to reliable water and sanitation services.

Urbanization and Resource Intensification

Current trends in urban growth and resource intensification are expected to accelerate over the coming decades, especially in East and Southeast Asia, sub-Saharan Africa, and Latin America. The greatest challenges are seen where fast-growing populations strain systems that were designed to supply far fewer people and where much of the clean water available is lost due to dilapidated, poorly constructed, or centuries-old infrastructure that is poorly operated and maintained. Water supply and sanitation (WSS) utilities in the Global South are under tremendous pressure to increase coverage and service levels (including to the urban poor), which often relegates increasing infrastructure resilience of new and existing assets to a secondary priority due to budget constraints. This is coupled with environmental standards and rising living standards and expectations of the city's residents.

Climate Change

Climate change impacts affect the water cycle cities and service providers rely on and amplify existing challenges. Recent estimates suggest that it will expose more people to water scarcity, which, combined with other factors, could lead to greater demand for already-depleted groundwater. Increased levels of rainfall variability, glacier loss, and rain rather than snow at altitude reshape the flows of rivers and stores of groundwater. Rising sea levels and storm surges impact water quality as

they drive saltwater into unconfined coastal aquifers and deltas. And finally, water-related natural disasters are increasing in frequency and intensity, with mounting evidence from China to California. Climate change tripled the likelihood of the drought that pushed Cape Town to the brink of "Day Zero." Moreover, the economic costs of these are also projected to rise. California's drought cost \$2.2 billion and over 17,000 jobs in the agricultural sector in 2014 alone. Germany, France, Italy, and Poland can all expect average annual flood damage costs to rise to more than € billion each by 2020. The proliferation of infrastructure in flood-risk areas could nearly double these costs for Poland and Germany to around €2 billion each. Given the concentration of populations and economies, cities are of preeminent concern regarding water-related disasters including coastal storms, saltwater intrusion, intense rainfall events, flooding, droughts, and changes in water availability, timing, and quality. Sudden shocks deeply impact cities' abilities to adequately treat and transport drinking water and wastewater in and out of urban areas. Coastal and delta cities are even more exposed and sensitive to such impacts often exacerbated by subsidence.

Globalization

In a globalizing system, environmental policy issues are intricately bound together with issues of trade policy, human rights, and economic security. For ex-

ample, the U.S.-Mexico border area has experienced an explosion of growth in response to international economic conditions and trade agreements in the 1990s, and the increased employment opportunities have led to a large influx of people into the border regions. These rapid changes in manufacturing and agricultural trends are greatly influencing water use as well as wastewater production patterns, and the potential implications of all these trends on water quality remain to be evaluated. In most regions of the world, over 70% of freshwater is used for agriculture to grow crops for food and feed purposes, for materials, such as cotton, and increasingly for the growth of energy crops. By 2050, feeding a planet of nine billion people will require an estimated 50% increase in agricultural production and a 15% increase in water withdrawals. More and more, water is used to produce commodities for export that are traded all over the world. Trade can enhance global water-use efficiency when crops are grown at other locations with the use of less water, but trade can also shift the environmental burden to distant locations. Matching water demand and supply is no longer a city or even a river basin issue, but a global issue. Consumption in one city or country impacts water systems elsewhere in the world at the various locations where the production processes take place. This makes most countries in Europe, North Africa, and the Middle East dependent on water resources in other parts of the world.

Water system resilience in the context of current practice

There is a clear demand to start thinking about and developing new approaches for providing essential water supply and sanitation services to city residents which is intricately linked to the resilience of the city and its urban water system. The concept of resilience has been more extensively explored in the context of cities than it has been for water, specifically. 100 Resilient Cities (100RC) defines urban resilience as the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience. Chronic stresses weaken the fabric of a city on a day-to-day or cyclical basis while shocks are sudden, sharp events that threaten a city. 100RC believes that a city's resilience is based on the resilience of specific urban systems with water being one of those systems, rather than the resilience of "the city" as a system itself. Consequently, the resilience of the water system is an integral part of the city's resilience.

