

PAPER 11

BUILDING URBAN WATER RESILIENCE FOR AFRICAN CITIES: LESSONS LEARNT FROM APPLICATION IN THE CITY OF JOHANNESBURG (COJ) AND NELSON MANDELA BAY MUNICIPALITY (NMBM)

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ABSTRACT

Africa is the fastest urbanizing region in the world (OECD, 2020), and most of this growth will be in the continent's cities. At the same time, African cities are facing increasing climate-change related challenges such as droughts, floods, and sea-level rise. Climate change impacts are projected to worsen water availability in African cities, while water demand is projected to triple by 2030. The IPCC's sixth assessment report (AR6) projects that this situation will worsen as climatic conditions will become more frequent putting pressure on the most vulnerable population groups. The impact will be particularly felt strongly in Africa.

In South Africa, increasing demands and climate change brings urgent attention to water-related challenges faced by cities. In the past the City of Cape Town, Johannesburg and eThekweni, and now Gqeberha, have illustrated the detrimental effects of water systems that are vulnerable and unequipped to handle climate change impacts. Climate change is not the only cause contributing to water challenges faced by cities, other systematic issues are at play. Sound planning, ecological management, investment and management of water resources and water services infrastructure is also critical to climate resilience. Building water resilience in African cities will require new approaches that include sustainable water investments, implementing changes in planning approaches, diversifying water sources, integrated and adaptive water management and across society, and shifting behaviour and mindset towards appreciating the true value of water.

As Africa's cities are central to humans, the economy, and ecosystems, there is an urgent need to address immediate and future water shock and stresses within the context of climate change. The scale and complexity presents new challenges for decision-makers in government, civil society, and the private sector.

Through the Urban Water Resilience Initiative in Africa, the World Resources Institute (WRI) and its partners are working with several cities in Africa including the City of Johannesburg (CoJ) and Nelson Mandela Bay Municipality (NMBM) to improve the understanding of urban water resilience challenges and to identify concrete pathways for action with the aim to strengthen the city's long-term water strategies and Resilience Actions. In this paper we present the initial results of the urban water resilience in these two cities.

1. INTRODUCTION

Globally, cities, particularly those in Africa, are increasingly

facing converging challenges: extending water and sanitation services for growing populations, managing watershed risks largely outside city jurisdiction, and designing for climate resilience (UNICEF 2017). Africa's urban population is projected to double and its water demand to quadruple over the next 20 years from its 2015 levels (Ndaw 2020; UN DESA, 2018; WRI, 2016; WRI; 2019). Millions of Africans will depend on infrastructure that has yet to be built. With 40% of the population living in semi-arid and arid regions with per capita annual water availability at two-thirds of the global average, water is an underappreciated crisis cutting across Africa's urban challenges, (WRI, 2021).

Already, a large number of the population in urban Sub-Saharan Africa lacks access to clean piped water (44%) and connected sanitation services (89%), impacting the health and productivity of millions (OECD, 2021). In the past five years, we have seen many cities in African Countries such as South Africa, Ghana, Morocco, Ivory Coast, Zimbabwe, and Mozambique face severe water shortages, nearing to Day Zero (OECD, 2021). Cities in the continent have also seen severe floods which have displaced the most vulnerable communities. As seen in Kenya, 260 000 people were displaced and a further 500,000 people in Somalia were affected in 2018 (WRI, 2021).

Furthermore, the fast-growing cities in Africa struggle with urban and regional land management practices. With a lack of strategic urban planning, resulting in environmental degradation and taking away the ability for cities to manage too little or too much water (Jacobsen et al., 2013; WRI, 2021).

These converging challenges represent a significant threat to sustainable urbanization. However, this moment of growth and development also presents an opportunity to approximately address water and sanitation challenges. To ensure sustainable and equitable urbanization, cities must build resilience to water and climate related risks.

While there is an urgent need to build water resilience where communities have safe, reliable, and affordable water they need to survive and thrive through sustainable, adaptive, and resilient urban water systems, African

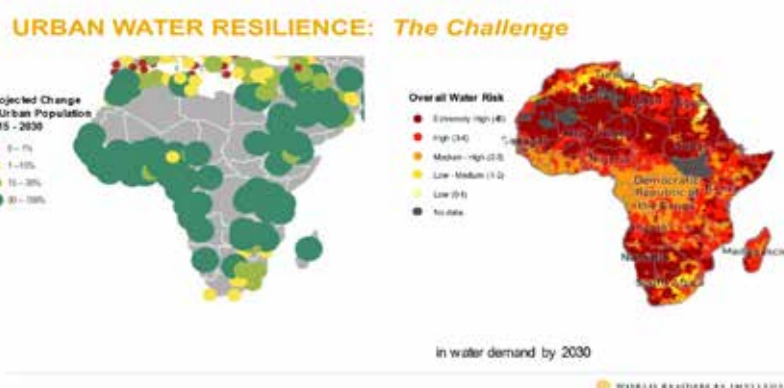


FIGURE 1: Projected Change in Africa's Urban Population (Source: WRI, 2016) & Overall Water risks default for Africa (source: WRI Aqueduct, 2019)

cities in particular grapple to rise to the occasion. Barriers specific to African countries include siloed and uncoordinated planning (vertical and horizontal), misalignment between political jurisdictions and hydrological boundaries, limited financial and technical capacity, knowledge and capacity gaps, technical bias toward rigid and centralized infrastructure, and lack of resilience thinking (WRI, 2021). For the sustenance of economic growth and community health, it is critical that African leaders come together to address their urban water resilience challenges holistically and in an integrated manner.

