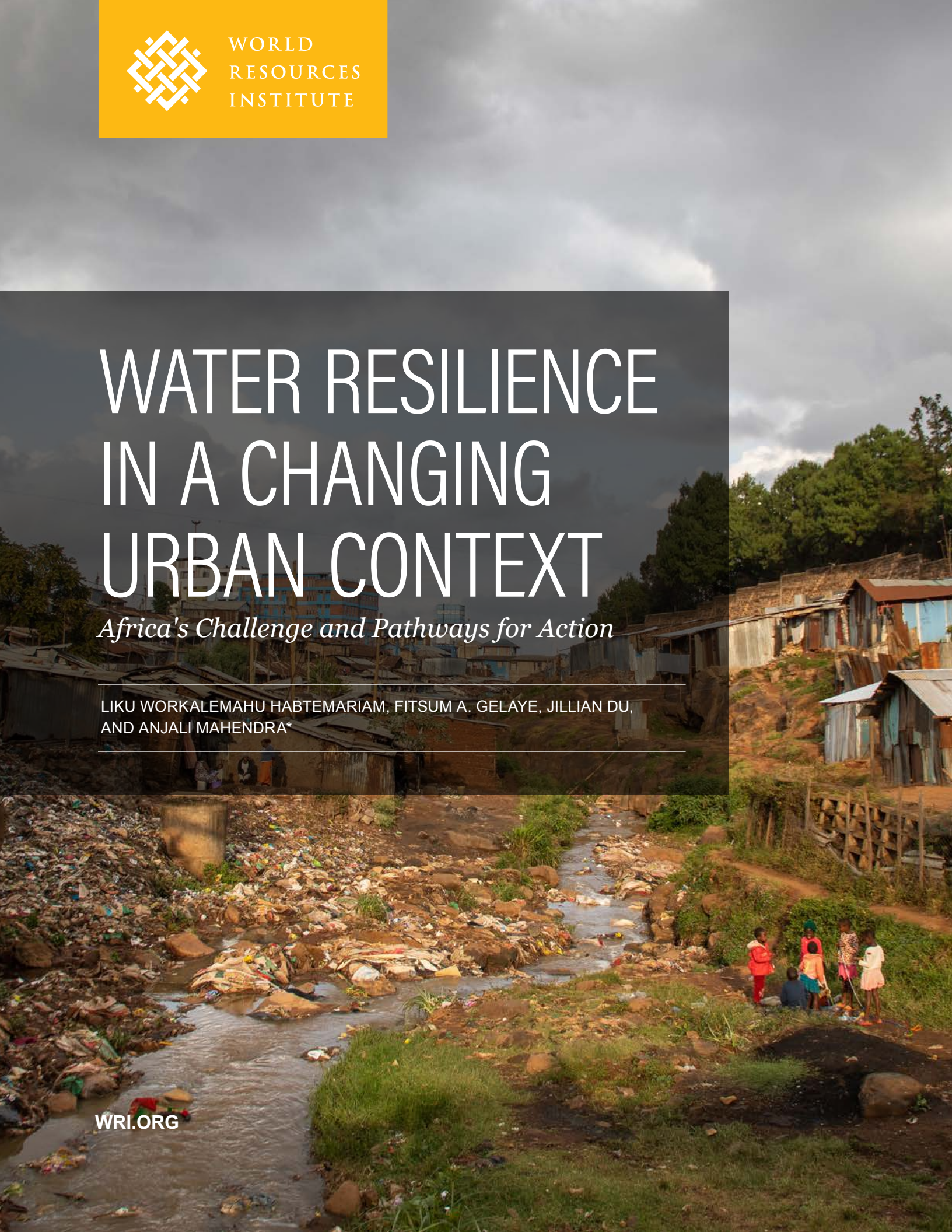

WORLD RESOURCES INSTITUTE

WATER RESILIENCE IN A CHANGING URBAN CONTEXT

Africa's Challenge and Pathways for Action

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Foreword

Cities in Africa face converging challenges: rapid urbanization, rising climate threats, and skyrocketing demand for increasingly constrained water resources. *Water Resilience in a Changing Urban Context: Africa's Challenge and Pathways for Action*, demonstrates that African cities can address these challenges with a fresh approach centered on water resilience.

Although Africans have contributed the least to climate change, they face some of the worst risks. Over two-thirds of urban residents in Africa lack safe, affordable, and reliable water and sanitation services. By 2050, a projected 1.5 billion people will call African cities home — double the population today. Two-thirds of Africa's cities are expected to face "extreme" climate risks, according to the Organisation for Economic Co-operation and Development.

Many African cities already face water crises that create vulnerabilities across multiple systems vital for human well-being. Cities throughout the continent are frequently hit by flooding or drought, even as inhabitants struggle to access clean water.

The answer: smart, systematic investments in urban water resilience that ensure communities have safe, reliable, and affordable water and that water resources are protected through disaster preparedness and water-sensitive infrastructure. Water resilience is essential to many development goals, from the Sustainable Development Goals and UN Habitat's New Urban Agenda, to the African Union's Agenda 2063 and the Paris Agreement. Water security is also key to building back better from COVID-19.

This report identifies four pathways for action for policymakers, practitioners, and funders: plan for water, prioritize the most vulnerable, create change at scale, get finance right. These are not easy tasks, but they can be done. The report, rich in revealing maps and insightful charts, features promising examples of success from across the continent. The authors, experts in water resilience in the African context, highlight the potential power of cities to drive transformation. As centers of innovation and political ambition, they write, cities are well-positioned to build momentum across various levels of government and diverse sectors.

This report is the first from WRI's new, multi-year Urban Water Resilience initiative, which is supporting cities with research to illuminate urban water resilience challenges and pathways, partnerships to enhance capacity and demonstrate solutions, and collective action to create enabling environments. It is a joint initiative of WRI Africa, WRI Ross Center for Sustainable Cities, and the WRI Water Program, as well as other partners.

Thank you to the German Federal Ministry for Economic Cooperation and Development (BMZ) for supporting this report.

While this report focuses on water, the scalable change the authors outline applies to many challenges facing cities today. Investing in resilience is shown to improve livelihoods, protect ecosystems, and confront climate change. As the COVID-19 pandemic and climate crisis have made clear, it is imperative to accelerate systems change that can underpin a more resilient, sustainable, and just world.

Ani Dasgupta

President & CEO
World Resources Institute

Wanjira Mathai

Vice President and
Regional Director For Africa

Executive Summary

The Challenge in Africa

By 2050, Africa will be a different continent than it is today. The total population is expected to double (Ndaw 2020), putting pressure on existing water infrastructure (UN DESA 2018). Climate change will have increasingly worse and unpredictable impacts on water, with cascading risks related to livelihoods, economies, health, and extreme weather events.

Highlights

- Most urban areas in Africa are confronting escalating water-related challenges compounded by climate change and projected growth. Current urbanization patterns, existing water supply systems, and governance and financial models will be unable to meet the unprecedented rise in demand and handle increasing water-related risks.
- Urgent needs include new approaches that connect local realities to basin-level issues and link action to crosscutting urban issues, such as service provision and land use. Efforts to build urban water resilience have immense potential to inform practice and move urban regions towards more resilient and equitable systems.
- This report frames the challenge, the rising role for cities, and priority pathways for urban and water-related stakeholders. It is based on an extensive literature review, key informant interviews, and the authors' collective experience working on these issues.
- Four priority pathways are highlighted for action: **plan for water** (mainstream risk-informed land management and water-sensitive urban development), **prioritize the most vulnerable** (increase equitable access to safe water and sanitation), **create change at scale** (develop innovative institutions and pursue partnerships for water resilience), and **get finance right** (increase and align water-resilient investments across sectors).
- Ultimately, transitioning to a water-resilient city requires collaborative action and alignment across hydrologically linked regions as well as public and private sector actors at different levels of government.

Without resilience to water scarcity, flooding, and climate disasters, current urban growth patterns and water management will not be sustainable. Alternatively, cities can provide new economic opportunities and better livelihoods—but only if they build resilient systems that are better equipped to handle the strain on their water resources. Decisions made today can dramatically impact how the continent transforms and the way people live for decades to come.

Africa's rapidly changing urban context necessitates urgent action to build water resilience. First, climate change will continue to expose the severe vulnerability of the continent's urban water systems. African cities contribute least to climate change, yet two-thirds of the continent's cities are at "extreme" risk of climate- and water-related shocks (OECD 2021). Second, Africa's urban population will more than double between 2020 and 2050 (UN DESA 2018). More than 1.5 billion people will be living in cities—cities that are under-resourced and have widening inequalities in basic service provision (UN DESA 2018). Most of this growth will be added to informal settlements, where families lack secure housing, water, and sanitation; such settlements already make up over 50 percent of cities (UN-Habitat and World Bank 2018). Third, compared to 2005 levels, water demand in Africa by 2030 is projected to reach almost 300 percent—up to three times higher than any other global region—mostly driven by the agriculture and municipal sectors (Wijnen et al. 2018).

Current urban and regional land management practices are escalating water challenges. The lack of strategic urban planning for fast-growing cities has resulted in the loss of protection for most cities' water resources, stripping away city-regions' ability to cope with "too many" or "too few" water events. Increased flooding events from poor drainage and paved surfaces have resulted in displacement, increased disease risks, and damaged housing and infrastructure (Jacobsen et al. 2013). Over the last three decades, 654 floods in Africa have affected more than 38 million people (OECD 2021). Urban development that threatens ecosystems vital for water supplies and recharge, such as wetlands, exacerbate a city's inability to respond to shortages. By 2050, it is estimated that 162 million people will be living in urban areas with perennial water shortages (OECD 2021); when

combined with the experience of water stress from poor or polluted water access, the figure will likely be much higher.

Business-as-usual water management falls short today and will be unable to respond to unprecedented growth in demand and increasing shocks and stresses. Practices that focus on a centralized, supply-focused network of gray infrastructure, large dams and aquifer exploitation, and large-scale treatment plants are costly, inefficient, and unsustainable (Pieterse et al. 2020). The ability to maintain this centralized infrastructure is often compromised by budget constraints, leading to a vicious cycle of underinvestment, water leakages, untreated sewage, intermittent access, contaminated storage, and water cuts (Mitlin et al. 2019; OECD 2021; Pieterse et al. 2020). Moreover, most watershed regions are changing faster than current institutional practices can respond. Competing demands between urban, rural, and sectoral needs are pushing limits and need effective conservation and restoration.

Unmanaged urban expansion, coupled with poor water management, has left large swaths of the population—especially the urban poor—without safe, affordable, and reliable access to water and sanitation. Over 50 percent and 80 percent of urban populations in Sub-Saharan Africa lack access to safely managed water and sanitation, respectively (WHO and UNICEF 2017). One major reason is because settlements have developed quickly and informally ahead of service and infrastructure provision. As a result, most African cities have a patchwork of formal, informal, and/or self-provided water and sanitation services, such as boreholes, water vendors, and self-built pit latrines that are largely unregulated (Cirolia 2020; Jaglin 2014). Those without access to public services, usually low-income residents, are forced to pay more, use unsafe water sources, or sacrifice in other ways. The deep inequalities in access to basic infrastructure place disproportionate water-related burdens on the urban poor.

Increasing pollution and degraded environments further entrench the lack of resilience. Sludge-filled rivers and untreated wastewater spill into communities during heavy rainfall events (Mugo et al. 2020). Urban construction, agriculture, and extractive industries overexploit forests vital for water quality, pollute surface water, and exploit groundwater sources (Koehnken et al. 2020). It is increasingly clear that an urban area's water supply depends heavily on the health of an ecosystem that may exist outside of any one city's jurisdiction, requiring action that transcends administrative boundaries (Browder et al. 2019; Juno and Pool 2020).