The concept of resilience is newer to the water sector. Globally it is often used in relation to flood and drought resilience, or climate resilience in a broader sense as well as infrastructure resilience or disaster resilience. There is comprehensive guidance published covering resilience planning for critical infrastructure or specific aspects such as drought planning. However, most measures tend to be focused around one specific hazard or one means of mitigation. The concept of resilience widely encompasses

the ability to "return to normal" by effectively coping with negative impacts or rapid-onset disasters, the ability to adapt to the "new normal" effectively, and the ability to accommodate radical shifts. In this context the demand for new concepts, approaches, and guidance on resilience has increased dramatically over the last few years focusing particularly on disaster risk reduction closely linked to infrastructure resilience and climate adaptation. Though the topic has been covered extensively in theoretical studies, works on resilience practice in the water sector are rare. However, there are examples of conceptualisation of resilience emerging as outlined in the examples below.

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Disaster Resilience

The increase in frequency and severity of hazards such as droughts, floods, and hurricanes over the past decade has led to calls for improving resilience in the water sector often referring to the capacity of households, communities, as well as cities and utility service providers to cope with disruptions in the water supply system as well as restore service provision as quickly as possible after, for example, a hurricane. In this context resilience in the water sector is more particularly linked to emergency response (this includes emergency supply and contingency planning) and recovery. However, as short lead time disruptive events or shocks disrupt service provision or cause environmental pollution not only because water and wastewater infrastructure is being destroyed but because these events or shocks also affected other infrastructure that a reliable water sector depends on including electrical power supplies, telecommunications, and transportation, the interdependencies of these systems is highlighted and needs to be considered. As an example, the United States Environmental Protection Agency's (EPA) concept of water resilience focuses on supporting water and wastewater utilities in identifying emergency preparedness, prevention, and mitigation measures to improve the resilience of drinking water and wastewater infrastructure to several types of hazards (flooding, drought, power failure, water contamination) to ensure the provision of clean and safe water in and after emergencies. EPA has developed a robust suite of products and services that will help small and medium sized drinking water and wastewater utilities learn more about becoming resilient to hazards. The importance of disaster resilience in the U.S. water sector was elevated on October 23, 2018, when America's Water Infrastructure Act (AWIA) was signed into law. The law requires community drinking water to develop or update risk assessments and emergency response plans.

Climate Resilience

Water resilience is often mentioned in the same sentence or is associated with climate resilience because water is at the front-line for climate change

and the sector most often mentioned for adaptation actions. Resilience in this context refers to the capacity of a project, infrastructure, or system to absorb shocks or stresses imposed by climate change to evolve into greater robustness. Projects planned with climate resilience as a goal are designed, built, and operated to better handle not only the range of potential climate change and climate-induced natural disasters, but also contingencies that promote an efficient, rapid adaptation to a less vulnerable future state. While WSS utility planners and engineers have dealt with natural climate variances and disaster planning as part of the infrastructure design process for many years, traditional methods have not considered the deep uncertainty around long-term water resource availability and water quality impacts of sea level rise as well as rapid, uncontrolled urbanization. In December 2018 the World Bank released a road map to Building the Resilience of WSS Utilities to Climate Change and Other Threats. This road map proposes a process in three phases that can inform the design of strategies necessary to WSS services provision. The road map builds on the understanding that climate change is most often an amplifier of existing uncertainties (many of which are threats), and, as such, should not be evaluated as a stand-alone impact. The approach reveals the strengths and vulnerabilities of investment plans concisely and helps utilities invest robustly by identifying near-term, no-regret projects that can be undertaken now, while maintaining flexibility in pursuing additional actions adaptively as future conditions evolve.

Utility resilience

If the concept of resilience is applied to water and sanitation service providers (utilities) it often refers to the capacity of the utility to provide reliable services and to cope with disruptions in the water supply system as well as restore service provision as quickly as possible after shock events. It is, therefore, strongly linked to the management of extrinsic threats and systemic risk and supports the development of proactive adaptation strategies. In the U.K., a resilience duty was introduced by the 2014 Water Act. Consequently Ofwat, the economic regulator

Defining water and sanitation service provider resilience

of the water sector, has set out its expectations for water companies to become more resilient in their business planning processes for the PR19 price review in 2017. This is the first time a regulator enforces a much broader resilience objective by linking long-term resilience of water supply systems and sewerage systems to environmental pressures, population growth, and changes in consumer behavior. In addition, Ofwat requires service providers to secure sustainability of water and sewerage services through appropriate long-term planning and investment, managing water resources in sustainable ways, and increasing efficiency in the use of water and reducing demand for water to reduce pressure on water resources. Ofwat highlights that its resilience duty requires it and the sector to think beyond the structure and functioning of assets and to consider whole systems and services.