It is in this context that the World Resources Institute (WRI) has initiated the Urban Water Resilience (UWR) Initiative in Africa to support African city leaders with building urban water resilience. The Urban Water Resilience Initiative is a three part action project that is funded by the German Federal Ministry of Economic Cooperation and Development (BMZ). WRI is tasked with implementing the project through:

1. Research on Water Resilience in Africa:

WRI worked with research partners to develop a report on urban water resilience with a pan-African perspective that identifies key pathways to address water scarcity, inadequate access, and flooding challenges in African cities. Water Resilience in a Changing Urban Context: Africa's Challenge and Pathways for Action has been developed in partnership with local water experts and researchers who have deep knowledge of the state of water needs and current practices in the region. The report includes city-level case studies, a spatial assessment of key urban growth trends, and early learnings from this initiative's city-level assessments.

2. Strategic Water Resilience Planning:

utilizing the City Water Resilience Approach (CWRA), planning helps city leaders understand the full dimensions of their climate and water challenges and identify critical actions to build resilience. WRI is initially in six cities across three countries: Addis Ababa and Dire Dawa in Ethiopia, Kigali and Musanze in Rwanda, and Johannesburg and Gqebera in South Africa. The work in cities entails assessing the current water resilience of each city, identifying priority actions towards long-term planning for urban water resilience, and providing discrete technical assistance towards scoping and implementation of key resilience actions.

3. Policy and finance action for Urban Water Resilience in Africa:

The third component of the Urban Water Resilience Initiative in Africa aims at mobilising action at a continental scale for policy and finance for the period 2022-2030. As such, WRI along with partners and cities is mobilising collective action through engagements with key actors influencing the enabling environment, such as national governments, regional governments, research centres, financial institutions, and urban water experts in the region.

The work undertaken in the two South African cities falls under the second workstream of the UWR Initiative, *Strategic Water Resilience Planning*. In implementing the UWR initiative in the two cities, WRI is working with local and international partners: Zutari, South African Cities Network, Arup, Resilient Cities Network, and the Resilient Shift.

This paper focuses on initial results emerging from water resilience assessments under the City of Johannesburg and Nelson Mandela Bay

Municipality. The assessment of the city's water resilience is a key initial step towards developing a city's water resilience action plan. The assessment identifies areas of existing strengths and weaknesses that can be addressed. Furthermore, the assessment establishes a baseline against which a city can measure its progress. While the CWRA has multiple components, the focus of this paper is on the Johannesburg assessment process and the results.

2. WATER CHALLENGES IN THE CITY OF JOHANNESBURG

While Johannesburg is a leading city in Africa, the city faces several significant obstacles to building urban water resilience. As a major economic hub, the city suffers from high levels of in-migration and inequalities with a large portion of the population, approximately 19.1% of the total population of 5,6 million, living in informal settlements. Adequate supply of water and sanitation services to informal settlements continues to be a challenge for the City of Johannesburg.

Johannesburg's water system also faces a number of insecurities. Unlike other metropolitan cities in South Africa, the city does not lie within a strategic water source area, see Figure 2, (David Le Maitre et al., 2019). The city therefore is reliant on regional water supply, Integrated Vaal River System (IVRS) that is supplemented by a neighbouring country, Lesotho, through the Lesotho Highlands Water Project. Delays in the expansion of the IVRS have over the years placed the City of Johannesburg in multiple near drought experiences.

The city is almost completely reliant on surface water from the IVRS. Groundwater as a source is largely unexplored in the city due to the water pollution caused by Acid Mine Drainage (AMD) as well as the volatile dolomitic soil areas. Furthermore, Johannesburg is known to have very high percentages of non-revenue water because of illegal connections as well as failing infrastructure that leads to leakages and pipe bursts.

While the City has an above average water consumption rate, it is experiencing extreme growth pressures due to population growth and urbanisation being the largest economic hub in Africa. Urban development has over the years resulted in impervious areas which causes environmental degradation and flash flooding.

