The ROCKEFELLER FOUNDATION

THE RESILIENCE SHIFT

SIWI

ARUP

THE CITY WATER RESILIENCE APPROACH

PARTNERING FOR A RESILIENT FUTURE

INTRODUCING THE CITY WATER RESILIENCE APPROACH

Global water crises—from flooding to drought—are the biggest threats facing the planet over the next decade. As the world's urban population grows larger, resilient urban water management will be critical to ensuring safe, healthy and prosperous cities.

At the same time, urban water issues are complex, involving overlapping and interconnected systems, and diverse sets of actors. Water is fundamental as an essential condition for human health, a catalyst of economic development, an ingredient in urban place-making, and an element in shared culture, heritage and history. Accordingly, water services are shaped by financial and political considerations, affected by urban growth, land use planning and environmental management. Given the complex nature of these relationships, planning for water resilience is neither simple nor straightforward. Cities require tools and approaches that help them understand what drives water resilience, and to navigate the process of building it.

The City Water Resilience Approach (CWRA) helps cities build the capacity of urban water systems to endure, adapt and transform in the face of new challenges. The approach will inform how water programmes and projects are prioritised, planned, delivered and operated to improve outcomes to individuals.

CWRA VALUE PROPOSITION

There is an urgent need to support cities in their efforts to provide high quality water services to their growing populations, and protect residents from water-related shocks and stresses. The City Water Resilience Approach (CWRA) addresses this need by proposing a clear and detailed process for assessing the strengths and weaknesses of urban water services, and then designing and implementing projects that improve water resilience.

The CWRA describes a five-step process that moves from stakeholder engagement and resilience assessment, to creation and implementation of resilience action plans, and then to monitoring the results of interventions. Within each step, the approach outlines a detailed methodology for achieving resilience goals. The CWRA also provides a set of resources to assist with the individual steps along the process, corresponding with the five steps. These are meant to guide the approach and reduce the time and effort required to complete each step, and consist of a mix of digital and analogue tools.

The CWRA responds directly to cities' critical needs in the following ways:

The CWRA helps cities formulate a clear vision of what urban water resilience means to them, including what specific conditions must be accomplished to achieve this vision, what efforts will be required to build resilience and what actors are involved in this project. For each city, the CWRA develops a vision plan that guides future actions. This plan is informed by extensive research into what makes up resilience, and builds off review of international best practices, insights from academic scholarship, and practical experience with eight pilot cities.

The CWRA provides a detailed plan for prioritizing key actions in cities and implementing them to achieve the city's water resilience plan. Based on an assessment of each city's strengths and weaknesses, the CWRA describes a rigorous, practical and researched process for translating shared vision into reality. The approach helps cities identify key actions and then guides them as they implement and monitor those actions.

The CWRA provides resources that will help cities carry out each step of the process. These tools include a mix of analogue and digital tools—including the City Water Resilience Framework (CWRF) and OurWater—that facilitate the critical steps along this process and address the practical problems that cities face.

The CWRA establishes an extensive and continuously growing body of knowledge on urban water resilience that cities can draw on to share experiences, identify innovative new approaches, and advance a community of practitioners at all stages of the resilience approach. As the CWRA expands to additional cities, the community of practitioners will benefit from new experiences, and help catalyse partnerships between a range of users and funders.