City Water Resilience Framework

In 2017 100 Resilient Cities and seven 100RC member cities started to support Arup in developing a global framework of water resilience as part of a grant Arup had received from the Rockefeller Foundation. The City Water Resilience Framework (CWRF) is supposed to help cities to better prepare for and respond to shocks and stresses to their water systems. Besides establishing a global definition for water resilience, the CWRF establishes qualitative and quantitative indicators to measure city water resilience. By applying the CWRF cities can diagnose challenges related to water and utilize that information to inform planning and investment decisions. It helps guide cities to build resilience in four dimensions: (1) Leadership and Strategy, (2) Planning and Finance, (3) Infrastructure and Ecosystems, and (4) Health and Wellbeing. These four dimensions are broken down into eight goals and detailed further in 53 sub-goals. Indicators for each sub-goal allow cities to measure performance and assess the overall resilience of their current water system. In this context urban water resilience has been defined as the capacity of the urban water system, including human, social, political, economic, physical, and natural assets, to anticipate, adopt, respond to, and learn from shocks and stresses, in

order to protect public health, wellbeing, and the natural environment, and minimize economic disruption.

We understand and agree that water resilience needs to consider the capacity of the whole water system or water cycle and strongly support the application of this definition. Because overall city resilience, water resilience, and catchment level resilience are mutually interdependent, an assessment of urban water resilience must consider the hydrological context (including water basins), built infrastructure, and the socio-political, and economic context (i.e., human, social, political, economic, physical, and natural assets). In a similar sense, water resilience must consider the interrelationships between water and other critical urban systems. The holistic approach to resilience is therefore key to designing interventions that make city and water systems resilient.

100RC recognizes that building urban water resilience requires a cross-sector, multidimensional yet dynamic understanding of resilience to respond to the different capacities of our cities as well as the differences in the enabling environment and potential entry points to start working on urban water resilience.

The scale of urban water resilience and the complexity related to the number of stakeholders involved in urban water management and the interdependencies that exist between the city water system and other systems (e.g., energy, agriculture and food supply, land, forest, communications, transportation) present both a conceptual challenge—to understand and measure a concept as complicated and fundamental as resilience—and a practical one, requiring long-term coordination across multiple stakeholders to undertaken meaningful action. While few disagree with the need to “do something” opinions vary about what exactly should be done and how and even more important who should take the lead. Considering that a lot of stakeholders that have an important role to play in building resilience may not be technical experts or familiar with the complexity of urban water systems, Arup proposed a second definition of urban water resilience which has been adapted from the definition of city resilience from the City Resilience Index. This high-level definition is intended for use with non-technical stakeholders: Urban water resilience is the capacity of the urban water system to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses and shocks they encounter. Even more than the definition before it highlights the importance of providing essential services to people.

Many of our cities are facing the reality that water and sanitation service delivery is insufficient and embedded institutionally within national, regional or municipal agencies (an inheritance of the European models which developed over a century ago). Stakeholder engagement and governance as well as the enabling environment in general are important when start working on resilience because there are powerful interests at play – professional experience and prestige, access to funds, and finally the ability to influence investment decisions. Considering these aspects which are difficult to address in the short-term, we may have to think again about how to do resilience right considering the different realities in our cities.

Fundamentally we must stop assuming that the situation and enabling environment in Southeast Asia or Africa is comparable to that in Europe or the U.S. (where universal coverage is the norm). While we agree that a common definition of water resilience is important and should inform resilience assessments and actions around the world, we also believe that it is important to help cities with lesser capacities to carefully decide what to do first, to decide what aspects of resilience are the most important; in other words, what aspect of urban water resilience is going to be dealt with as a priority. This is not simple as most practitioners would agree that “resilience” as a whole is a “big” idea. Not least because it covers the whole water cycle, the stakeholders and the services that rely on

grey, green and blue infrastructure that allows for providing safe water and disposing off or reusing wastewater and provides protection from water.

Focusing on the “whole resilience challenge” can seem very daunting, and there is no doubt that in some cases, the felt enormity of the problem results in stasis. What is often forgotten is that the whole problem does not have to be solved simultaneously. In many cases, more progress can be made by focusing on a few solvable problems, and dealing with the most important challenges first, before turning to the management of the overall situation which may have to be deferred to a later date. While it may be useful to plan for a wholistic solution, practicality, political buy in and resources may dictate that a phased or stepped approach must be taken to implementation.