Several policies and plans are in place that aim to address the challenges highlighted above however, budget constraints, governance fragmentation, lack of institutional and financial capacity, and the absence of resilience

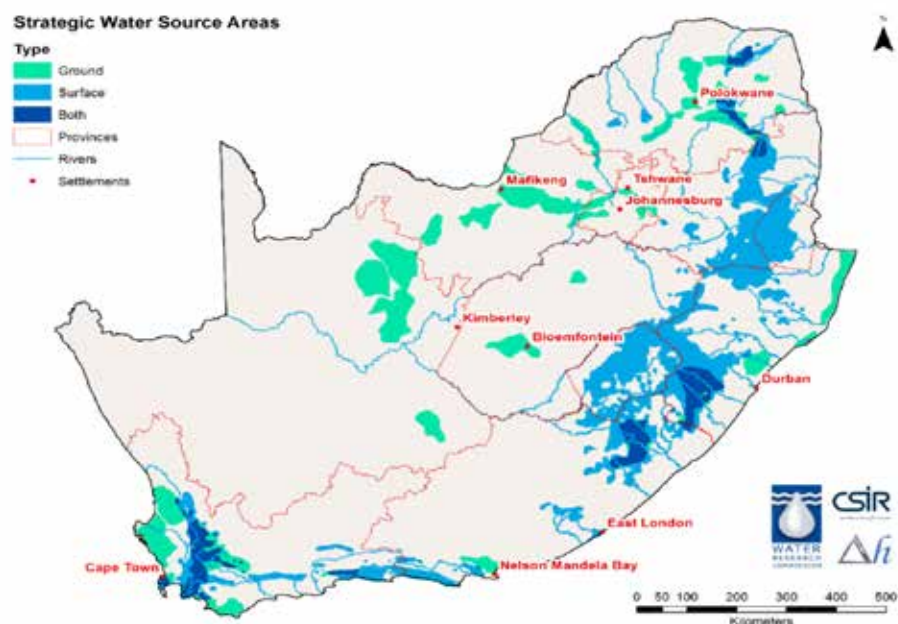


FIGURE 2: Adapted version of strategic water sources in South Africa (David Le Maitre et al., 2019)

thinking have led to little improvement. As a result, Johannesburg faces several shocks and stresses that affect the resilience of its urban water system. These shocks and stresses include water security challenges, climate change, flooding, population growth, environmental degradation, aging infrastructure, and growing inequality. In order to tackle these water security challenges, it is important to better understand the shocks and stresses that places Johannesburg in a vulnerable position and the implementation of suitable actions.

In doing so, the City of Johannesburg's (CoJ) Environment & Infrastructure Services Department (EISD) completed its first Water Security Strategy in 2022 to meet goals aligned with the City's long-term strategy. This strategy serves to develop a long-term vision and enable systemic change towards a water secure Johannesburg. Building on this on-going work, now developing the Implementation Plan, CoJ is strengthening the resilience component to prioritise resilience-related actions that can withstand shocks and stresses by taking advantage of the UWR's resilience strategic planning while building a resilience thinking culture

3. WATER CHALLENGES IN NELSON MANDELA BAY MUNICIPALITY: GQEBERHA

Gqeberha is currently experiencing a dual grip of COVID-19 and the worst drought ever recorded. Its water supply is in a critical condition. Climate change projections indicate that the municipality will continue to face climate change water-related shocks. WRIs aqueduct data and the in-depth assessment developed by Council for Scientific and Industrial Research, South Africa (CSIR, Greenbook project) provide a quantitative assessment of likely impact of climate change. Both these assessments suggest that Gqeberha faces extreme drought risk and extreme coastal flood risk. While climate change is an important contributor to the current water status in the municipality, there are other primary causes such as integrated planning, investment and management of water resources and water services infrastructure, non-revenue water losses, declining collection rate, and urbanisation influencing the growth of informal settlements.

Several internal and external programmes have been put in place to manage the current drought. Internal programmes include a combination of augmentation, water demand management, and communication efforts. Key external support includes the work of the National Treasury, through the Cities Support Programme (CSP). The CSP continues to provide direct support at city level on water issues. The CSP supported the City of Cape Town during the drought crisis, and in the development of a new water strategy during 2017 and 2018 and is currently supporting the city in the implementation

of this strategy. CSP undertook a diagnosis in 2018 of the water challenges facing the city. CSP and the city continue to work together in managing the on-going drought.

While several internal and external measures have been put in place to address and manage the current drought, there is a need for the municipality to engage in strategic long-term planning for building water resilience for the city. Sustainable urban growth in the municipality can only be achieved if water resilience is built. The Urban Water Resilience Initiative provides an opportunity for Gqeberha to achieve strategic water resilience planning that considers the full dimensions of climate and water challenges and identify critical actions to build resilience. The program offers the opportunity for WRI and partners to work with Nelson Mandela Bay Municipality, a local administrative which Gqeberha falls under, in a strategic long-term planning process through identification of priority urban water resilience actions and advancement of the city towards implementation by providing targeted technical assistance to planning, governance, and/or finance processes. WRI also aims to strengthen capacity and support Nelson Mandela Bay Municipality to become a more thriving, resilient city through strategic planning for resilience actions and discrete technical support towards the implementation of the plan.