CWRA value proposition

KEY STAKEHOLDERS	COMMON CHALLENGES
High-level decision-makers in: - *City Government* - *Regional/National Government* - *Private Sector*	- Logistical challenge of identifying and convening all relevant stakeholders - Complex, time-consuming process required to agree on a shared plan for resilience - Difficulty communicating benefits of resilience to constituents for buy-in (citizens, corporate stakeholders, board of directors, etc.)
Department / organizational heads in: - *City Government* - *Water Utilities* - *Private Sector* - *Multi-National Government Organizations* - *Regional/National Government* - *Catchment/Basin Authorities* - *NGOs* - *Community Organizations* - *Development Banks*	- Lack of tools to help identify/assess how the city is performing at a high level - No systematic approach to identifying and prioritizing necessary actions - Little cross-organizational agreement on action plan and actors involved to improve performance - Limited opportunities for communication between cities or awareness of innovations being piloted (i.e. what other cities are doing and who can resilience practitioners learn from)
Department heads *or* technical leads in: - *Development Banks* - *Multi-National Government Organizations*	- Difficulty finding projects to fund with well-considered actions, clear resilience benefits and broad support from stakeholders
End users : - *Residential Users* - *Commercial Users* - *Citizens/Electorate*	- Limited understanding of individual's role within a wider water system and awareness of opportunities to impact water services in their city - Poor coordination between water providers results in lower quality of water service for end-users

DIRECT GAINS	VALUE
- Suite of resources for identifying and mapping relevant stakeholders, roles and links - Detailed five-step process for achieving end goal, realized according to in a clearly defined objectives and time horizons - Clear articulation of holistic benefits of resilience to all stakeholders	**The CWRA helps cities formulate a clear vision of what urban water resilience means to them,** including what specific conditions must be met to achieve this vision, what efforts will be required to build resilience and what actors are involved. For each city, the CWRA develops a vision plan to guide future actions. This plan is informed by extensive research into what makes up resilience, and builds off review of international best practices, insights from academic scholarship, and practical experience with eight pilot cities.
- CWRF shows how city performs in 12 goals of urban water resilience - Develop a coherent vision with targets for resilience - Detailed five-step process for achieving defined objectives according to defined time horizons - New platforms (digital platforms, conferences, etc.) for sharing knowledge across cities	**The CWRA provides a detailed plan for prioritizing key actions in cities and implementing them** to achieve the city's water resilience plan. Based on an assessment of each city's strengths and weaknesses, the CWRA describes a rigorous, practical and researched process for translating shared vision into reality. The approach helps cities identify key actions and then guides them as they implement and monitor those actions.
- Action plan prioritizes key projects including potential costs and benefits of projects, with wide stakeholder buy-in	**The CWRA provides resources that will help cities carry out each step of the process**. These tools include a mix of analogue and digital tools—including the City Water Resilience Framework (CWRF) and OurWater—that facilitate the critical steps along this process and address the practical problems that cities face.
- Mapping of the water system to show role of various actors and how individual users can best influence governance processes - Better coordination results in improved water service - Action plan combining a bottom-up and top-down approach, and focusing on resilience dividends to final users	**The CWRA establishes an extensive and continuously growing body of knowledge on urban water resilience that cities can draw on** to share experiences, identify innovative new approaches, and advance a community of practitioners at all stages of the resilience approach. As the CWRA expands to additional cities, the community of practitioners will benefit from new experiences, and help catalyse partnerships between a range of users and funders.

WHAT IS CITY WATER RESILIENCE?

Water resilience describes the capacity of cities to function in the face of water-related stresses so that those living and working within the city can survive and thrive. Water systems are the lifeblood of cities and urban water systems. Because overall city resilience, water resilience and catchment level resilience are mutually interdependent, an assessment of urban water resilience cannot be thought of in isolation from its hydrological context, including the basins, the built infrastructure and the socio-political and economical context. A holistic approach to resilience is therefore key to designing interventions that make systems resilient.

As water is used every day in formal and informal ways, resilience needs to be grounded in the existing decision-making processes around the socio-political, economical and hydrological context where the city lies. One fundamental challenge for most cities is that water governance functions are often siloed, and there is limited coordination, collaboration and knowledge sharing between actors working in the water system. In planning interventions to build resilience, it is therefore important to identify all stakeholders responsible for making the system resilient, and making decisions about what should be made resilient and for whom. New initiatives that build resilience must strengthen existing infrastructure assets and systems, but also address the duplications, overlaps and gaps in the roles and responsibilities of the stakeholders across multiple levels and sectors, responding to different shocks and stresses.