For cities with very low access to safe water and basic sanitation increasing access to and improving the reliability and effectiveness of water supply and wastewater service provision may have the biggest impact particularly on public health and the poor and the vulnerable. For this reason, some cities may legitimately decide to focus their efforts at this level in the short-term. Each city needs to work out what is the most sensible and cost-effective way of thinking about urban water resilience in the short and long term and then act accordingly. Flexibility and pragmatism should be the key words. A pragmatic approach with an eye to wider aspects of resilience is likely to result in more progress than blind adherence to a rigid global definition and implementation approach.

In many of our cities in the Global South building resilience is a prerequisite for development and development is multifaceted. We acknowledge that shocks and stresses can reverse years of development gains and efforts to eradicate poverty. Progress in nutrition, health, education, work, equality, and environmental protection are all, however, related to the availability and sustainable management of water and universal access to effective systems for disposing of our waste. Yet, today, millions

of citizens still lack access to safe water and sanitation. At the same time, demand for water – from agriculture and industry as well as domestic use – is rapidly rising and water pollution and ecosystem degradation are being made worse by increasing amounts of untreated wastewater. And all of this is happening against a backdrop of climate change, which is playing havoc with the predictability of water being available. That’s why we believe that building water resilience must tackle weak funding, planning, capacity, and governance of water and sanitation services as a top priority.

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While the physical assets of the water system are an important part of it, there is a large human or social aspect that lies at the core of a resilient water system: people all over the world want and need confidence that clean, safe drinking water will be reliably available and that they can rely on their wastewater being taken away. Society needs confidence that these services will be provided today and in the long term, without compromising the natural environment, and more widely that decisions made today will not impoverish future generations. This puts water and sanitation service providers and their performance at the center of water resilience. It highlights the need for long-term resilience of water and wastewater infrastructure and service provision when faced with increasing external stresses, such as climate change, population growth, or changes in consumer behavior. It

highlights the need to promote long-term planning and investment, and the use of a range of measures to manage water resources in sustainable ways and increase efficiency in water use and reduce demand for water to minimize pressure on water resources including the use of alternative sources of water.

Addressing first resilience at the service provider level can be an entry point in building water system resilience in the long run. Therefore, we allow for another “basic” definition of water resilience that reflects the dynamic and integrated understanding of resilience by putting the utility service provider at the centre because reliable and sustainable water and wastewater services are essential for people, for the economy and for the environment and an essential function of the urban water system. We therefore define resilience of service provision or utility resilience as the ability of the utility service provider to cope with, and recover from, disruption and anticipate trends and variability in order to provide reliable and sustainable water and/or wastewater services for the people living and working in cities – particularly the poor and the vulnerable – for the economy, and protect the natural environment now and in the future.

Providing resilient water and wastewater services requires that cities and service providers understand the systems they depend on and the interdependencies and risks they face. By strengthening the underlying fabric of service provision and better understanding the potential shocks and stresses service providers may face, they can improve and sustain services provided to all – poor or rich households, businesses, industries as well as agriculture and water important to contain essential ecosystem services. Applying the resilience lens will allow service providers not only to provide essential services and to reduce risks to their operations, it will allow them to improve their organizational performance and to create additional social, economic and physical benefits (co-benefits) through their services for cities, communities, households and businesses as well as the natural environment.

To address resilience, service providers need to identify shocks and stresses that may impact their operations, their performance (continuity and quality of service) as well as their financial sustainability. They need to establish robust processes to learn from past experience and regularly review and improve core processes as well as identify new emerging risks associated to climate change, urbanisation and population growth. They need to analyse, and address, vulnerabilities associated with retaining and securing a highly skilled work force, changing supply chains and emerging risks through increased dependence on computer networks and automated control systems to operate and monitor processes (cyber threat), which bring challenges to planning and operation. And more importantly they need to learn how to deal with both dynamic hazards and chronic stresses.

Water and sanitation services will only be resilient if the service provider and the systems that underpin them are resilient. The overall system on which water and wastewater services depend is complex. It includes many different things including infrastructure and networks that cities or service providers own, maintain and operate, personnel but also eco-systems and financial systems. In addition, the customers or the recipients / end-users of the services themselves are an important part of this system and largely influence its resilience through their demand (related to service levels as well as, for example, water consumption). Finally, it is important that water and sanitation service providers are financially resilient and have a corporate and organizational structure that allows them to provide services to their customers as well as protect the environment now and in future.