4. THE CITY WATER RESILIENCE APPROACH

At its core, the City Water Resilience Approach (CWRA) helps to assess the resilience of an urban water system a city depends on, including upstream and downstream catchment related issues. The CWRA responds to a demand for new approaches and tools that help cities grow their capacity to provide high quality water resources for all residents, and to protect them from water related hazards. In doing so, the approach outlines a path for developing urban water resilience and provides a suite of tools to help cities identify, assess, take action to address and ultimately survive and thrive in the face of water-related shocks and stresses.

The CWRA is based on fieldwork and desk research, collaborative partnerships with subject matter experts, and direct engagement with city partners. The development of the approach was very much a collaborative process of deep investigation in eight cities and consultation with over 700 individual stakeholders by Arup. Working closely with the Stockholm International Water Institute (SIWI), Resilient Cities Network, the Organization for Economic Co-Operation and Development (OECD), investigations of the approach were conducted with Cape Town, Amman, Mexico City, Greater Miami, and the Beaches, Hull, Rotterdam, Thessaloniki, and Greater Manchester. Each partner city confronts persistent water-related shocks or suffers chronic water-related stresses and is committed

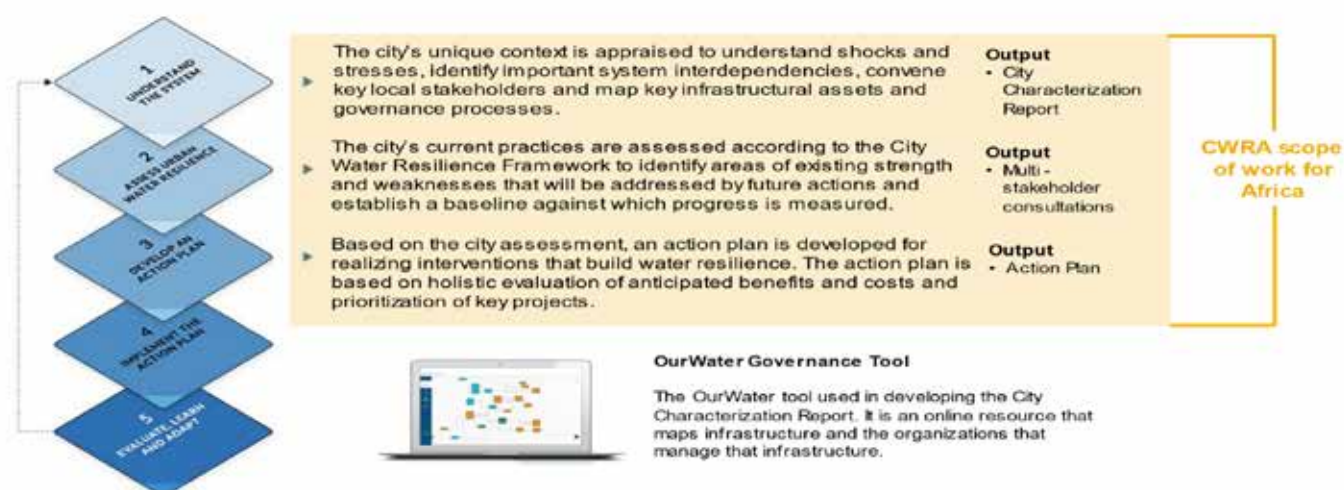


FIGURE 3: Overview of the five-step process of the City Water Resilience Approach and its application

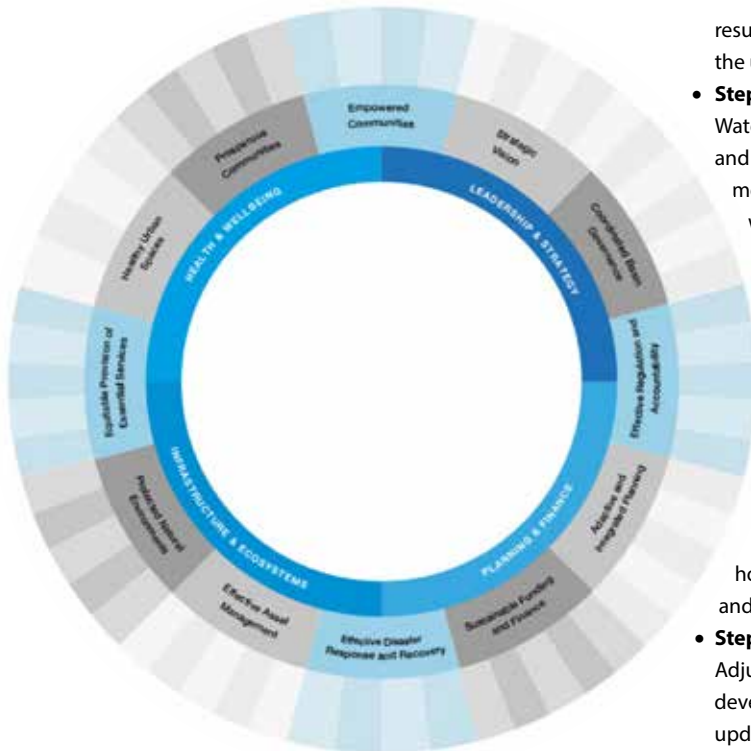


FIGURE 4: City Water Resilience Framework

to co-creating water resilience approaches. The cities represent diverse geographies and face a range of shocks and stresses in various socio-political contexts.