A water resilient city can survive and thrive in the face of water-related shocks and stresses, including hazards related specifically to water—ranging from drought to flooding, storm surges, and sea level rise—and the potential impact of a range of shocks and stresses, not limited to water-related hazards (for example, the impact of an earthquake on key water infrastructure). It exhibits the capacity to 1) provide access to high quality water resources for all residents, 2) protect residents from water-related hazards and 3) connect residents through water-based transportation networks ("provide, protect, connect"). The CWRA provides a model for water resilience and outlines a path for achieving these capacities.

Decision-making over water resource supply across different levels in Cape Town, South Africa

Cape Town's main catchments include the mountain fynbos areas located to the east and north-east of the city. Water to City of Cape Town (CCT) is transferred from other catchment areas as well, which includes Berg, Riviersonderend and Palmiet Rivers through an integrated water supply system called the Western Cape Water Supply System (WCWSS). Nearly 14 dams are integrated to the WCWSS, with a collective capacity that feeds Cape Town. Three of these dams (Riviersonderend, Voelvlei and Berg River Schemes) are owned and managed by the National Department of Water and Sanitation (DWS). In this interconnected water system, lack of coordination between institutions across different levels can pose serious challenge towards building resilience for CCT.

FOCUSING ON RESILIENCE AT THE URBAN SCALE

Water resource management involves large numbers of actors and multiple nested, overlapping, and interconnected urban systems. Water is impacted by energy and transportation networks, and directly affected by land use and waste management practices. It guides economic growth, is driven by local politics and shaped by relationships between local stakeholders.

As a result, water resilience demands action at a large scale, through interventions that affect the myriad systems that impact water service delivery. Because the natural water cycle does not neatly align with administrative or political boundaries, the CWRA encompasses actors existing throughout the urban area, including stakeholders that operate beyond city limits but whose influence is felt by city residents.

While recognising the influence of these actors, the CWRA focuses on the city as the ideal scale for meaningful participation by diverse local stakeholders, including academia, civil society and the private sector. Ultimately, it guides actions implemented at the urban scale and for the benefit of city residents.

In this way, the CWRA strengthens the symbiotic relationship between the city and its catchment, connecting the range of stakeholders and systems that bridge natural and urban systems.