How African cities and countries handle this moment has immense potential to inform practice and move towards more resilient and equitable systems even beyond the continent. Building water resilience could form the bedrock for building resilience against many future challenges that transcend boundaries and require collaboration across agencies. Global and regional initiatives such as the Sustainable Development Goals and the African Union's Agenda 2063 can raise the political ambition to build equity and resilience together (AU 2015). The global COVID-19 pandemic highlighted this inextricable connection, exposing how the most socially vulnerable—who usually lack safe water and sanitation access—were the first to be left behind. Failing to build urban water resilience will hamper development or, even worse, unleash humanitarian disasters and conflict over water resources. To secure future economic growth and community health in Africa and to build back better from COVID-19, it is imperative that water resilience becomes a foundational priority.

About This Report

This publication frames the challenges and opportunities related to water resilience in rapidly growing African cities and suggests pathways forward for actors involved in urban water resilience. It is based on an extensive literature review (theoretical, empirical, and gray literature) focusing on Africa, the authors' collective experience working on these issues, and key informant interviews from utilities and city agencies conducted throughout May–July 2020 in four cities: Addis Ababa, Ethiopia; Cape Town, South Africa; Kampala, Uganda; and Nairobi, Kenya. These cities were selected to capture the range of country economies and, at the time,

were also in consideration for further city-level assessments and partnerships as part of the broader initiative. As a result, this report draws from primary and secondary data from East and South Africa, supplemented by literature focused on West and North Africa when available. It should also be noted that although this report explores future trends of climate risks and urbanization with a pan-African perspective, it draws heavily from the political and historical context of Sub-Saharan Africa. Box ES-1 describes our working definition of a water-resilient city.

The report is organized as follows: Section 1 overviews the challenge of water resilience in Africa's changing urban context. It then offers a brief look at the historical context and political economy of water in African cities and frames a new approach for water resilience. Section 2 outlines four priority pathways for building urban water resilience in African cities: plan for water (mainstream risk-informed land management and water-sensitive urban development), prioritize the most vulnerable (increase equitable access to safe water and sanitation), create change at scale (develop innovative institutions and pursue partnerships for water resilience), and get finance right (increase and align water-resilient investments across sectors. Finally, Section 3 concludes with an action agenda for different stakeholders and levels of governance.

This publication frames the initial kickoff of a multiyear initiative on urban water resilience for African cities. The Urban Water Resilience Initiative of the World Resources Institute (WRI) is working to help cities advance their resilience goals through research to illuminate urban water resilience challenges and pathways, partnerships with cities to enhance capacity and demonstrate viable pathways, and collective action to improve enabling environments.

The Political Economy of Water in African Cities: A Look at History

Although there are vastly different political economies and histories across African regions, the water sector in Sub-Saharan Africa follows the dominant trends of centralized water management systems,

BOX ES-1 | Working Definition of *Urban Water Resilience*

Based on our research, we use the following working definition of *urban water resilience* in African cities:

> **Urban water resilience** means **equitable access to safe, reliable, and affordable drinking water and sanitation; flood-protected neighborhoods**; and **healthy regional watersheds** resulting from **water-sensitive infrastructure** and **aligned city and regional development**, enabled by **governance, planning, and finance systems** that continually adapt to changing local contexts and climate risks.

This report posits the city-region as the context for action, where water resilience efforts can build momentum and capacity. The city-region includes relevant urban areas and its hydrologically linked areas (e.g., any watersheds that the city impacts or is impacted by). This report, therefore, focuses on the actions needed from a range of actors within the city-region context.

We note that cities will need to include local communities and diverse stakeholders to coproduce contextualized knowledge related to water resilience. This process needs to be progressively scaled up across levels of decision-making (community to city to regional) and to organizations playing a role in the urban water management system. A wide coalition of actors needs to buy into the idea of urban water resilience and the process through which this has been generated; otherwise, it will be difficult to sustain broad-based support for these efforts.[a] Transitioning to a water-resilient city will require relevant stakeholders to reach a shared understanding for joint action across the region.[b]

Sources: a. Roberts et al. 2020; b. Habtemariam 2019; Mukhtarov and Daniell 2018.

with unequal provision across cities. Unequal provision is in large part a legacy of the colonial regimes that formally served white minority colonial neighborhoods while excluding the large majority of Africans in surrounding neighborhoods (Barraqué and Zandaryaa 2011; Jaglin 2014; Niasse and Varis 2020; Njoh 2013). Despite efforts to improve urban water systems through the postcolonial period of the 1970s–1980s, water challenges have escalated. Internationally supported public reform efforts to modernize water systems failed to address worsening spatial disparities, resulting in a growing population dependent on alternative, private, and largely unaffordable or unsafe water supply methods.

From the 1990s to early 2000s, international development agencies ushered in a new decade of privatization and market principles in response to the lack of government capacity to effectively provide water infrastructure and services. Despite expectations, this did not significantly improve access because of problems related to unaffordability and limited financial viability (Mitlin et al. 2019). The privatization of urban water systems was highly criticized, and price hikes sparked unrest in several cities (Adams et al. 2019; Barraqué and Zandaryaa 2011; Goldman 2015). Studies also document how this exacerbated the neglect, overexploitation, and pollution of water resources, as management and lease contracts gave little incentive to invest in water source protection in the long-term (Barraqué and Zandaryaa, 2011; Silva et al. 1999). This neglect of regional water sources has continued to worsen urban water challenges and highlights the need for cities and regional authorities to coordinate on water management.

From the 2000s to the present day, most cities in Africa have corporatized utilities, which prioritizes short-term cost recovery and technocratic approaches. Climate-related or other urban risks and water source protection are seldom prioritized (Chu et al. 2019; Mitlin et al. 2019; Satterthwaite et al. 2019). Investments have trended towards large, physical infrastructure and supply expansion but have failed to increase coverage substantially. Municipal capacity has been unable to keep pace with urban growth, widening inequalities in access to services and infrastructure (Mitlin et al. 2019). Unmet demand and long-standing infrastructure deficits for water and sanitation have resulted in a largely unregulated ecosystem of alternative, informal providers and/or self-provision (Cirolia 2020; Pieterse et al. 2020).

A New Approach for Africa's Changing Context

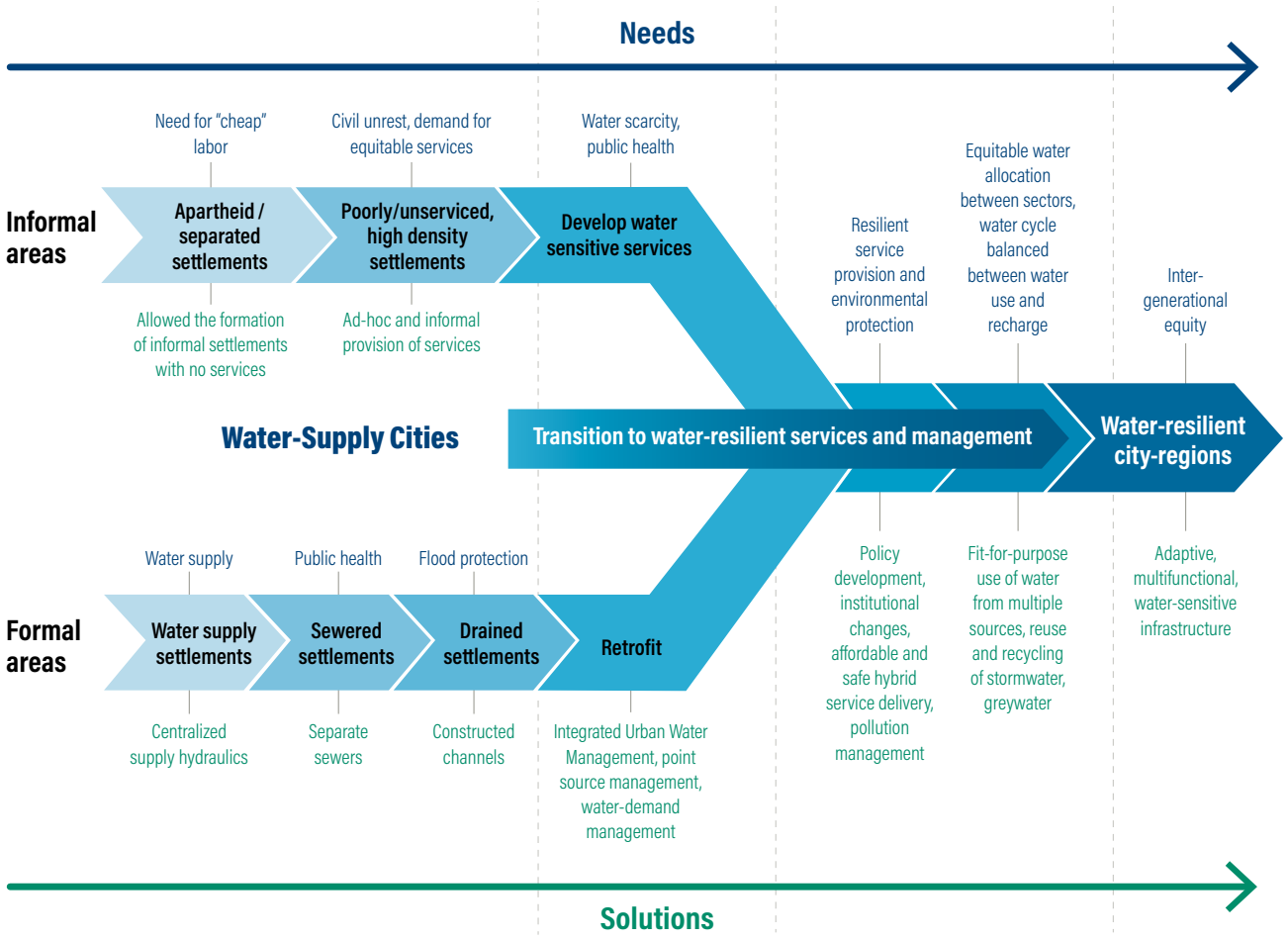
Today, most cities operate as "water supply cities." The historical context and political economy of Africa's water systems has led us to the parallel development of formal urban areas, focused on supply-oriented expansion of gray infrastructure, and informal areas, dependent on ad hoc and informal water provision (Nastar et al. 2018). Figure ES-1 describes a framework adapted for the African context to transition from a water supply city to a water-resilient city-region.

Our research highlights the objectives, key players, and priority pathways that should frame a new approach for action. The new approach requires connecting the realities of cities with basin-level issues and linking water to crosscutting urban issues, such as land use, equity, and service provision. It must enable action on the regional scale, shifting water practices for hydrologically linked areas. It should sharpen the focus on the most socially vulnerable groups, tackling social and political barriers that leave groups such as informal dwellers, women, children, tenants, and minorities most exposed to water-related shocks and stresses (Grasham et al. 2019). Scholars note that any transition, or "leapfrog," for African cities must center social infrastructure and the enabling role of governance and institutions (Habtemariam 2019; Kareem et al. 2020).[1]

An Emerging Role for Cities: Elevating Water Resilience

Cities can drive change towards a new approach. Although the political, regulatory, and fiscal powers of local governments vary across the continent, in many countries where the devolution of powers is more established, the potential for cities to drive resilience is promising.[2] Cities are

Figure ES-1 | Transitioning from a water supply city to a water-resilient city-region



Source: Adapted from Fisher-Jeffes et al. 2017.

centers of innovation and political ambition that can lead action across stakeholders and multiple levels of government. A recent Organisation for Economic Co-operation and Development (OECD) survey on water governance across 36 African cities found that increasing the leadership of city governments in water policy has been key for confronting silos, poor planning, and a lack of policy coherence (OECD 2021).

Cities alone, however, cannot elevate water resilience. The extent of city authority and technical capacity across the continent varies widely, but in almost all cases, change is largely impossible without the support of noncity actors. Thus, it is imperative for cities to look beyond their own borders, moving from merely being "water suppliers" to "water managers" to playing a crucial and proactive role in both protecting the healthy watersheds that feed urban demand and increasing water and sanitation access at the household level. Doing so requires holistic water management, strengthened and new types of capacity, and incentives across government agencies, featuring collaboration with civil society and the private sector. For urban agendas to effectively elevate water resilience, they need the involvement of key players across sectors and industries that are not traditionally viewed as part of the water sector yet directly impact the water system, such as land development and management, planning, construction, mining, roads and drainage, transport, farmers, and forestry.