CWRA is a five-step process with supporting tools including the City Water Resilience Framework and the OurWater Governance (Figure 3). The five steps entail the understanding of a city's water system and relevant stakeholders, assessing the water resilience, developing, and implementing an action plan, and monitoring the results of these actions.

The five steps are briefly described below:

- **Step 1: Understand the system:** The city's unique context is appraised to understand shocks and stresses, identify system interdependencies, engage local stakeholders to clarify gaps in information, and map key infrastructure and governance processes. This first step of the CWRA process results in the City Characterization Report that summarizes the

results of this research and a mapping of the urban water system with the use of OurWater Tool.

- **Step 2: Assess urban water resilience:** Through the use of the City Water Resilience Framework (CWRf) to identify areas of existing strength and weaknesses and establish a baseline against which progress is measured. This second step results in a City Water Resilience Profile, which summarizes the assessment process and outlines potential actions to build resilience. This paper focuses on the assessment of Johannesburg's water resilience.
 - **Step 3: Develop an action plan:** Based on the city assessment, an action plan is developed for realizing interventions that build water resilience. The action plan is based on a holistic evaluation of anticipated benefits and costs and prioritization of projects identified in the previous step.
 - **Step 4: Implement the action plan:** Actions agreed upon during the previous step are implemented according to best practices. In this step, the CWRA provides best practice guidance for how ongoing actions can be monitored to ensure objectives are met, and resources are used appropriately.
- **Step 5: Evaluate, learn, and adapt:** Implementation is evaluated. Adjustments are made to the implementation plan to account for new developments or changing circumstances in the city, and to align with updated objectives for the next period.

The approach brings together stakeholders to diagnose the resilience of their city's water system and based on a shared understanding of resilience, develop a collective action plan. The different stakeholders together bring different perspectives while considering the inter-dependencies with other systems.

5. CITY OF JOHANNESBURG URBAN WATER RESILIENCE ASSESSMENT

1. Approach and Methodology

With the use of a City Water Resilience Assessment (CWRA) tool (Figure 3), 49 multi-sectoral stakeholders were convened over a two-day virtual workshop in May 2022 to assess the current water resilience of the City of Johannesburg. A strong effort was made to bring together stakeholders with diverse and technical expertise and knowledge of the subject areas as well as from both government and the private sector. The City Water Resilience Framework (CWRf) tool is used in the CWRA to evaluate the strengths and weaknesses of an urban water system, and the city's overall resilience to water-related shocks and stresses.

DIMENSION: Leadership & Strategy: Health & Well-being	GOAL: 1. Empowered Communities	SUBGOAL: 1.1 Active community engagement and participation around water issues
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INDICATOR:
Legal and Institutional frameworks and mechanisms promote active, free and meaningful participation around issues related to water supply, sanitation, drainage and flooding.

GUIDING CRITERIA / GUIDING QUESTIONS:

- Active, free and meaningful participation is promoted through elements that create an enabling environment for participation:
 - Free and safe participation: Institutions encourage bottom-up initiatives and guarantee free and safe participation. Participation is voluntary and free from conditions or threats, while people who engage should be protected from reprisals or discrimination.
 - Inclusiveness: Organizational structures, frameworks and policies exist to promote inclusiveness by ensuring that all relevant stakeholders are engaged in decision-making, and that barriers to participation are removed. Inclusiveness can be promoted through efforts to identify and reach out to all relevant groups.
 - Access to information: Information is shared with all stakeholders. Information is complete, timely, relevant and free of cost. It is widely to reach target groups, and shared in a variety of formats and multiple languages if needed.
 - Opportunity to influence: Legal frameworks engage stakeholders in the design and implementation of water-related decisions, policies and projects. Community stakeholders have the opportunity to influence the design of the participatory processes. Authorities are willing to engage, listen, and eventually change proposals through the participatory process.
 - Accountability: Mechanisms diagnose and review stakeholder engagement challenges, processes and outcomes. Authorities should be accountable, letting people know how their inputs were considered, what decisions were made, and on what grounds.

DIMENSION: Leadership & Strategy: Health & Well-being	GOAL: 1. Empowered Communities	SUBGOAL: 1.1 Effective communication of government programmes and policies around water
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INDICATOR:
Mechanisms ensure that comprehensive information on government programmes and policies are disseminated to all stakeholders.