The following figure tries to outline the different aspects and levels of resilience:



Figure A. The scope of an LED Resilience Workstream

Thereby 100RC defines resilience of the three subsystems of a utility service provider as follows:

Corporate Resilience:

Corporate resilience is the ability of the service provider’s governance, accountability, and assurance processes to help avoid, cope with, and recover from disruption of all types and to anticipate trends and variability in its operations to prepare for a sustainable future. Thereby governance comprises the systems and processes concerned with ensuring the overall direction, effectiveness, supervision, and accountability of the service provider.

Financial Resilience

Financial resilience is the service provider’s ability to avoid, cope with and recover from disruption to its finances and to be financially sustainable in the long-term. Service providers need to have the financial means to protect critical assets against

shocks, maintain infrastructure to avoid disruption of services, allow for investments taking uncertainties due to climate change into account, and to deal with and recover from a disastrous event without major economic interruption or even bankruptcy. In addition, service providers need to be able to provide services to all for an affordable price including the poor and the vulnerable without compromising their financial situation.

Operational Resilience

Operational resilience is the ability of the service provider’s infrastructure and assets, skills and staff to run and maintain its infrastructure and to establish relevant core processes and responsibilities to cope with, recover from disruption and enhance its operational performance in the long term. It is about maintaining a quality service for everybody at a price that current and future generations can afford.

As with cities, resilience lies at the heart of service provision. It is part of everyday operations and

building resilience is an ongoing process. Resilience is not an add-on – it is central to effective management. A robust, effective approach to resilience does not mean that nothing ever goes wrong, or that services never fail. It means that risks are managed well, informed by clearly defined priorities now and in future and that whenever initiatives or investments are designed, they aim at enhancing performance of service provision and minimize unintended consequences and create co-benefits (through systems thinking). Resilience is an ongoing process and part of everyday decision making.

Like cities resilient service providers demonstrate seven resilience qualities that allow them to withstand, respond to, and adapt more readily to shocks and stresses:

Resilient service providers use past experience to inform future decisions (reflective). They understand the importance of external engagement, partnerships and networks to share insights and learn from others. They analyse and document responses from past events / incidents to learn and improve their reactions and past performance. They analyse trends for latest evidence and collect information and data that could influence service provision in the medium- to long-term particularly related to impacts of climate change and urbanisation.

Resilient service providers recognize that there are alternative ways to use precious resources (resourceful) including applying circular economy approaches, reuse and recycling of waste- and stormwater. They value the water they have – in all its social, cultural, economic, and environmental dimensions – to educate their citizens, reduce wastage and pollution, ensure water is available for societies’ priorities, reduce risk, and to make water services more sustainable. They focus on water demand management, reduction of non-revenue water and facilitating behavior change of end-users to conserve water and install water saving devices to reduce water consumption of needed. They encour-

age their customers to become more engaged, empower them and provide incentives to change the level and pattern of their demand. They design and apply concepts that reduce the amount of rainwater entering the sewer network and work with customers to reduce inappropriate items being flushed.

Resilient service providers establish well-conceived, constructed, and managed infrastructure systems (robust). They provide their customers with confidence that clean, safe drinking water of sufficient quantities will be available whenever they need it and that they can rely on their wastewater being taken away and disposed off safely without harming public health or the environment. They provide continuity of service by enhancing the ability of assets, networks and systems to anticipate, absorb, adapt to and/or rapidly recover from a disruptive event. Resilient service providers assess their maintenance processes to ensure assets are functioning as designed and are ready when called upon. They consequently apply resilience principles when designing infrastructure and ensure assets meet latest best practice, industry standards and legal requirements while at the same time allow for innovation to increase the ability to respond to threats and opportunities.

Resilient service providers ensure that they have the right people to operate and manage service provision, that they train and develop their workforce and provide incentives to perform. If failure occurs, resilient service providers are able to respond quickly in line with coordinated and pre-prepared emergency plans that ensure that all their customers receive a minimum level of service even in extreme circumstances. Resilient service providers have the right equipment available including communication to support and engage the public during an emergency or crisis. They collaborate with other service providers or critical infrastructure to ensure an efficient emergency response. They control and manage their assets though effective and real time monitoring. And, resilient service providers take out appropriate insurance mechanisms to support the costs of emergency operations or

Developing a strategy and program for water and wastewater service providers



costs of loss or damage that may occur as a result of extreme events.