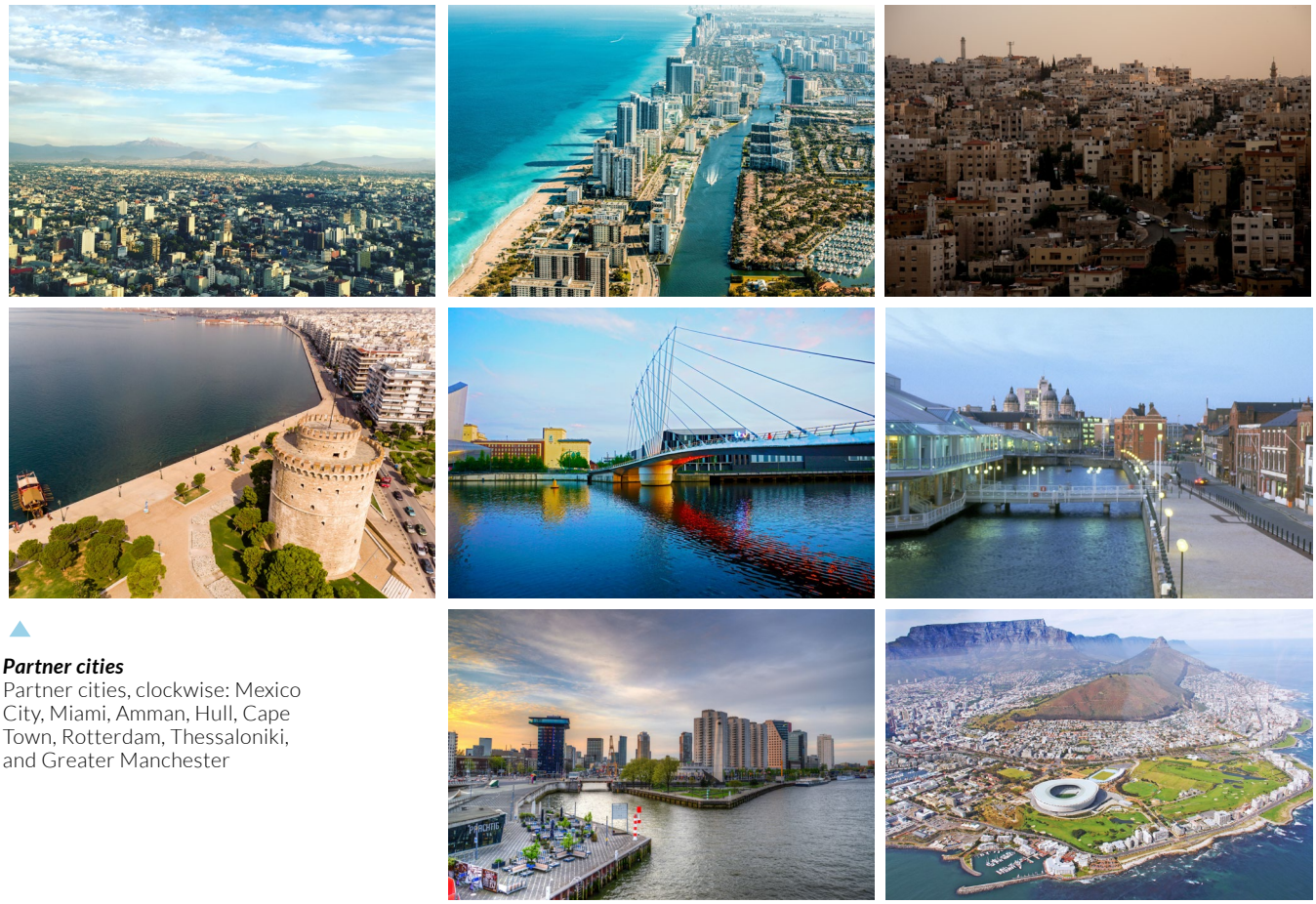
LEARNING FROM CITIES

The project team first reviewed literature describing the factors (assets, practices and qualities) that help build water resilience in cities; the shocks and stresses typically encountered; and common tools, approaches and frameworks used. In total, we examined more than 50 academic sources, and 40 sources on shocks and stresses. These included academic reports, government and regulatory guidance, and guidance from non-government, non-profit and policy institutions. We also examined 31 approaches to assessing resilience in the context of cities or water systems, including 9 frameworks, 8 methodologies and 14 tools. Based on these investigations, the team identified 750 factors contributing to the resilience of urban water systems.

City workshops
Kingston upon Hull

The literature suggested the need for coordination between interdependent systems operating at different scales. It also suggested that a need exists for holistic approaches that combine the physical aspects of cities with the less tangible aspects associated with human behaviour, including and social and intellectual capital.

New approaches to building resilience must be relevant in the context of economic, physical and social disruption and apply at the full catchment scale rather than to individual systems within a city. Moreover, the literature review reinforced the need to understand water resilience as a function of interdependent urban systems. Systems-thinking helps account for the important ways governance influences decisions around assets, how socio-cultural systems determine human behaviour, and how these phenomena ultimately impact how physical systems are designed and deployed in the urban environment.



Partner cities
Partner cities, clockwise: Mexico City, Miami, Amman, Hull, Cape Town, Rotterdam, Thessaloniki, and Greater Manchester