A new approach that builds water resilience is urgently needed. Although the challenge is not new, today's rapidly changing context requires bold, urgent action. Acting now has the potential to address existing inequalities in both access to water and the effects of water stress. It could incentivize much-needed water-sensitive investments, practices, and partnerships that align urban water policy with national, regional, and sectoral policies. Building water resilience is a critical step towards a trajectory of higher productivity and more sustainable development across Africa while safeguarding against immediate shocks and long-term stressors.

Priority Pathways for a New Approach

This report recommends four priority pathways for urban and water-related stakeholders interested in building urban water resilience (see Figure ES-2). These crosscutting pathways can help enable new approaches to transition to a water-resilient city-region. All pathways require action, but how cities prioritize and operationalize urban water resilience—and which pathways they choose to institute first—will depend on their local context, political opportunities, and policies already on the agenda.

This report does not exhaustively recommend actions that can help solve all water-related challenges in Africa. Instead, it focuses on connecting different agendas and bodies of knowledge to highlight priority pathways to build water resilience in the face of increasing urbanization and climate risks. Next, we present the priority pathways with a brief description of the main barriers and the recommended strategies forward, with examples for each. The end of Section 3 includes an action agenda for relevant actors (city government, utilities, civil society, private sector, regulators, and the international community).

Figure ES-2 | Priority pathways for a new approach to urban water resilience

Source: Authors.

Plan for Water: Mainstream Risk-Informed Land Management and Water-Sensitive Urban Development

Barriers: Urban expansion in Africa, typically through informal, unmanaged, or haphazard developments, is predicted to be the highest in any region in the world, with a dramatic 700 percent increase between 2000 and 2030 (McDonald et al. 2013). Resource-constrained cities tend to react to development trends instead of proactively planning for growth. The resulting urban expansion, especially outside of a city's administrative boundaries, is pushing the limits of conventional water management (Mahendra and Seto 2019). Cities are struggling to keep up with water demand, and pressure is compounded by forest degradation, water-intensive plantations, and interbasin conflicts. Poor waste management, extractive industries, and the resulting increase in pollution are further degrading water resources. This cumulative water stress has cascading effects beyond a single city, affecting peri-urban agriculture, food security, and nearby secondary or downstream cities (Kareem et al. 2020). Cities also contain extensive built-up infrastructure and impervious surfaces, which means more runoff during rain events and decreased groundwater recharge (Douglas et al. 2010; Juno and Pool 2020). Ultimately, land-use decisions in hydrologically linked areas (e.g., catchment areas) affect water recharge, quality, and availability for cities.

Strategies forward:

A. City decision-makers must understand water-related risks and plan for growth. This involves shifting urban planning towards a more integrated, strategic accounting for climate-related and other risks for all hydrologically linked regions. This should happen in collaboration with regional planning, if this exists, or at least strengthen the imperative for planning across key sectors at the regional level (e.g., agriculture, waste management, construction).

B. Cities should also diversify water supply sources and management options, starting with increasing investments in water resource conservation and water demand management strategies. This will help plan for future population growth, identify deficits in water supply, and ensure future water security.

C. Lastly, decision-makers across government levels should invest in water-sensitive infrastructure design as part of mainstreaming urban water resilience. This includes a strong focus on nature-based solutions that comprise a mix of green and gray infrastructure, which protect natural water resource systems. When such solutions are implemented, care must be taken to mitigate any negative equity impacts on vulnerable groups (UN-Habitat 2020).

Examples: Learning from their Day Zero experience—where the city almost ran out of water at its main reservoir—Cape Town's new Water Strategy commits to developing new, diverse water supply sources and management options, including groundwater, gray water reuse, and desalination (City of Cape Town 2020). In Windhoek, Namibia, the utility has been producing drinking water from recycled wastewater since the 1960s and recharging its aquifers with surplus reclaimed water since the mid-2000s. Commitments to scale nature-based solutions can be found in Sierra Leone, where the mayor has committed to planting 1 million trees over the next couple of years to reduce erosion, landslides, and runoff from flooding (UNEP 2020a). In Kampala, Uganda, and Ibadan, Nigeria, peri-urban agricultural communities have recognized the increasing role of farmland and green spaces in buffering cities against floods and storms, recharging aquifers, strengthening food security, and mitigating climate risks for the city-region's watershed. To improve these functions, they have implemented nature-based solutions, such as increasing tree cover and greening drainage channels (Lwasa et al. 2015).

Prioritize the Most Vulnerable: Increase Equitable Access to Safe Water and Sanitation

Barriers: The number of water-insecure urban residents in Africa is rising, even when dams are full and aquifers are replenished by the wet season (Asante-Wusu 2020; We Are Water Foundation 2017). The urban population living in slum areas

in Sub-Saharan Africa with inadequate water and sanitation services has doubled from 1990 to 2012, from 102.6 million to 213.1 million people (Chitonge 2014). Municipal water and sanitation networks often only cover a portion of a city, placing complex burdens related to cost, time, space, and gender on residents without access. This has devastating impacts on the urban poor, who end up paying many times more for less quantities of water and worse sanitation services. The challenge worsens with increasing water stress at the basin level, resulting in more severe rationing and intermittency (Interviews 1, 5, 13; Niasse and Varis 2020). Moreover, there is a lack of robust and disaggregated data to accurately capture water insecurities at the household level to inform policies at the city level.

Strategies forward:

A. Cities and utilities need to target policies to increase water connections, affordability, and availability for the most socially vulnerable. Such efforts should leverage the existing ecosystem of service providers, from community-managed water kiosks to small-scale sanitation pit emptiers, as potential parts of the solution.

B. City decision-makers should pursue the comprehensive upgrading of water-insecure areas to increase access to safe water and sanitation infrastructure and healthy spaces. Efforts should bolster existing localized innovations, such as rainwater harvesting and storage, and ensure affordability.

C. Public, private, and project-related stakeholders need to integrate local data, knowledge, and community participation in decision-making. Successful resilience-building strategies are underpinned by a coalition of local actors, locally led implementation, and a shared vision with adequate buy-in from impacted communities.

Examples: In Mukuru, Nairobi, a slum area home to 100,000 residents, the county government is partnering with the Muungano alliance—a local coalition of slum dwellers—and other actors to carry out comprehensive upgrading plans. They have created an integrated development plan, including upgrades to water, sanitation, and drainage services critical for improving access and flooding issues (Dodman 2017; Lines and Makau 2018). In Kumasi, Ghana, a social enterprise offered freestanding, portable toilets and collection services as an alternative to overflowing pit latrines, septic tanks, or open defecation (Greenland et al. 2016). This could be a promising, localized innovation to mitigate the disease burden from poor sanitation and flooding, if supported and made more affordable by the public sector. Slum/Shack Dwellers International has bolstered the role of slum dwellers across many African cities by collecting and processing data about their local communities, revealing nuanced vulnerability and investment needs (SDI 2018).

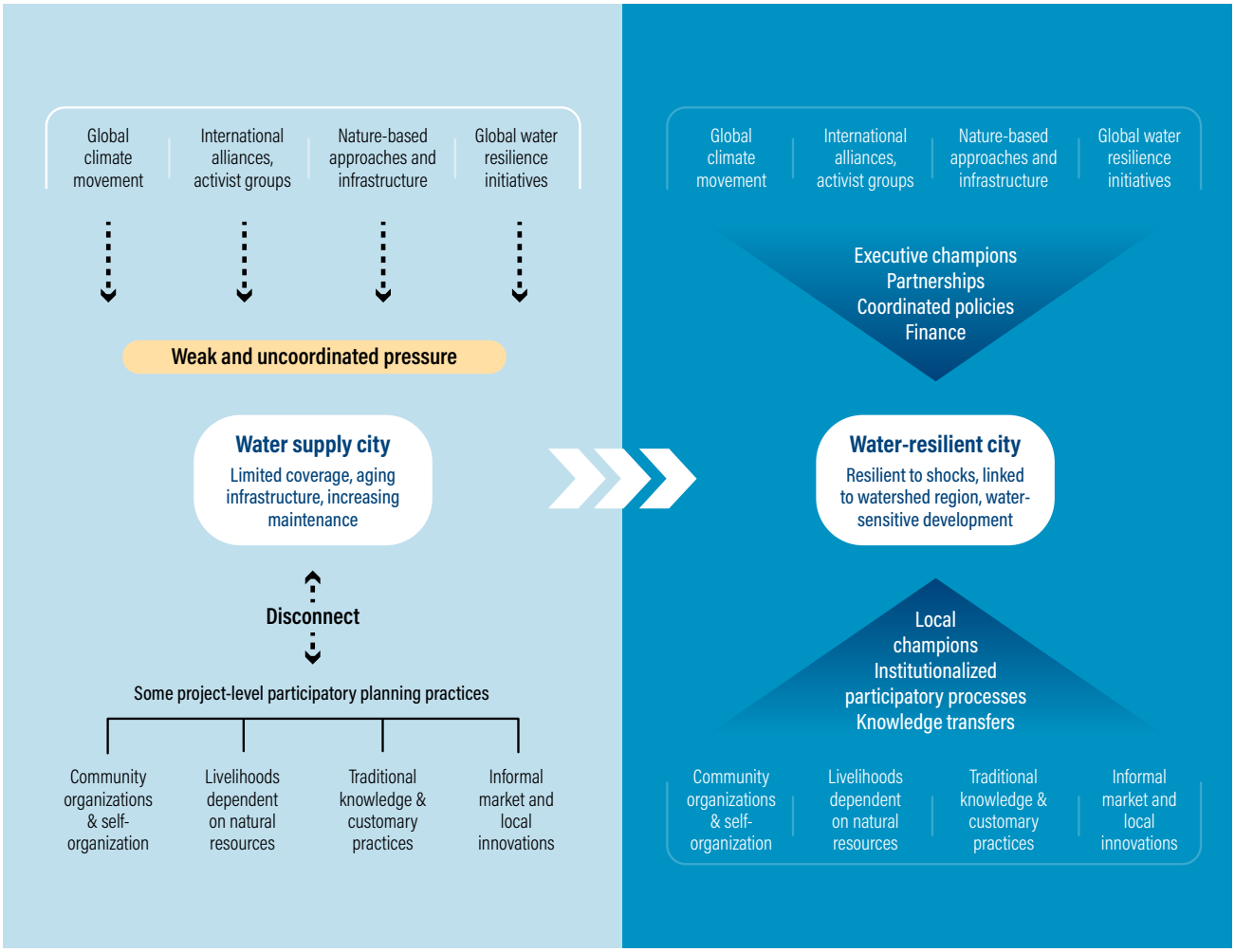
Create Change at Scale: Develop Innovative Institutions and Pursue Partnerships for Water Resilience

Barriers: Many countries in Africa currently have fragmented water governance that limits key stakeholders' ability to meaningfully engage around building water resilience. Misalignments between sectoral agencies and city departments exacerbate existing environmental, health, and social vulnerabilities. Overlapping mandates between central ministries, water resources authorities, environmental regulators, and regional governments reinforce disconnects between local and national policies. Political jurisdictions do not typically correspond to water system boundaries, requiring a new level of coordination and collaboration across levels of government and across agencies within levels of government. In some cities, water can also be easily politicized for short-term wins with costly inefficiencies. Without strong political coalitions and platforms for the most marginalized communities, corruption and dominant lobby groups can easily undermine actions towards water resilience.

Strategies forward:

A. Government agencies across levels and municipalities across jurisdictions need to establish more incentives for collaboration and coordination. This is the first step towards enabling more adaptive and flexible governance that is equipped to respond to water challenges that transcend borders.

Figure ES-3 | Top-down and bottom-up leadership, political commitments, and partnerships play a key role in enabling a water-resilient transition



Source: Authors, adapted from Brown et al. 2009; Habtemariam 2019; Mguni 2015.

B. Leaders from top-down and bottom-up initiatives must together increase political commitments towards new, institutional practices for water management (see Figure ES-3). With significant authority over water resources, finance, and infrastructure that affect cities, national governments must align and enable local leadership and strategies for water resilience to create change at scale.