GUIDING CRITERIA / GUIDING QUESTIONS:

- Roles and responsibilities: Dedicated institutions produce or collate information from relevant sources and official information about policies, strategies, existing and planned programmes and projects around water.
- Sufficient resources: Sufficient financial resources, technical capacity and skill, information and technological tools exist in order to support the organizations responsible for collecting, collating and sharing information.
- Identification of stakeholders: Mechanisms identify target audiences, their communication needs and potential barriers to effective communication.
- Dissemination: Government shares credible, complete and updated information of their programmes and policies around water in a timely manner with all stakeholders and at no cost, maintaining a consistent and clear information flow through reliable channels and platforms. Information is clear and understandable. Where appropriate, information should be disseminated in different formats, in more than one language if necessary, avoiding overly technical language.
- Monitoring and evaluation: Monitoring and evaluation occurs to ensure the correct information is disseminated to audiences that need it.

FIGURE 5: Stakeholder Resilience Assessment Guide

INDICATOR SCORES

4.5-5.0 Optimal

The indicator fully reflects conditions in the city. No improvement is required.

3.5-4.4 Good

The indicator mostly reflects conditions in the city. Minimal improvement is required.

2.5-3.4 Fair

The indicator somewhat reflects conditions in the city. Some improvement is required.

1.5-2.4 Low

The indicator mostly does not reflect conditions in the city. Significant improvement is required.

1-1.4 Poor

The indicator does not at all reflect current conditions in the city.

N/A

The indicator is not relevant to the city.

FIGURE 6: City Water Resilience Framework indicator scores

The tool breaks down the meaning on resilience in the water context through the use of 4 dimensions, 12 goals, and 64 sub-goals with quantitative indicators. The innermost ring of the CWRF consists of four dimensions, critical areas for building resilience. Within each dimension are the resilience goals that cities should work towards to build resilience in that area. Hybrid goals, which are marked in a different colour, refer to goals that can be placed in more than one dimension. Resilience sub-goals identify the critical elements for realising each goal. They provide additional detail and help guide the concrete actions that help realize each goal. The outermost layer of the CWRF wheel consists of indicators, which measure how the city performs according to each area. Indicators help measure complexity when direct measurement is difficult (or impossible) (Figure 4). To help guide discussions, a series of

guiding criteria and guiding questions were provided to participants at each table. Guiding criteria have been based on desk research and expert inputs,

and they identify important considerations for each indicator. Responses to indicator questions help identify strengths and weaknesses, and measure progress over time.

Because each city is confronted with its unique challenges, solutions appropriate to one city are not necessarily appropriate to another. Consequently, while sub-goals are widely applicable, they do not stipulate specific solutions. This certainly emerged in the assessment of Johannesburg's water resilience.

The 49 stakeholders invited are subject matters from private sector, public sector, civil society, NGOs, research institutions were engaged in assessment of the city's water resilience. The selection of the stakeholders was informed by a detailed stakeholder analysis undertaken in the early stages on the project.

During the workshop, stakeholders were introduced to the Johannesburg's Water Security Strategy and the urban water resilience initiative which aims to introduce a resilience lens into the strategy. On each day, participants were split into six groups with each group assessing two different goals with the guidance of a facilitator and a note taker. Due to time limitation, most groups could only cover one goal. By the end of the second day, all the 12 goals with their qualitative indicators were assessed by the stakeholders. Facilitators explained the assessment process to participants. Following the outlined process, participants assessed the qualitative indicators, see Figure 6 with Stakeholder Guidance Book, by providing an initial score and an explanation to the score. Indicator scores ranged from 1 to 5, reflecting how well Johannesburg performs when compared against best cases. The CWRF also allows the stakeholders to leave out an indicator should it not be applicable to the context of their city.

2. Results from the City Water Resilience Assessment

There CWRF wheel (Figure 7) provides a snapshot of strengths and weaknesses for Johannesburg in building its resilience to water-related shocks and stresses. It describes how the area performs against a best-case scenario for each of the 64 sub-goals. Scores for all resilience sub-goals are provided along the outer edge of the CWRF wheel, while averaged scores for resilience goals are shown in the inner ring. Overall, Johannesburg's water resilience goals scored low when compared to cities operating at optimal level.

Of the twelve goals, *Equitable Provision of Essential Services*, scored the highest at 2.9 reflecting that some water improvement is required. While the score is the highest compared to the rest of the goals, stakeholders in group discussions raised key concerns around equitable access to basic services particularly when considering informal areas. Participants noted that although the average income of Johannesburg is nearly double the rest of the country, Johannesburg is the second most unequal city in the world. According to the Water Services Act, every citizen has a right of access to basic water supply and sanitation services and every municipality has the responsibility to plan in its water services development to realise these rights. Despite these basic rights, service provision in the CoJ is starkly varied between formal and informal areas.