CITY ENGAGEMENT

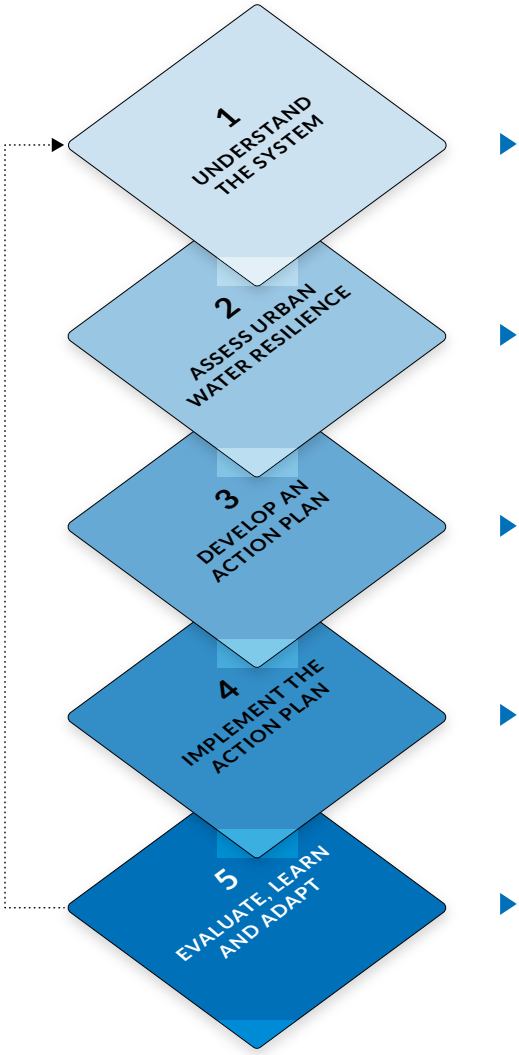
The second stage of research involved fieldwork in five "Wave 1" cities: Cape Town, South Africa; Mexico City, Mexico; Miami and the Beaches, United States of America; Kingston upon Hull, United Kingdom; and Amman, Jordan.

We selected these pilot cities because they confront persistent water-related shocks or suffer chronic water-related stresses, and have expressed commitment to co-creating water resilience approaches. The cities represent diverse geographies, a range of shocks and stresses faced, and a variety of political systems. By casting a wide net, we anticipated the need for approaches that work in a range of cities around the world, confronting different challenges in different socio-political contexts.
Fieldwork involved 10 workshops and 38 structured interviews, with 710 participants in five cities. In an additional three "Wave 2" cities—Rotterdam, Holland; Thessaloniki, Greece; and Greater Manchester, United Kingdom—the team provided remote support to city partners leading on-the-ground engagement. The research team carried out workshops, focus groups and key informant interviews with people from the municipal government, utility providers, business and civil society. Site visits helped the team better understand the realities of water shocks and stresses in each city, and the tools and approaches currently used to tackle those problems.

USING THE CWRA

The CWRA emphasises five key steps, with activities under each step, including the resources to be used in each step. The approach recognizes the need to understand urban water system from a holistic perspective, and the need for in-depth analysis to improve understanding of governance of city water resilience for achieving better outcomes.

The five steps of the CWRA begin with engaging local stakeholders using a suite of customized resources that help map the landscape of local stakeholders and natural or man-made assets. The approach then guides users as they conduct an assessment of local water issues. This assessment forms the basis for developing an Action Plan that identifies and prioritises key projects for the city. As part of the CWRA, the project team advises local actors as they implement key projects. Throughout, the plan is revisited and updated so that it remains current and aligned with local needs.



1. Establish a core team
2. Collect background information
3. Multi-stakeholder inception workshop

Resources:
- OurWater

1. Research data collection
2. Assessment and diagnosis process
3. Findings report
4. Validation workshop

Resources:
- CWRF
- Stakeholder responsibility Matrix

1. Interpretation of results
2. Prioritizing
3. Develop a Joint Action Plan

Resources:
- Governance analysis
- A CWRA Action plan Toolbox

1. Develop a M&E mechanism
2. Engage Facilitators and coaches
3. Evaluation of the baseline assessment

Resources:
- A CWRA Action plan Toolbox
- Workshop facilitator's guide book

1. Evaluate the implementation of resilience measures
2. Analyse changes in context and stakeholders involvement
3. Re-asses objectives for next period

WHO CAN USE CWRA?