C. Public agencies from across sectors should prioritize building institutional capacity that supports planning, disaster preparedness, experimentation, and reflective learning. This includes technical capacity as well as soft skills such as negotiating and relationship building.

D. Partnerships and coalitions—such as between cities and community groups, cities and regional stakeholders, and cities and national agencies—are key to sustaining and accelerating the transition to water resilience. Such alliances can strengthen regional water governance and political alignment as well as sustain momentum when confronted with short-term political changes. This includes reinforcing platforms and political dialogue with inclusive representation to counter corruptive practices for short-term gains.

Examples: In eThekwini Municipality, cross-sectoral collaboration and diverse stakeholder engagement enabled the uMngeni Ecological Infrastructure Partnership, a transmunicipal coalition, to improve the resilience and management of the uMngeni River catchment. This also set a foundation for the creation of Durban's resilience strategy, which involved extensive participatory stakeholder engagement and integration of local knowledge. The resulting commitment highlights cross-sectoral priorities targeted at systemic changes, with buy-in across a wide breadth of groups (Roberts et al. 2020; Sutherland et al. 2014, 2019). At the national level, the African Green Stimulus Programme, launched in late 2020, announced ambitious strategies on nature-based solutions, restoration and biodiversity efforts, and climate action (UNEP 2020b, 2021). Impressively, it has been endorsed by all ministers of environment from across the continent.

Get Finance Right: Increase and Align Water-Resilient Investments across Sectors

Barriers: The current financing approach is siloed and mismatched for water resilience. Utilities, water resources authorities, and environmental regulators are underfunded and often compete for the same donor funding, as seen in Kenya (Interviews 3 and 6). The dependence on external funding can present conflicting agendas, inefficiencies, and trade-offs that prevent equitable water-resilient investments in cities. Moreover, the conventional financial model for utilities may create risk cascades, or "shocks within shocks," in the face of disasters. Cape Town's Day Zero crisis exposed additional limitations of municipal finance models reliant on cost recovery assumptions. The utility struggled from a steep revenue decline as residents reduced water consumption and invested in off-grid solutions, especially from higher-income and high-level water consumers (Simpson et al. 2019). Furthermore, infrastructure interventions have been largely biased towards large-scale, centralized projects with rigid and exclusionary procedures. Current financial analyses may seldom include the long-term benefits of adaptation and lead to shortsighted investments. Powerful financiers often create "solutions" and knowledge that miss the daily needs and realities of the most socially vulnerable groups, and not enough finance is channeled to support locally led action (Lawhon et al. 2013; Zimmer 2015).

Moreover, at least US$66 billion is needed to address infrastructure backlogs for universal access to water and sanitation (AfDB 2018). An additional $9–$14 billion is needed per year to achieve secure water resources in Africa (OECD 2021). The dire funding gap for addressing the water crisis is clear. Yet even clearer is what financiers and cities invest in, and how, must also shift dramatically. Over the last decade, more than 80 percent of water sector spending in Sub-Saharan Africa has gone to water and sanitation—making up more than $7 billion per year in 2011—and access levels have hardly improved (Damania et al. 2017). A shift in how water is financed will require a more holistic, long-term view of water-resilient, nature-based interventions, with investments aligned across sectors.

Strategies forward:

A. First, to get finance right, national governments, international financiers, and cities need to increase funding for policies and programs that improve locally led adaptation and basin-level water resilience. Some ways that city governments can tackle this is by redirecting existing resources and developing financing mechanisms to improve their revenue streams.

B. Partnerships between national, international, and private funders can leverage investments in equitable, water-sensitive design. These are critical for enabling city-regional and cross-sectoral financing, such as for water source protection, as well as channeling resources to frontline communities. Private financing, such as blended finance and microfinance for small-scale enterprises, plays an important role in complementing public finance. It should be noted that these financing approaches are limited in their ability to reach the poorest and most vulnerable, and they often depend on local enabling and regulatory environments (Attridge and Engen 2019; Convergence Finance 2018).

C. Lastly, financial models and fiscal planning must integrate the long-term economic benefits of adaptation, transparency, and criteria for equitable access to water in investment allocations. Given the role of development banks in Africa, they are well poised to mainstream this type of valuation and elevate resilience in their funding portfolios.

Examples: The Kenya National Drought Management Authority piloted a devolved climate finance and planning mechanism, called the County Climate Change Funds, and it is now scaling it to all counties. This allows for subnational authorities and local communities to tap much-needed resources to build resilience against droughts (IIED 2017). In 2021, the Global Commission on Adaptation, WRI, and the International Institute for Environment and Development released the "Principles for Locally Led Adaptation" to guide how current practices can mobilize funds for local impact; it was endorsed by over 40 organizations (WRI and GCA 2021). An innovative city-regional platform is the Water Fund model of The Nature Conservancy (TNC), which brings downstream water users such as businesses or cities together to invest in upstream water conservation efforts. Successful efforts are ongoing in Kenya, Sierra Leone, and South Africa. In Kenya's Upper Tana watershed, for example, TNC, the Kenya Water Towers Agency, and the Kenya Forest Service worked with smallholder farmers to implement soil retention and water conservation practices that have increased water supply by 27 million more cubic meters daily (Brown 2019).

Transitioning to a Water-Resilient City

Cities in Africa are facing unprecedented, rapid urbanization and climate-related shocks and stresses. Without action, millions will be left behind without basic access to urban water infrastructure and services and the ability to adapt to climate risks as well as health risks, as shown by the COVID-19 pandemic. The costs of inaction are tremendously high.

We offer four priority pathways for action but recognize that this framing is only a starting point (see Figure ES-4). All cities in Africa have different local and regional contexts, and these pathways are intended to remain flexible. This report provides a starting point for analyzing the barriers and necessary linkages across sectors and development actors needed to elevate urban water resilience, but future work in these areas remains essential. The transition potential of African cities can only be harnessed if the process starts with research grounded in the realities of the system. Approaches should welcome critical debates on how to achieve a just and water-resilient city, which entails encouraging new models, financing systems, organizations, and working relations across all key actors involved.

There is a key window of opportunity to transform the urban water pathways of Africa's cities. The world faces two potential inflection points for the future: a massive recovery from the COVID-19 pandemic and a new decade of climate action. Accelerating water resilience is integral for both global agendas, necessary to underpin a resilient recovery, and imperative for the climate emergency. It is clear that the health and economic impacts of the pandemic, climate change, and inequality are deeply intertwined. Increasing urban inequalities means emphasis needs to be placed on building resilience capacities of marginalized groups, such as slums and informal settlements, the urban poor, people with disabilities, and women and girls.

Ultimately, we must align incentives across the different actors and interests to promote forward-looking measures that build resilience today. Repairing damage inflicted by climate change and other water risks is far more costly than taking preventative steps now. Now is the moment for African cities and countries to chart a more water-resilient approach, laying a foundation for prosperity for all.

Figure ES-4 | Key pathways for building urban water resilience in African cities

Source: Authors.


JULIAF SERVICES

1. The Challenge for African Cities

By 2050, Africa will be a different continent than it is today. The total population is expected to double (Ndaw 2020), putting pressure on existing urban water infrastructure. The impacts from climate change on water resources will worsen, with cascading risks related to livelihoods, economies, health, and extreme weather events.

Decisions today will dramatically impact how the continent transforms and the way people move, live, and thrive for decades to come. Cities can provide new economic opportunities and better livelihoods—but only if equipped to handle the strain on their water systems. Increasing urbanization and climate-related pressure, poor management, and inequitable distribution are creating a vicious cycle of water insecurity for most urban residents. With the knowledge we have today, it is possible to escape this trajectory and create a virtuous cycle of resource conservation, coordinated planning and governance, and equitable access.

A new approach that builds water resilience is urgently needed. Although the urban water challenge is not new in Africa, few approaches have successfully focused on the rapidly changing African urban context. Cities and urban areas face escalating water-related challenges arising from fast and haphazard urban expansion; limited access to safe water and sanitation services; and worsening flood, drought, and pollution risks. Many African cities are already suffering from deep inequalities in access to basic infrastructure that place disproportionate water-related and disease burdens on the urban poor. One in two urban residents in Africa live in an informal settlement (UN-Habitat and World Bank 2018). Over 50 percent and 80 percent of urban populations in Sub-Saharan Africa lack access to safely managed water and sanitation, respectively (WHO and UNICEF 2017). This varies widely across countries; for example, in Liberia, 9 percent of the urban population has access to safely managed sanitation, compared to over 90 precent in South Africa (WHO and UNICEF 2017).

Water-related disasters have worsened and become more frequent. Over the last three decades, 654 floods in Africa have affected over 38 million people (OECD 2021). By 2050, it is estimated that 162 million people will be living in urban areas with perennial water shortages (OECD 2021). Several countries, including Côte d'Ivoire, Ghana, Morocco, Mozambique, and Zimbabwe face severe water shortages (Bendix 2019). This will worsen with climate change, devastating economies, threatening livelihoods and the health and well-being of billions, and causing instability that echoes far beyond the current generation. Under the climate scenario in which global temperatures rise by 4°C, the World Meteorological Organization reports that the African gross domestic product (GDP) will decline between 7 percent and 12 percent (WMO 2020).[3] Already, 70–80 percent of disease cases in Sub-Saharan Africa, such as from cholera and dysentery, are attributable to poor water quality (Ndaw 2020).

This report is being drafted as the world faces two potential inflection points for the future: a massive recovery from the COVID-19 pandemic and a new decade of climate action. Accelerating water resilience is integral for both global agendas:

- First, the global COVID-19 pandemic and its lockdown orders in 2020 demonstrated severe vulnerabilities arising from urban inequality and the limitations of current water, sanitation, and wastewater management practices. As cities recover from COVID-19, smart investments and policies targeted at increasing resilience must be part of stimulus packages. A 2020 study from McKinsey calculates that, globally, governments have announced at least $10 trillion in post-COVID stimulus packages, providing an opportunity to progress towards carbon neutrality and resilience building (Cassim et al. 2020). A resilient recovery can achieve a triple dividend: helping cities boost their economies; improving equity; and preparing communities for inevitable climate, water, and health threats.
- Second, the new decade on climate action requires bold, swift ambition to limit global warming and ensure adaptation. To limit warming to 1.5°C, the world needs to cut global emissions by at least eight times by 2040 (Lebling et al. 2020). To limit uneven loss and damage, especially for African countries, renewed commitments on climate action must also simultaneously step up in areas of adaptation and finance. This is critical for improving water resilience where impacts are acutely felt at the local level. In 2017, despite countries committing $100 billion in climate finance, much of it has yet to be paid. Less than 10 percent has been dedicated for local action (IIED 2017; UNFCCC 2015). Promisingly, in late 2021, COP26 will bring together 70 countries and key players, with resilience and adaption taking center stage for the first time (UNFCCC 2020).

The health and economic impacts of the pandemic, climate change, and inequality are deeply intertwined. Water is an underappreciated crisis that cuts across all of these challenges. The need to accelerate water resilience in cities and to invest in multibenefit strategies is higher than ever before. Moreover, bolstering water resilience now can lay the foundation for an overall agenda of climate, social, and economic resilience. To secure future economic growth and community health in Africa and to build back better from COVID-19, it is imperative that water resilience becomes a foundational priority.

African cities and countries present a unique opportunity to develop comprehensive water resilience actions that leverage their energy, growth, youthful demographic, and cultural diversity. In most African countries, cities that will exist in 2050 have yet to be built. This, along with technological innovations, creates an exceptional opportunity to get water management right, addressing climate-related risks for both overall water availability at the regional scale and access to water in cities. This includes incentivizing urban design and practices to be sensitive to water issues. It also means establishing coordinated governance models that align urban water policy with water needs in other sectors, and across national and regional policies. With an equity-centered approach, this also has the potential to address existing inequalities in both access to water and the effects of water stress.

How African countries handle this opportunity has immense potential to inform practice and move towards more resilient systems even beyond the continent. Building water resilience could form the bedrock for building resilience against multiple future challenges that transcend boundaries and require collaboration across agencies. Building water resilience is a critical step towards a trajectory of higher productivity and more sustainable development across Africa while safeguarding against immediate shocks and long-term stressors. There is an opportunity to build better water resilience now to protect the next generation of cities.