There is an overall poor effort in terms of legal and institutional frameworks within the water sector to support marginalised communities. The issues with basic service provision, especially sanitation, in Johannesburg is largely concentrated in informal settlements that house the most marginalised and vulnerable people in the city and formal low-income residents who cannot afford the tariff charges. Informal settlements often exist on illegal land on which the municipality is by law not able to provide permanent service provision. Citizens living in these

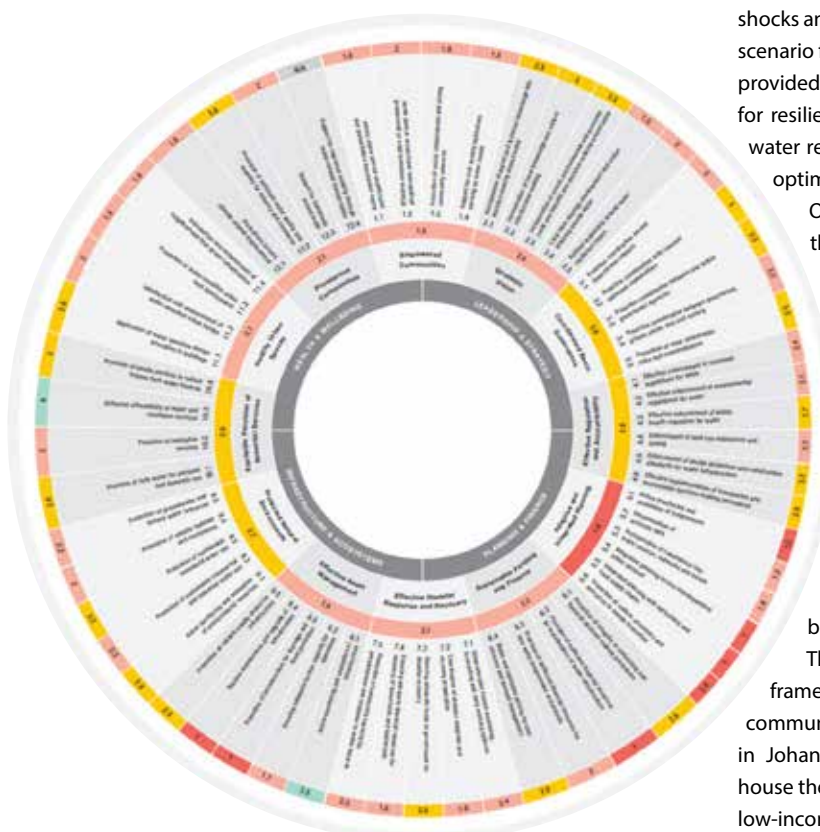


FIGURE 7: The City Water Resilience Framework qualitative scoring for Johannesburg

areas often have poor levels of access to adequate sanitation contributing to poor water quality and are the most vulnerable to the impacts of climate change such as increasing flood risk and temperatures. Where sanitation services have been provided, they are often shared or not maintained to the extent that they are unhygienic and longer considered as adequate or dignified.

The lowest goals scored, *Adaptive and Integrated Planning*, scored at an average of 1.4 indicating that Johannesburg's conditions do not at all reflect the ideal case scenario. Insights from experts in the group's discussion revealed that while a set of acts define clear roles and responsibilities which are mandated to different authorities exists, planning takes place in a context of a highly regulated and bureaucratic environment. On paper, such a highly regulated environment is prescribed for a well-run urban water management system. However, this highly regulated environment has resulted in lack of coordination and collaboration between departments and agencies and overlapping mandates.

Over the long run, governance structure has resulted in fragmentation and development of a strong culture of silo-ism which limits both efficiency, innovation, and adaptive management. Experts also highlighted the limited ability for the city to take on an adaptive planning approach, noting that adaptive planning and management requires good coordination internally and effective relationships with external stakeholders. Experts pointed out that the City of Johannesburg currently lacks coordinated and collaborative relationships with its stakeholders, both at the city and catchment level. This was recognized as a missed opportunity not only for future planning, but also for the city to meaningfully engage its stakeholders over complex water and sanitation issues that it currently grapples with such as its billing system, effective use of data, water conservation and demand management, informality, procurement processes, and general communication. A resilience planning approach was identified as key to canalizing an adaptive and integrated planning approach. However, the city lacks integration of climate adaptation into its planning and implementation processes to be better prepared for times of disruption.

Issues around finance, which came up in the discussions in the *Sustainable Funding and Finance* goal and other goals, posed key questions around sustainable funding mechanisms for building water resilience in Johannesburg. While the goal scored of 2.5, indicating that the city is performing fairly on this goal with limited improvement required for improvement, it must be noted that 2.5 is a bottom of the scoring range, a low which requires significant improvement. The detailed discussion by the stakeholders does indeed reflect significant improvement still being required. Key concerns were around CoJ's maintenance backlog of about R19.2 billion and the below average water interventions which have been reported. Inadequate maintenance of water assets has over the long run led to failing and dilapidated infrastructure, high non-revenue water, and poor service delivery. The lack of financial resources, capacity, prioritisation of maintenance, political support for OPEX vs CAPEX is some of the barriers to effective water asset maintenance. Furthermore, low tariffs, inadequate income from other sources of revenue, lack of up-to-date data, and capacity limitations over the long run have led to a vicious circle of poor maintenance and deterioration of services that affect users' willingness to pay and induced a decrease collection efficiency. At the moment the CoJ lacks the understanding, data, political will, and capacity to design and implement strategies that can allow them to fund water and sanitation services through a mixture of revenues including tariffs, taxes, and transfers while enabling economic efficiency, providing water conservation incentives, ensuring equity and affordability.