The CWRA is intended for all actors that are committed to building water resilience and who are able to effect change at the urban scale. The approach has been designed for cities of different sizes, located in diverse natural and developmental conditions, and which confront different shocks and stresses.

In fact, the only criteria for leading the CWRA in cities are that local champions have the local knowledge, resources and expertise to bring together a diverse set of stakeholders towards developing and implementing an action plan for their city.

The CWRA is designed for a wide range of adopters, with the recognition that building resilient practices requires diverse voices. While in many cases the appropriate city champion will be city government, local champions might come from specific public agencies or non-governmental actors such as inter-governmental organizations, development banks, public utilities, academia, NGOs, civil society, the private sector and community groups.

The local resilience champion can be a single organization or a team of organizations working together. The champion is identified at the onset of the CWRA process and leads the approach through all five steps, with ongoing advice and support from the advisory team.

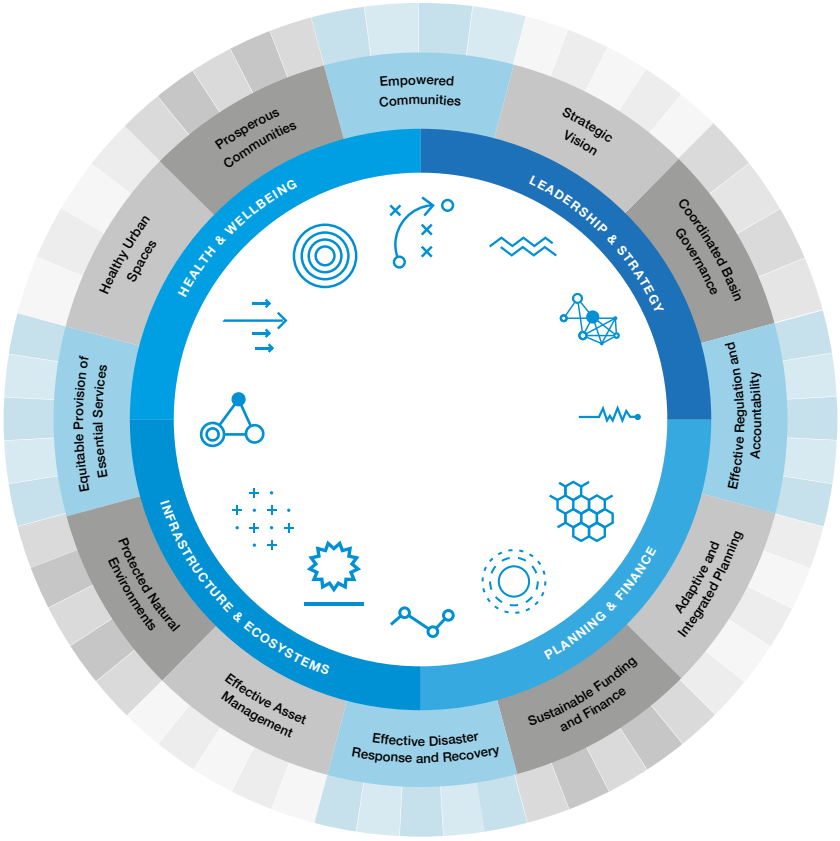
RESOURCES FOR RESILIENCE

To help cities enact the multi-step CWRA process, Arup has developed a suite of resources, including digital and analogue tools and frameworks, with additional resources planned for the following steps of the approach. In developing these resources, the project team first identified guiding qualities to inform this work, based on field research and inputs from project partners

The **OurWater** digital tool is designed to help cities improve water governance though better understanding of local water systems and the role of key decision-makers. This means improving awareness around the types of shocks and stresses confronted, the impact of various hazards natural and man-made infrastructural systems, and the interaction between stakeholders involved in urban water management. OurWater allows users to input information about the infrastructure and governance processes they participate in, and to map relationships between stakeholders throughout the entire water system. By answering key questions about the number, type and interaction between assets and actors that make up the water system, the tool addresses a fundamental challenge in most cities, where water governance functions are often siloed, and limited coordination, collaboration and knowledge sharing exists between actors working in the water system. In crowd-sourcing these tasks, OurWater creates a platform for city-wide information supplied by users across multiple sectors and levels of government.