1.1 About This Report

This publication frames the challenges and opportunities related to water resilience in rapidly growing African cities and suggests paths forward for actors directly or indirectly involved in urban water management (see Box 1 for a working definition of *urban water resilience*). The primary audience is decision-makers and practitioners at the city, municipal, regional, and national levels involved at any point of the water system, including resource management, service provision and distribution, and treatment and reuse. In addition, this publication will be useful for investors, multinational aid agencies, funding institutions, and private sector actors involved in urban water management in African cities. It can also help strengthen the link between research and on-the-ground practice in cities across the world facing similar water resilience challenges. The report focuses on the fast-changing urban context and does not exhaustively cover all water-related issues, such as transboundary water governance.

Building water resilience could form the bedrock for building resilience against many future challenges that transcend boundaries and require collaboration across agencies.

This report is based on an extensive literature review (theoretical, empirical, and gray literature) focusing on Africa, supplemented with a geospatial assessment of key urban growth trends and key informant interviews from utilities and city agencies conducted throughout May–July 2020 in four cities: Addis Ababa, Ethiopia; Cape Town, South Africa; Kampala, Uganda; and Nairobi, Kenya. These cities were selected to capture the range of country economies, with South Africa as upper middle income, Kenya as lower middle income, and Uganda and Ethiopia as low income, according to the World Bank's 2020 country classification.[4] To complement this, the geospatial analysis assessed built-up area, forest cover loss, low elevation zones, and surface water loss in these four cities as well as Cairo, Egypt, and Maputo, Mozambique.[5] These cities were also in consideration for further city-level assessments and partnerships, as part of the broader initiative. As a result, this report draws from primary and secondary data from East and South Africa, supplemented by literature focused on West and North Africa when available. It should also be noted that although this report explores future trends of climate risks and urbanization with a pan-African perspective, it draws heavily from the political and historical context of Sub-Saharan Africa.

This report posits the city-region as the context for action, where water resilience efforts can build momentum and capacity. The city-region includes relevant urban areas and its hydrologically linked areas (e.g., any watersheds that the city impacts or is impacted by). This viewpoint also elevates the role of secondary cities and smaller towns, which may share watersheds with larger cities, face increasing water challenges, and often have the fewest financial and political resources. This report, therefore, focuses on the actions needed from a range of actors within the city-region context.

The report is organized as follows: Section 1 overviews the challenge of water resilience in Africa's changing urban context. It then offers a brief look at the historical context and political economy of water in African cities and frames a new approach for water resilience. Section 2 outlines four priority pathways for building urban water resilience in African cities: plan for water (mainstream risk-informed land management and water-sensitive urban development), prioritize the most vulnerable (increase equitable access to safe water and sanitation), create change at scale (develop innovative institutions and pursue partnerships for water resilience), and get finance right (increase and align water-resilient investments across sectors). Finally, Section 3 concludes with the path forward for different stakeholders and levels of governance.

This publication frames the initial kick-off of a multiyear initiative in urban water resilience for African cities. The Urban Water Resilience Initiative of the World Resources Institute (WRI) is working to help cities advance their resilience goals through research to illuminate urban water resilience challenges and pathways, partnerships with cities to enhance capacity and demonstrate viable pathways, and collective action to improve enabling environments. The initiative will work with up to six cities in Africa, with two each in Ethiopia, Rwanda, and South Africa.[6]

BOX 1 | Working Definition of *Urban Water Resilience*

Based on our research, we use the following working definition of *urban water resilience* in African cities:

> **Urban water resilience** means **equitable access to safe, reliable, and affordable drinking water and sanitation; flood-protected neighborhoods**; and **healthy regional watersheds** resulting from **water-sensitive infrastructure** and **aligned city and regional development**, enabled by **governance, planning, and finance systems** that continually adapt to changing local contexts and climate risks.

This report posits the city-region as the context for action, where water resilience efforts can build momentum and capacity. The city-region includes relevant urban areas and its hydrologically linked areas (e.g., any watersheds that the city impacts or is impacted by). This report, therefore, focuses on the actions needed from a range of actors within the city-region context.

We note that cities will need to include local communities and diverse stakeholders to co-produce contextualized knowledge related to water resilience. This process needs to be progressively scaled up across levels of decision-making (community to city to regional) and to organizations playing a role in the urban water management system. A wide coalition of actors needs to buy into the idea of urban water resilience and the process through which this has been generated; otherwise, it will be difficult to sustain broad-based support for these efforts.[a] Transitioning to a water-resilient city will require relevant stakeholders to reach a shared understanding for joint action across the region.[b]

Sources: a. Roberts et al. 2020; b. Habtemariam 2019; Mukhtarov and Daniell 2018.

1.2 The Fast-Changing Urban Context and Compounding Climate Risks

The rapidly changing urban context in Africa has the potential to compound the devastating consequences of existing water challenges. Climate change, projected urban growth, and increases in water demand pose astonishing current and future risks that must be urgently addressed now.

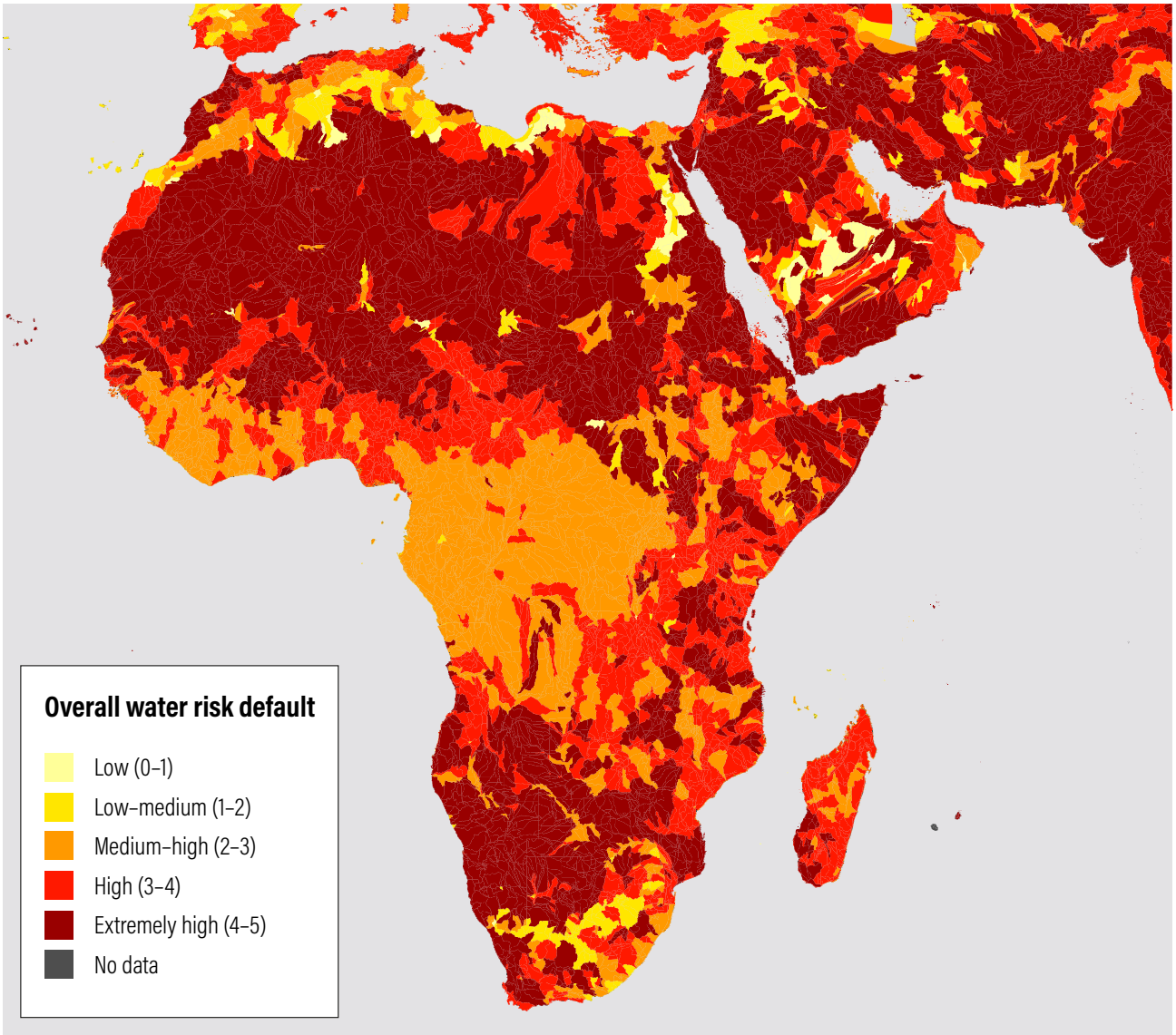
1.2.1 The compounding risk of climate change

On the current trajectory, climate change and other potential disasters will expose the severe vulnerability of urban water systems in Africa (see Figure 1 for overall water risk). Two-thirds of African cities are at "extreme" risk of climate-related shocks (OECD 2021). Climate change is estimated to accelerate warming, increase precipitation in wet months, and decrease precipitation in dry months, exacerbating the continent's water stress (Wijnen et al. 2018).

In Sub-Saharan Africa, a 2010 assessment of disasters found that floods and droughts alone were responsible for around 80 percent of disaster-related deaths and 70 percent of economic losses across the region (Ndaruzaniye et al. 2010). In 2018, Sub-Saharan Africa faced its worst drought in 35 years, with 30 million people at risk of severe water stress and food shortages across the eastern and southern parts of the continent (Wijnen et al. 2018). In 2019, the port city of Beira, Mozambique, was hit by Cyclone Idai (see Figure 2). The disaster destroyed about 70 percent of the city's buildings and resulted in an economic loss of over $300 million—equivalent to 2.3 percent of the country's GDP growth that year (ClimateWire 2020; Municipality of Beira 2019). In Saint-Louis, Senegal, sea level rise is already destroying homes and flooding streets and croplands, drowning a historic city recognized as a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage site (Yeung 2019).

Climate-induced water impacts may also worsen the continent's challenges around water quality and contamination risks. Cholera outbreaks have had a more sustained impact on Africa than on any other continent since the 1980s, largely due to household-level water insecurities. An estimated 40–80 million people in Africa live in cholera hot spots (UN-Water 2019). Cyclone Idai also led to a severe cholera outbreak in Beira. Without adapting to the higher frequency of natural disasters resulting from climate change, cities will experience increasing damages and more major humanitarian crises. Studies also show that climate change will have adverse impacts on the quality of surface and groundwater sources in North Africa from increased salinity, irregular sedimentation, and other polluting effects (Hamed et al. 2018). This is likely to occur in other regions of Africa as well, threatening vital environmental flows and ecosystems.

Figure 1 | Every region of Africa has water basins facing medium to extremely high water risk



Note: Overall water risk measures all water-related risks at the basin level by aggregating all selected indicators from physical quantity, quality, and regulatory and reputational risk categories. Higher values indicate higher water risk for relevant basins. This does not necessarily reflect water risk at the city or household level, meaning the basin a city is in could have "low" water risk, yet the city itself may still have low household access to water and sanitation services. See the Aqueduct website for more information, https://www.wri.org/aqueduct.

Source: WRI Aqueduct, based on Hofste et al. 2019.

Figure 2 | Cyclone Idai caused severe flooding in Malawi, Mozambique, and Zimbabwe (March 2019)

Residents taking refuge on rooftops in Mozambique during Cyclone Idai.