Resilient service providers provide spare capacity purposively created to accommodate disruption (redundant) which includes backup systems in operations, IT and supply chains to ensure continued service when something fails. They consider financial protection mechanisms like catbonds that can provide necessary funds in case of an emergency or crisis. They manage their catchments and use nature-based solutions to reduce flood risk and improve storm water management while delivering wider benefits for recreation, biodiversity, and carbon storage.

Resilient service providers are willing and able to adopt alternative strategies in response to changing circumstances (flexible). They design their networks to enhance capacity and flexibility to allow water to be moved where it is needed.

Resilient service providers have strong governance mechanisms to effectively manage water, provide ways for the full range of stakeholders to engage with and take responsibility for water resources, as well as water and sanitation services (inclusive).

Resilient service providers identify solutions to address their risks and vulnerabilities through approaches addressing technical, institutional, financial, social, and environmental issues simultaneously (integrated). They have a strong leadership team and cooperate well beyond the city, service provider or water community. Resilient service providers lead an integrated agenda at the local, regional and even national level and put people at the center of service development.

Building resilience into their service provision will result in increased reliability and operational effectiveness of a water and sanitation service provider in both the short and long term. There are multiple pathways that can help lead service providers down the road to a resilient future. However, we believe that the following 6 steps are crucial:

Step 1: Defining Resilience

Service providers need to understand what resilience means in the context they operate, how to assess it and how to use the results to inform decision making and solutions design. This requires that they formulate a clear vision of what resilience means to them, what specific conditions must be accomplished to achieve this vision, what efforts will be required and who from inside and outside the organization needs to be involved in the process (e.g., shareholders, customers, regulators, government, etc.).

Step 2: The Resilience Champion

Service providers need to establish a resilience champion or leader within the organization. There may be varying views within the organization on who should lead on resilience, however, as the Chief Resilience Officer in cities, the “Utility Resilience Officer” should be part of the management or executive team to be able to influence decision making. At the beginning of the resilience journey we don’t believe that the establishment of a new position or department will be necessary, however, the core

function of building resilience should be integrated into job descriptions as soon as possible to anchor resilience from an organizational perspective. We believe that to improve coordination and cooperation as well as to strengthen resilience within the organization and the sector or city a resilience action group should be established that includes a wider group of stakeholders from inside and outside the organization (e.g., customer representatives, community based organizations and nongovernmental organizations, regulators, government agencies). The remit of this group is to guide and inform the resilience-building process keeping the different interests in mind. It also will validate information and act as an advisory committee during the resilience journey.

Step 3: Understanding Resilience

Service providers need to understand their current level of resilience. To inform the resilience assessment in the next step they need to collect data and information to understand the institutional landscape they are operating in including governance structure, legal and regulatory framework. They

need to understand and map their water system, their organizational structure and their core operational processes. Data collection should also include the analysis of existing plans and strategies. Service providers tend to have a lot of plans that relate to resilience – even if they are not called resilience plans (strategic plans, investment plans, business plans, emergency plans, etc.). However, a multitude of plans, operating procedures or processes may lead to complacency and ultimately lower resilience. Building resilience requires reviewing and stress-testing plans and core processes as widely as possible. This should include a consideration of cascade failures, the reliance of other sectors and the risks related to cybersecurity, which means better multisectoral planning and coordination.

Service providers need to prioritize shocks and stresses and prepare an inventory of actions that are potentially tied to address these shocks and stresses. This can include actions that are currently being implemented or planned. In this context it also can be helpful to collect qualitative data to better understand how key stakeholders from within and outside the organization define and perceive the service providers resilience (perceptions inventory – key informant interviews or focus discussions) as the perception of gaps, risks and vulnerabilities can vary widely and is often biased by personal experience as well as access to information.

Step 4: Assess Resilience, Prepare a Resilience Profile and Identify Priority Areas for Intervention

To guide a utility towards improving its resilience an assessment tool and methodology need to be developed which a) consider the water system service provision depends on and b) includes the subsystems of resilience as defined above. The resilience assessment should cover all core functions and processes of the service provider and examine the resilience of these subsystems to identified shocks and stresses which can ultimately impact service provision. Additional internal shocks and stresses can be identified at this stage and inte-

grated into the assessment if considered necessary. The assessment will allow the service provider to identify risks and vulnerabilities and to establish the maturity of its resilience at a specific time. The first assessment serves as the baseline against which resilience improvements will be measured. To allow for the establishment of resilience values and potentially benchmarking or comparison of resilience as well as rate of improvement sound metrics and indicators need to be developed. These can be qualitative or quantitative measures of resilience. Selected indicators should then be also used to report against a set of resilience criteria. Based on the information and data collected in Step 3 and the results of Step 4, a resilience profile will be established and priority areas for intervention identified.