The OurWater digital tool

The City Water Resilience Framework



The **City Water Resilience Framework** (CWRF) assessment aligns with the second step of the CWRA, helping cities assess strengths and weaknesses in their water systems, and generate a "water resilience profile" to guide future action. The framework responds directly to cities' critical needs in the following ways:

The CWRF brings together diverse stakeholders to agree upon a shared vision of urban water resilience in their city. The framework provides a clear definition for resilience, and the specific elements that contribute to water resilience. Rather than prescribe specific solutions, the CWRF helps cities identify the range of potential strategies that might be appropriate for them. The assessment process results in a vision statement that will guide cities throughout the multi-year project of building resilience.

The CWRF allows cities to measure progress through key indicators associated with each sub-goal. By evaluating performance against quantitative and qualitative indicators, cities can identify specific areas of strength to support, weakness that should be addressed. The assessment baselines cities' ongoing efforts against future actions, to measure progress over time.

The CWRF results in a Water Resilience Profile that helps cities identify and prioritize key actions and the actors best positioned to implement those actions. Based on detailed assessment of each city's strengths and weaknesses, this profile helps translate a shared vision into an implementation plan based upon broad stakeholder agreement and common objectives.

FROM ASSESSMENT TO ACTION

Understanding the city's current water system—including physical infrastructure and governance processes — and assessing a city's current status (the local challenges and opportunities, ongoing initiatives and areas for improvement) is a critical early step in building water resilience.

However, assessment is useful insofar as it leads to real, tangible and meaningful solutions that improve the lives of urban residents. For this reason, the CWRA—and the tools developed to assist cities along each step in the process—describes a full cycle that begins with identifying areas of greatest need and opportunity; prioritising interventions that will have the greatest impact upon local resilience; testing potential solutions before enacting them at scale; implementing projects according to best practices; and then monitoring results to ensure projects have achieved what they initially set out to do.

Working with cities through the CWRA process means co-developing responses that address the needs of many stakeholders to bring the biggest gains to the greatest numbers of users. Water resilience results in multiple benefits and strong partnerships for future action. It requires

Project prioritisation workshop in Santa Fe, Argentina

Water sensitive urban design in Baotou, China

Assessment and Prioritisation

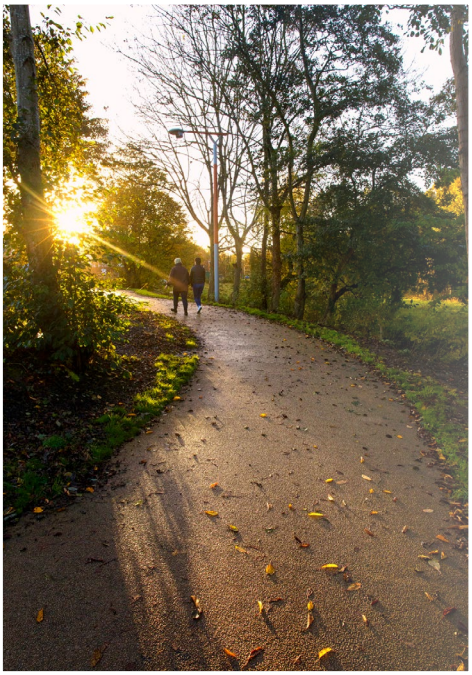
Solution prototyping in Dhaka, Bangladesh

Solution Prototyping

aligning future actions with ongoing projects, to make sure new initiatives dovetail with current work done in the city and build on city strengths, resources and natural assets.

Of course, there is no one-size-fits-all solution. Where one city's specific challenges may require an infrastructure solution, in another, public education and outreach might be most appropriate. Blue, green and grey interventions are often critical pieces in responding to water shocks and stresses, but strong local governance structures and engaged actors are often required as a first step to ensure such interventions are sustainable over time. Our diverse project team brings experience as engineers, planners, architects, and finance experts working with all types of public and private sector clients. This means that we can provide guidance at each stage of the project development cycle, and our experience cuts across many project types and activities.