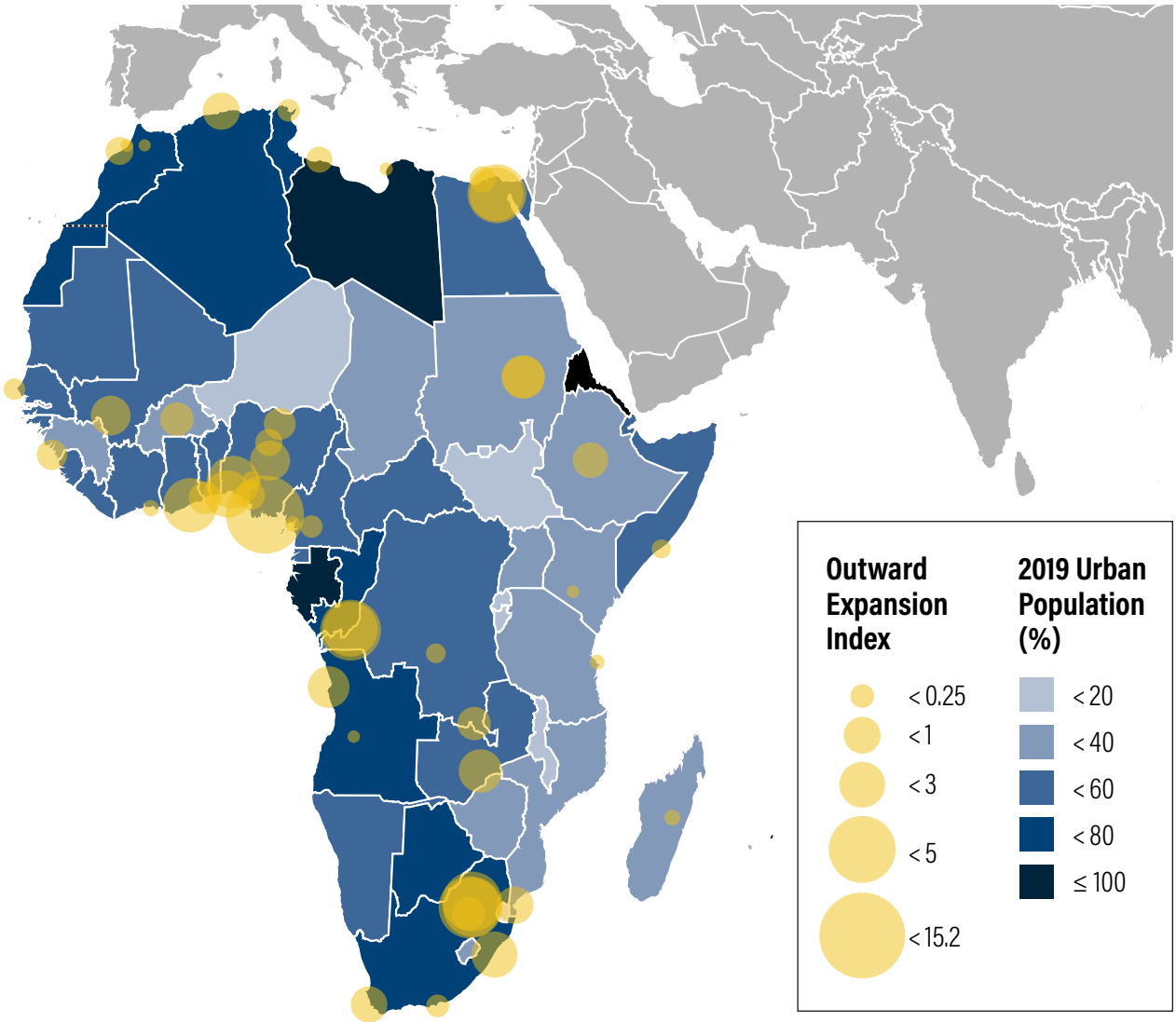
Source: Flickr/Department for International Development 2019.

1.2.2 Cities will continue to expand

Unprecedented urbanization in the coming years has the potential to make the situation in African countries exponentially disastrous. Africa's population is growing faster than any other continent in the world (see Figure 3). By 2050, the population is set to double in 100 cities that currently have more than 1 million dwellers. Over 900 million people will be added to cities, more than doubling between 2020 and 2050 (UN DESA 2018). Based on current growth patterns, most of this will channel into urban slums and informal settlements (Muggah and Hill 2018; Ndaw 2020). In Sub-Saharan Africa, where most of this urbanization is expected, 38 percent of urban demographic growth will take place in cities of under 1 million people over the next 15 years (UN DESA 2018; Wijnen et al. 2018). Thus, whereas in 2000 only 2 cities across the continent (Kinshasa and Lagos) had population numbers exceeding 5 million, by 2030, 15 cities—including Addis Ababa, Antananarivo, Kampala, and Nairobi—are projected to be home to 5 million people or more. Dar es Salaam and Luanda will exceed 10 million inhabitants, and Kinshasa and Lagos will reach 20 million (UN DESA 2018). The metropolitan regions surrounding these cities are expected to grow as well. Just under 50 percent of this increase is expected to come from natural population growth (UN DESA 2018).

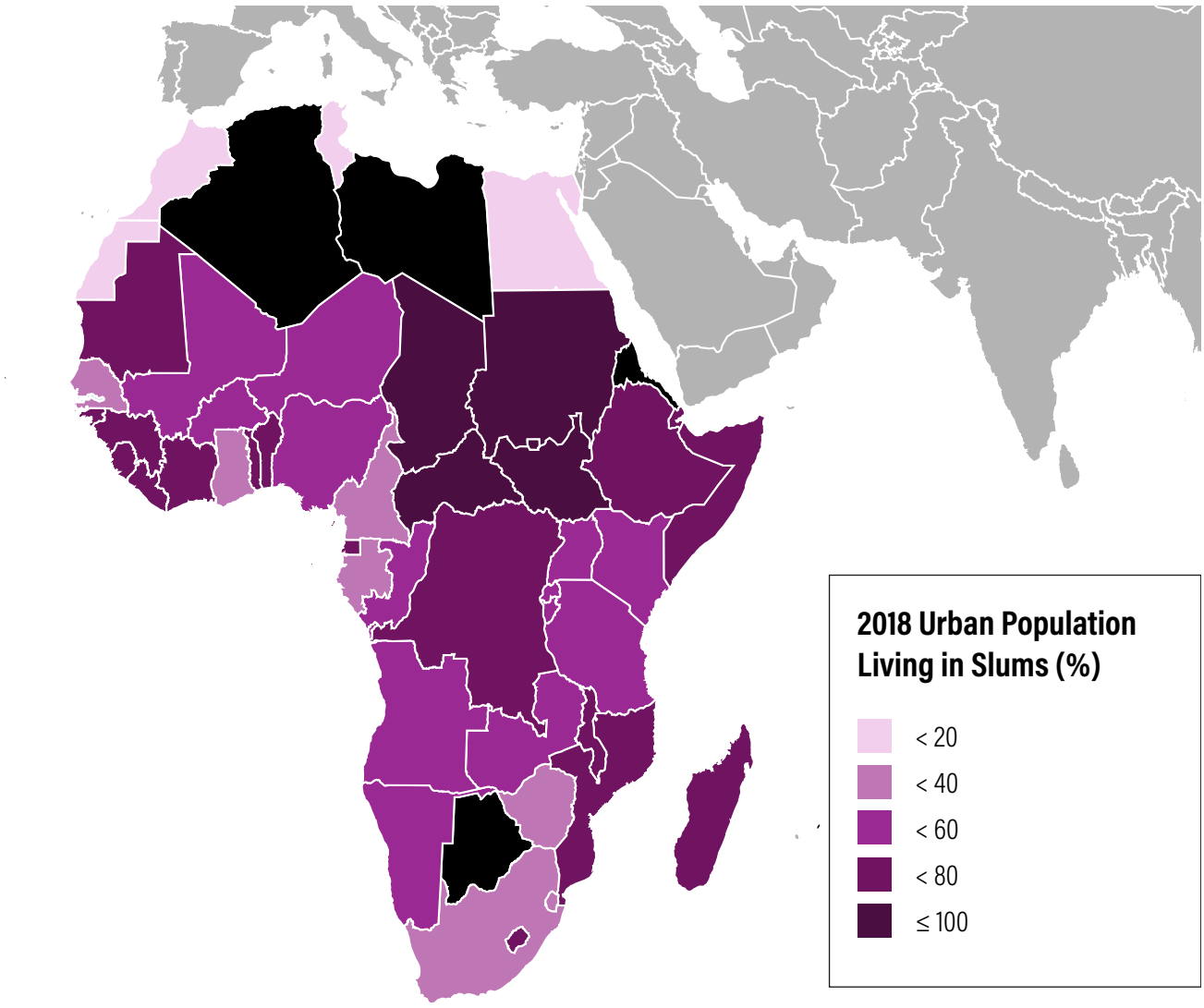
Another reason for urban growth is migration within countries. Over the last decade, urban Africa's newfound economic growth has been fueling rural-to-urban migration. As the population living in cities increased from 32 percent to 37 percent, nominal per capita GDP in Sub-Saharan Africa increased from $521 in 2002 to $1,800 in 2014 (Cartwright et al. 2018). However, urbanization and real GDP per capita do not necessarily correlate. Few African countries have experienced economic and development progress while having an urban transition, as this typically depends on the provision of infrastructure and services (Cartwright et al. 2018). The availability of economic opportunities in bigger cities, as well as past and ongoing conflicts in some regions, are driving migration from rural areas and leading to the proliferation of overcrowded, unplanned, and haphazardly constructed settlements across the continent.

Figure 3A | Level of Urbanization and Urban Expansion across Africa



Source: A. Outward Expansion Index (2018), based on Mahendra and Seto 2019; 2019 Urban Population, based on UN DESA Population Division and World Bank 2019.

Figure 3B | Percentage of Urban Population Living in Slums in African Countries



Source: B. 2018 Urban Population Living in Slums, based on UN-Habitat and World Bank 2018.

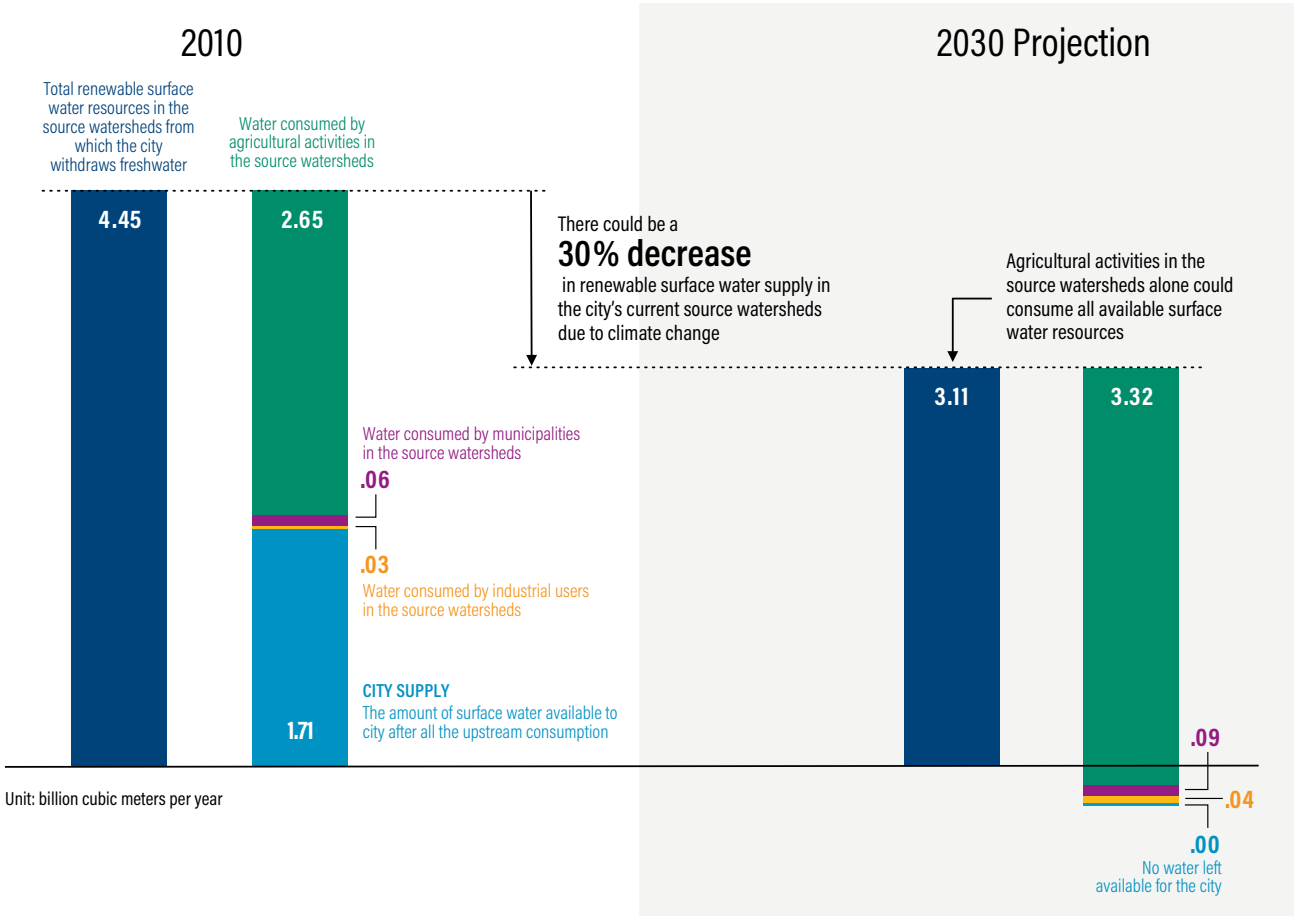
Between 1990 and 2005, the continent's urban population living in informal settlements doubled (Jacobsen et al. 2013). Today, it is estimated that at least 56 percent of the urban population in Africa lives in informal settlements (OECD 2021). In Lagos, 70 percent of the city's dwellers live in informal settlements; in Kampala and Mzuzu, the number is 60 percent (Mitlin et al. 2019). The growth of these informal settlements, home to one in two urban residents in Africa, typically outpaces municipal capacity to provide core services and infrastructure, such as piped water, piped sewage and stormwater drains, electricity, or paved roads (UN-Habitat and World Bank 2018). Municipal capacity becomes even more strained when considering day population growth—the number of people added during the day commuting from the wider metropolitan area. As a result, many informal dwellers may lack secure housing due to tenure insecurity, insufficient finances, or location-based hazards, and they must rely on alternative solutions. The proliferation of informal settlements and their poor access to basic services has become a defining character of African cities.