We believe that there is a demand for a rapid but comprehensive tool which is easy to implement, can be used by utilities of varying sizes, contexts, and being confronted by different shocks and stresses. The rapid resilience assessment is the first step of building resilience which can be built upon or extended based on commitment, time, and resources available. The development of the tool should be informed by international best practice including the City Resilience Framework (CRF) and CWRP as well as other toolkits or guidance that aim at improving performance or different aspects of resilience (e.g., climate or infrastructure resilience) including relevant metrics and performance indicators. The tool needs to consider the different subsystems of resilience as outlined before and clearly identify the level of resilience that should be achieved or would be desirable. All this should be based on a good understanding of risks faced, the cost of failure, and the cost and benefits to avert failure or to manage and recover from failure. At this stage, a resilience tool must highlight gaps and vulnerabilities as well as risks and a resilience level to inform the preparation of an action plan.

Step 5: Develop an Action Plan and Integrate Resilience into Business and Investment Planning Process

Based on the risks and vulnerabilities as well as the priorities identified, service providers will prepare an action plan and integrate concrete initiatives as well as resilience objectives in their strategic, business and investment planning. Thereby service providers should focus on actions with resilience qualities-such as being inclusive, integrated, flexible, redundant, reflective, resourceful, and robust-and targeting issues of equity, transparency and sustainability. The process of building resilience provides the opportunity to address some of the underlying challenges that may have prevented efficient and equitable service provision in the past. Beyond building its capacity for resilience, service providers at this stage can take advantage to embark on a unified planning exercise. Such a planning exercise can help devise and design a more precise set of initiatives, projects and programs that can improve its development trajectory and the well-being of its customers.

To avoid putting an additional burden on WSS utilities resilience assessments and resilience building need to be incorporated into the utilities core processes and procedures. Resilience assessments need to become an integral part of their performance improvement and strategic, business and investment planning processes. This will likely require a shift or reorientation in the current practices to a) incorporate analytics on resilience as part of their organizational development and b) incorporating uncertainty in water systems planning and investment design to bolster their capacity to provide critical services to cities.

Step 6: Monitor and Report on Resilience Progress

A standardized rapid resilience assessment will allow WSS utilities to compare their performance / resilience with other utilities around the world. It would also allow regulators to evaluate and report on a utilities performance and set objectives as part of their duty. In addition, it will allow to measure the impact of initiatives taken or investments made on the resilience of the utility and service provision. Metrics need to be at a level of detail appropriate to the scale of the risk; be practical and easy to measure; measure impacts on people and the environment (as well as potentially the city as a whole and the economy) and establish the minimum levels of resilience expected. A certain level of standardization will require a greater discussion between WSS utilities, regulators, government, and the public about how to tackle resilience and a resilience standard needs to be developed. This could be a qualitative measure as opposed to a quantitative metric. However, WSS utilities should report against a set of resilience criteria with clearly defined indicators. They can be qualitative or quantitative and need to be linked to their strategic goals.

Conclusion

With an estimated 2 billion new urban residents estimated by 2050 and a growing backlog of particularly poor and vulnerable populations who still do not benefit from safely managed water and sanitation, there is a clear demand for new ways of providing essential water and sanitation services. However, the scale and complexity of this need presents a challenge to decision-makers across the world and multiple-sectors. A clear demand exists for innovative approaches and tools that help cities build water resilience at the urban scale. 100RC and its partners focus on developing new tools and concepts that help cities to grow their capacity to both anticipate and mitigate water-related shocks and stresses, to identify risks and vulnerabilities related to safely managed water and sanitation service provision and to utilise that information to inform planning and investment decisions. Through its global network of cities, 100RC will be piloting and improving these approaches over the coming years and actively advocate for a shift in the current practices of urban water management. 100RC welcomes others to join the effort to help cities changing their relationship with water. Incorporating analytics on resilience and uncertainty in water systems planning and investment design is crucial to bolster the capacity of cities to survive, adapt, and grow no matter what chronic stresses and acute shocks they face.

The time to build resilience is now.

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