The Kensico Eastview Connecting Tunnel in New York, USA



Connswater Community Greenway in Belfast, Ireland

Smart technology infrastructure solutions for Welsh Water

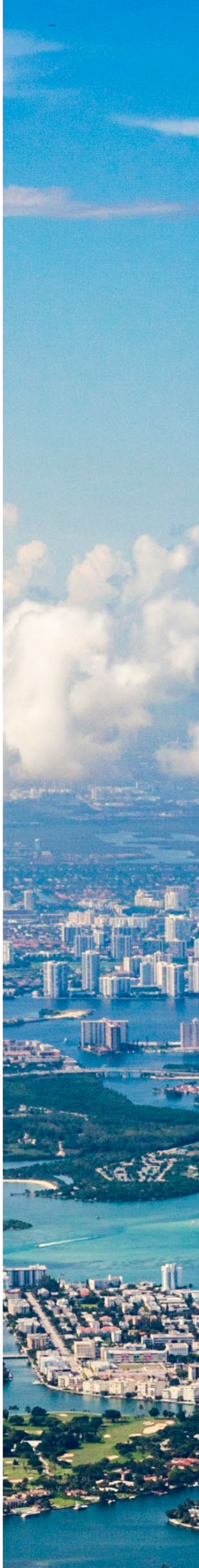
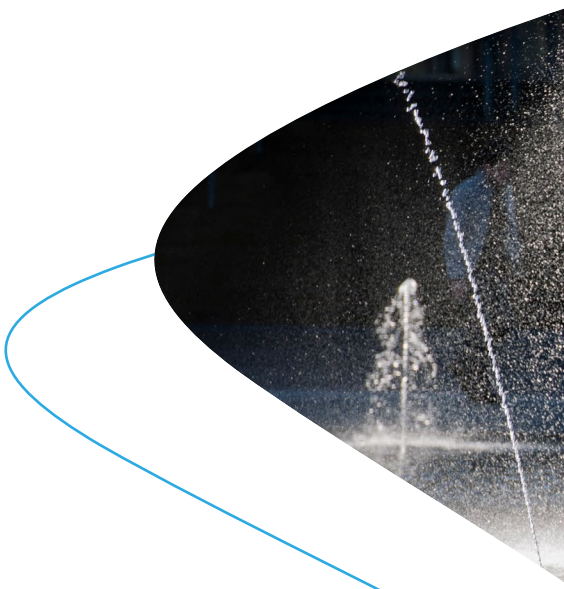
LOOKING FORWARD

Over the next 12 months, we will continue to apply the CWRA in our partner cities. These cities have already completed the first step in the five-step CWRA process, related to engaging with stakeholders to understand the urban water landscape.

The CWRA team is always looking for new partners who are interested in advancing this important theme—as donor, city champion, or subject matter expert. We recognise that the project of building water resilience in cities is an ambitious one and cannot be achieved alone, and we would be delighted to discuss how we might work together with your organisation.

In particular, we are looking for partners to work with us to introduce the CWRA to new cities, making the approach more robust and applicable to even more urban partners. Learning from an expanded network of participants lets new partner cities leap-frog development by learning what has worked and what hasn't in other cities. At the same time, we are working to develop a suite of resources —the City Water Resilience Framework, OurWater and others—that can be applied to all cities now and in the future. While these are intended as open-source tools, inputs are always needed to help us continue to build and refine them.

If you are interested in partnering with us to apply the CWRA in your city or across multiple cities, we would be glad to work with you to this end. The challenges involved in building water resilience as significant, and a collaborative effort will always yield better results.
For more information, contact:

Martin Shouler, Associate Director
martin.shouler@arup.com

Inigo Ruiz-Apilanez, Senior Consultant
inigo.ruiz-apilanez@arup.com