1.2.3 Water demand is expected to rise exponentially

Regional increases for water demand in 2030, compared to 2005 levels, are projected to reach almost 300 percent—up to three times higher than any other global region (Wijnen et al. 2018). Industrial expansion, an increase in the service economy, and growth in construction demand are driving the consumption of more and more water.

In a watershed, there are often competing demands between municipalities, agriculture, and industry. Agriculture accounts for 87 percent of water usage in Sub-Saharan Africa, and demand for food will increase as the population grows (Faurès and Santini 2008). Water usage through irrigation has increased over the last few decades and is projected to grow (Kadigi et al. 2012). Downstream cities dependent on surface water are affected by upstream consumption but have little control over it. Many regions may find that with business-as-usual conditions, the projected supply in source watersheds will not be able to meet all of the region's demands. The 2030 projections for Casablanca's watershed, for example, show that freshwater resources may decrease by 30 percent, not leaving enough to split among cities and irrigation (see Figure 4). Moreover, Morocco's

Figure 4 | By 2030, Casablanca's current watersheds are likely to experience 30 percent fewer freshwater resources and a 30 percent increase in water consumption



Notes: Baseline and projected future water supply and demand are aggregated across all of the city's current source watersheds. Source watersheds are identified with water intake points from The Nature Conservancy's Urban Water Blueprint database and watershed delineation from the World Resources Institute's Aqueduct Water Risk Atlas. Water supply and demand data are from the Aqueduct 2.1 database. Future projections are modeled with CMIP5 data and under the middle-of-the-road scenario (RCP8.5 and SSP2). City water demand includes industrial and domestic uses that are estimated by aggregate-gridded Aqueduct water demand data within city boundaries that are from the *Atlas of Urban Expansion* by the Lincoln Institute of Land Policy.

Source: Angel et al. 2012; McDonald and Shemie 2014; WRI n.d.

second-largest reservoir, which Casablanca depends on, shrank by 60 percent between 2015 and 2018 due to recurring drought and increasing demand (Watts 2018). Many cities are focusing efforts solely on expanding water supply, transporting water from faraway sources rather than conserving or reusing water. As a result, more and more distant water sources are increasingly exploited by interbasin transfers (Bourblanc and Blanchon 2014; Showers 2002). There are political and environmental implications for extracting water from other areas as well as discharging wastewater to downstream areas (Mgquba and Majozi 2020).

The sheer increase in the number of people living in cities, projected water demand, and the threat of climate change are already escalating the water crisis in cities, but it is important to understand that they are not the primary drivers. The seeds of these challenges trace back to structural drivers among water, urban, and regional sectors as well as to the political economy and historical background of water in African cities.

1.3 The Water Crisis in African Cities: Four Drivers

Cities across Africa are facing escalating water challenges that some may characterize as too little supply or too much demand, but the root causes lie elsewhere. The supply and demand challenges arise because of four primary drivers: poor urban planning; unsustainable water management and distribution practices; unaffordable, unreliable, and unsafe access to water and sanitation; and environmental degradation and water pollution. Section 2 of this report discusses the problems and barriers for each in more detail. An overview of these root causes illuminates how building water resilience in Africa requires going beyond the typical perspectives of water security, water stress, and water supply expansion. Cities must not only secure adequate water supplies and adapt to water stress but also need to accommodate flood shocks and sea level rise. They need to design and build urban water systems 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.

1.3.1 Poor urban planning

Current urbanization patterns are resulting in the loss of protection for a city's water resources, stripping away the ability for city-regions to cope with "too much" or "too little" water. A construction boom that favors concretization through massive highway projects and buildings with little consideration of ecologically sensitive areas is redefining the footprint of African cities, altering the natural functions of land to balance the water system (Interviews 7 and 8; Jacobsen et al. 2013). Without open green spaces and surface water bodies to drain and store excess water, flooding from storm surges or future sea level rise will overflow existing drainage systems and have nowhere else to go. As natural drainage channels have been built over, flooding results in blocked roads, damaged housing and infrastructure, displaced lives, and increased disease risk (Jacobsen et al. 2013). In Addis Ababa, vulnerability to flooding is increasing due to more impermeable surfaces, insufficient drainage systems constantly clogged by solid waste disposal, and loss of green space. Some 30,000 residents across the city are vulnerable to flooding (DPPC 2015). In Kisumu, Kenya, flooding from heavy rainfall and backflow around Lake Victoria in 2020 have displaced over 3,200 residents, most of whom are poor (Wafula and Raballa 2020).

The lack of urban planning as cities have expanded outward has led to a patchwork of formal, informal, and unregulated water and sanitation services (Cirolia 2020; Jaglin 2014). Many fast-growing cities have struggled to address the spatial imprints and segregated infrastructures of colonial histories that determined access to basic services. Furthermore, settlements have developed quickly and informally ahead of infrastructure provision. To immediately fill gaps, communities have provisioned their own alternative, informal, or small-scale provisions (such as boreholes, water vendors, and self-built pit latrines; Evans et al. 2018; Mguni et al. 2020). With few planning mechanisms to manage growth, settlements have continued to expand regardless of access to public service networks, pushing into and threatening surrounding ecosystems (Mahendra and Seto 2019). As such, poor urban planning practices underpin the following three drivers as well.

1.3.2 Unsustainable water management and distribution practices

The status quo model for water management and distribution is no longer sustainable. The conventional, business-as-usual model describes a centralized, supply-focused network of gray infrastructure, reliant on large dams and aquifer exploitation (Pieterse et al. 2020). For water, these systems are linked to bulk treatment facilities and distribute water services to fee-paying customers, often at a deficit to the utility. For sanitation, one or a few large-scale sanitation treatment plants are often developed at great cost but serve a very limited part of the city. The ability to maintain this centralized infrastructure is often compromised by budget constraints, leading to a vicious cycle of underinvestment, water leakages, untreated sewage, intermittent access, contaminated storage, and water cuts (Mitlin et al. 2019; OECD 2021; Pieterse et al. 2020). The main water supply for municipalities remains highly dependent on natural resources and climate patterns, which are increasingly unpredictable. The traditional solution to this problem has been to focus on supply expansion, investing in water reservoirs farther and farther away.

It is clear that business-as-usual practices are unable to meet growing water demand and the sanitation needs of sprawling settlements (Cirolia 2020; Pieterse et al. 2020). Alternative provision and vendors fill in the gap for water and sanitation services, but without regulation, these further water resource exploitation (e.g., overdrawing wells) and water pollution (e.g., dumping untreated fecal sludge directly in water bodies).

Without change, conventional urban water management will face high economic costs when confronted by shocks and stresses. For example, a single water outage for an urban business can reduce its monthly revenue by more than 8 percent. If that business is in the informal sector, as many are in the developing world, monthly revenue can decline by 35 percent due to less ability to cope with service disruptions. Informal businesses also suffer from more frequent outages due to poorer services, ruining livelihoods and stagnating urban economic growth (Damania et al. 2017, 52).[7] The lack of resilience and sustainability in business-as-usual water management will put millions at risk for potentially disastrous impacts.

1.3.3 Unaffordable, unreliable, and unsafe access to water and sanitation

Access to affordable, reliable, and safe water and sanitation services is inextricably tied to a household's ability to withstand the shocks and stresses of water scarcity. Millions of residents in African cities face water stress on a daily or weekly basis, either unable to afford safe quantities of water or because they only have access to low-quality or contaminated water. A study that surveyed five cities in Sub-Saharan Africa found that public piped water is the most affordable option for many, yet only 22 percent of households had access to direct connections (Mitlin et al. 2019). The challenge of affordable, safe, and reliable water for large swaths of the city was particularly acute during the global COVID-19 pandemic. Several cities, such as Cape Town and Kigali, responded by providing temporary free access to water and hygiene facilities or free connections to the water network in order to protect people's health. However, governments need to scale such interventions and ensure that they cover the costs of these programs for already underfunded utilities.

Other countries facing scarcity, such as Zimbabwe, are not so well equipped. At the height of COVID-19's first wave in Harare, the taps were running dry again from the worst drought in years and residents struggled to get enough water for daily needs, let alone frequent handwashing (Mukwazhi 2020). Water from tanker trucks became unreliable due to lockdown road closures. Those unable to afford tanker truck water or queuing resorted to fetching from polluted open wells and surface water. In Bulawayo, the drought pushed some families to sleep overnight in water queues, compromising pandemic guidelines for social distancing (Ndhlovu 2020).