Lastly, issues around *Protection of Natural Environments Goal and Healthy Urban Spaces Goal* emerged strongly. Johannesburg grapples with poor riverine and wetland health with the majority of its rivers near complete loss of habitat and destroyed ecosystem functions and with 13 of its 21 wetlands being critically endangered. Experts felt strongly that there is an opportunity for the city to incorporate nature-based solutions as part of encouraging alternative water sources and protection of ecological systems and its benefits.

3. Emerging cross-cutting challenge themes

Post the resilience workshop, the project team (WRI, Zutari, Arup, Resilient Cities Network, and the South African Cities Network) conducted an analysis from notes captured in group discussions to identify emerging themes around gaps in resilience from multiples group discussions. The team prioritised 10 critical challenges confronting Johannesburg's urban water systems. These challenges were validated by the City of Johannesburg prior to being finalised.

Key challenges and related problems statements are:

1. **Urban water asset management:** What are the opportunities for the City of Johannesburg to address the maintenance backlog and create enabling structures that result in a robust system by overcoming the challenges that result in maintenance failure?
2. **Internal Governance:** How can the City of Johannesburg re-imagine its current regulatory environment and roles and responsibilities of the various entities to unlock collaborative planning implementation processes?
3. **External Governance:** How can the City of Johannesburg create an enabling environment for long-term collaborative relationships with city and catchment stakeholders in a manner that allows for resilience planning, co-production of data and evidence, access to reliable information, joint establishment and maintenance of collaborative platforms, and regular social surveys to better understand the needs and perceptions of citizens?
4. **Digital water:** How can the City of Johannesburg create an enabling environment for long-term collaborative relationships with city and catchment stakeholders in a manner that allows for resilience planning, co-production of data and evidence, access to reliable information, joint establishment and maintenance of collaborative platforms, and regular social surveys to better understand the needs and perceptions of citizens?
5. **Resilience Planning:** What are the opportunities for institutionalizing a resilience agenda in the City of Johannesburg's planning and implementation processes to enhance its championing and mainstreaming?
6. **Equity (Formal/informal):** How can we ensure an equitable and just transition towards achieving a water resilient city in the face of unprecedented challenges despite the historical inequalities in access to reliable and affordable water supply and sanitation?
7. **Water Sensitive Design:** How can CoJ strengthen the integration of WSD into urban planning and implementation to improve the water resilience of the city?
8. **Alternative Water Sources:** How can we incorporate the use of alternative water sources into long term water security planning by overcoming the issue of cost recovery, the associated stigmas and negative perceptions and the lack of capacity and resources to ensure an urban water supply that is resilient with redundancies?
9. **CAPEX Funding:** How can we sustainably finance the urban water

system by overcoming finance and capacity challenges in the form of an under-performing cost recovery model, disabling bureaucracy and fund availability to enable a resilient water system?

- 10. OPEX Funding:** How can we sustainably finance the operation and maintenance of the urban water system by setting equitable tariff arrangements and overcoming finance and capacity challenges in the form of an under-performing cost recovery model, disabling bureaucracy and fund availability to enable a resilient water system?

6. CONCLUSION AND NEXT STEPS

Through the Urban Water Resilience Initiative in Africa, the World Resources Institute (WRI) and its partners have been working with the City of Johannesburg and Nelson Mandela Bay Municipality to improve understanding of urban water resilience challenges and to identify concrete pathways for action with the aim to strengthen the city's long-term water strategies and Resilience Actions.

In this paper we presented the initial results of the urban water resilience in these two cities. The assessment of the city's water resilience is a key initial step towards developing a city's water resilience action plan. The assessment identifies areas of existing strengths and weaknesses that can be addressed. Furthermore, the assessment helps to establish a baseline against which a city can measure its progress. As a next step from the water resilience assessment, WRI and partners will work together to develop the resilience actions that will support long-term plans that the city's have. Furthermore, WRI will provide discrete technical assistance towards scoping and implementation of identified key resilience actions.

For the City of Johannesburg, the assessment indicates that there is still significant work needed to be done to improve urban water resilience across the different goals defining resilience. Issues of urban water resilience related to adaptive and integrated planning, sustainable finance, equity, and protection of natural environment have been identified as urgent areas for building water resilience. As such, the City of Johannesburg has initiated a process for developing a business case for an integrated riverine programme to help mobilise political and financial support for nature-based solutions.

Once the water resilience assessment has been conducted in Nelson Mandela Bay Municipality, the city will have a better understanding of its own areas of strengths and weaknesses. However, due to the water crisis currently facing the city, the Urban Water Resilience Initiative is supporting the municipality with a Feasibility Study for Non-Revenue Water Performance Based Contracts. This work is aimed at enabling the municipality to build resilience with its non-revenue water area of work which it continues to grapple with.

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