Even when connected to the public water network, there may not be water in the pipes (Herslund et al. 2018; Herslund and Mguni 2019). In Dakar, due to a severe water shortage between April and July 2019, tankers were used to supplement the failing utility-managed water distribution system (Niasse and Varis 2020). In 2017, Nairobi also faced a severe drought that led to municipal rationing that is ongoing in 2021 (Interview 2; Ndege 2017). Whereas households that can afford to cope rely on storage tanks, other households are forced to make

sacrifices in other ways. It is important to note that reasons for dry taps are more complex than water shortages. For example, tenants with access to a shared tap may be subject to restrictions set by their landlord (Mitlin et al. 2019).[8]

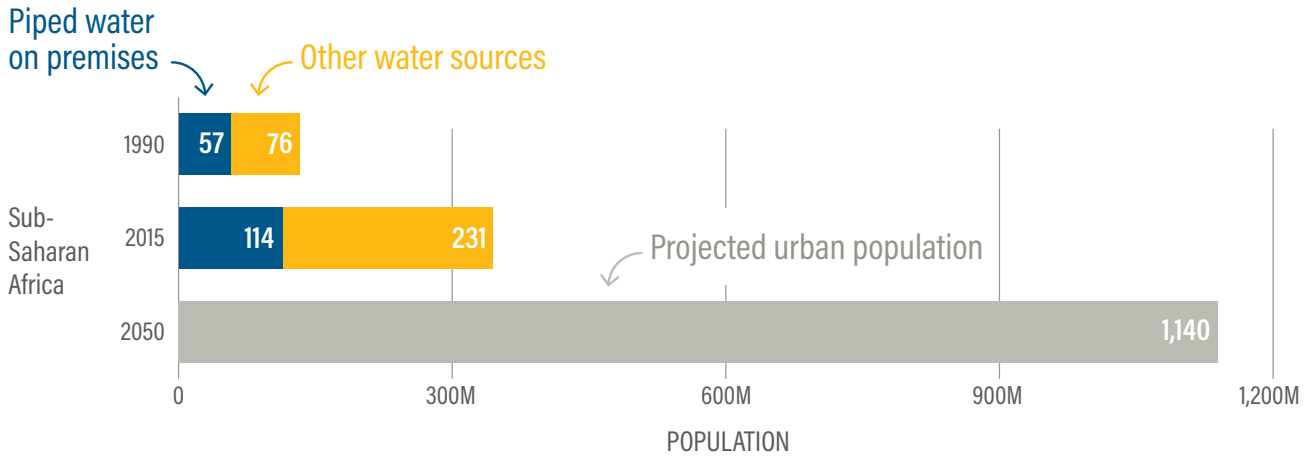
Access to sanitation for households across cities on the continent is even more limited. Safe and functioning sanitation systems, which often require a reliable water source, prevent disease outbreaks from flooding events, prevent contamination of water sources, and bring health benefits for the entire city (Satterthwaite et al. 2019). According to the Joint Monitoring Programme (United Nations Children's Fund/World Health Organization), only 20 percent of all urban areas in Africa have access to safely managed sanitation services (WHO and UNICEF 2017). Harar, a secondary city in eastern Ethiopia, has no wastewater treatment facilities and instead uses fecal sludge drying beds, which have led to groundwater contamination.[9] Meeting the water and sanitation needs of African cities will continue to be a challenge given the projected urban population growth (see Figure 5).

1.3.4 Environmental degradation and water pollution

Polluted ecosystems and degraded environments can have lasting negative impacts on water flows, quality, and availability. Within the city, poor waste and wastewater management threatens local water resources and ecosystems vital to communities with poor access to water services (further discussed in Section 2.1). Outside of the city, changes within the water basin can dramatically alter an urban area's resilience to water shocks and stresses. Forests in watersheds that cities depend on and mangroves in coastal areas are vital for water quality, can act as storm buffers, and keep the aquifer recharged, yet they are disappearing due to rampant urban construction, agriculture, pollution, and other extractive industries that do not account for these benefits (Browder et al. 2019).

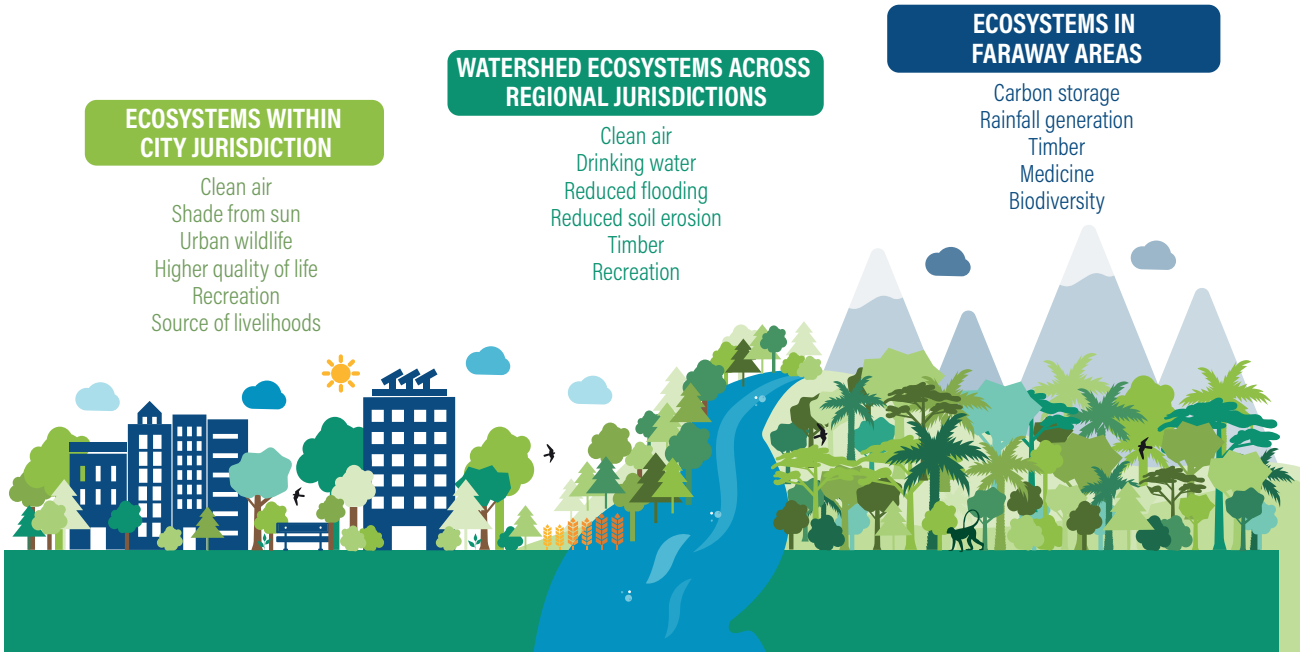
The water supply for an urban area depends heavily on the health of an ecosystem that may exist outside of any one city's jurisdiction (see Figure 6). A study found that out of 25 large cities in Africa, 8 rely on protected forestlands within the watershed as a primary factor for drinking water availability and quality (Dudley and Stolton 2003).[10] The number should be higher, but forest degradation in the watershed of some cities, such as Dakar (Senegal) and Kano (Nigeria), has affected the water quality and availability. Instead, Dakar transports water from over 200 kilometers away (Dudley and Stolton 2003).

Figure 5 | Meeting the water needs of African cities will be a challenge given projected urban population growth



Source: Mitlin et al. 2019, based on data from UN DESA 2017; WHO and UNICEF 2015.

Figure 6 | Ecosystem functions within and beyond city boundaries



Source: Adapted from Cities4Forests.

1.4 The Political Economy of Water in African Cities: A Look at History

To understand the present water crisis in African cities, we trace the institutional and historical context of water management. The inequalities that exist in the continent's current water management systems were introduced during the colonial era and intensified thereafter. The dominant approach followed the conventional, centralized system and network of gray infrastructure with limited coverage, mostly serving white neighborhoods and/or the African elites while excluding the majority of Africans. These under-served groups relied on traditional means for water access (e.g., self-providing from local wells and rivers) and on-site sanitation management (e.g., pit latrines) (Barraqué and Zandaryaa 2011; Jaglin 2014; Niasse and Varis 2020; Njoh 2013). The impacts of colonial water policies remain a major challenge in some areas. For example, in Johannesburg, racial inequities are well documented in municipal water and sanitation service charges, financing, and level of investments (Goldman 2015).

1.4.1 The 1960s and 1970s: Reform attempts to modernize water systems bolster inequality

In the postcolonial period, there was an international effort to launch successive reforms in Sub-Saharan Africa, including research on hydrological data at the basin level and capacity building in the water sector (Adams et al. 2019; Jaglin 2014). Focus was given to expand the modernist and centralized water management system through government subsidies and investment in large-scale projects (Barraqué and Zandaryaa 2011). This was meant to offset colonial injustice and lay the foundation for major urban improvements and economic development wherein water was regarded as a public good by governments (Adams et al. 2019; Barraqué and Zandaryaa 2011; Goldman 2015). These improvements were also promoted during the Water Decade program by international organizations (the World Bank and the African Development Bank) and were driven by the modernization theory. This theory assumes that societies will inevitably change from traditional

to modern; it typically frames this social change as "catching up with the West's" capital-intensive, large-scale modern technologies with little consideration for the local context and increasing disparities between different social groups (Goldman 2015; Mabogunje 1990).

This approach increased dependency on dominant Global North perspectives and expensive centralized urban water systems while failing to address the disparity between the few urban elites concentrated in former colonial neighborhoods and the rest of the city (Adams et al. 2019; Goldman 2015; Habtemariam 2019; Jaglin 2014; Niasse and Varis 2020).

The proliferation of informal settlements and slums was similarly met with modernization programs. A number of sub-Saharan government leaders continued the colonial legacy by bulldozing slums and squatter settlements (e.g., Abidjan, Dakar, Dar es Salaam, Lagos, Lomé, and Nairobi), mainly for their own advantage. In theory, these were to be replaced by government-built low-cost housing (Fox 2014; Stren and Halfani 2001). However, apart from Côte d'Ivoire, the supply of replacement housing was far below the need (Mabogunje 1990; Majale et al. 2011). In general, these programs were ineffective. Informal housing—most of which had no access to the public water network—continued to persist as the only alternative solution for the urban poor's shelter needs (Fox 2014).

1.4.2 The 1980s and 1990s: The enabling approach, the Water Decade program, and community-based water projects

During the 1980s, the attention of international organizations (the World Bank and the United Nations Development Programme) shifted to support water-upgrading schemes (such as public taps, stormwater drains, communal ventilated improved pit latrines, and septic tanks), consistent with other sectoral interventions (Adams et al. 2019; King et al. 2017). These programs focused on on-site upgrading and self-help housing initiatives for slums and squatter settlements, drawing from lessons learned in Latin America (Majale et al. 2011).

There was notable progress on access to services such as water and housing by programs that shifted to an enabling approach that relied on nonstate actors (nongovernmental organizations, community-based organizations, small-scale private operators) to provide water services and infrastructure. This approach also included measures to increase the financial capacity of the poor through income-generating schemes, microfinance, and targeted subsidies (Harris and Miraftab 2015; Keivani and Werna 2001). Although the enabling approach included fundamental measures to ensure tenure security for the poor, the promotion of homeownership alone and the failure to consider home-based employment and informal housing markets prevented fruitful progress to improve the tenant conditions and the poorest of the poor (Harris and Miraftab 2015). In addition, this approach has failed to recover costs and was not financially sustainable. As a result, many water improvements were not properly maintained, had no funds for repairs, and eventually became dysfunctional (Adams et al. 2019; Harris and Miraftab 2015; Keivani and Werna 2001).

1.4.3 The 1990s and 2000s: Structural adjustment and private sector involvement

Concerned with the ability of state agencies to effectively provide services, international organizations such as the World Bank ushered a new decade of private sector and market principles into the water sector. Since the 1990s, the focus was on cost recovery to redress the water system's financial sustainability. This pivoted away from previous concepts of water as a public good and conceived of water as an economic good (Goldman 2015; Mitlin et al. 2019). It aimed to increase the water sector's financial performance by reducing public spending and tapping private capital to cover the investment, operation, and maintenance costs of water infrastructure and projects. It was assumed that low-income households would buy water from the utility, reducing their own expenditure on water and providing additional revenue for the utility. As a result, users were required to pay for connection, and service charges were collected based on the amount of consumption. However, connection fees and stringent requirements were set without consideration of affordability and the rights of those

who were not able to pay and fulfill the conditions, such as informal dwellers without a secure address (Barraqué and Zandaryaa 2011; Mitlin et al. 2019).

For these reasons, private sector involvement in water supplies has not significantly improved access. Since the 1990s, the proportion of urban populations in Sub-Saharan Africa receiving piped water has decreased from approximately 45 percent to 35 percent (Satterthwaite 2016).[11] The privatization of urban water systems was highly criticized due to adverse effects such as price hikes, resulting in unrest in different sub-Saharan countries, including Gambia, Guinea, Kenya, Mozambique, South Africa, and Zimbabwe (Adams et al. 2019; Barraqué and Zandaryaa 2011; Goldman 2015). The cost recovery approach was also criticized because of its unfair shifting of costs and responsibilities, which increased the burden to poor communities (Jaglin 2002). Overall, it reduced the affordability of water and the economic viability of the private sector in sub-Saharan countries (Harris and Miraftab 2015; Keivani and Werna 2001).

Another consequence of private sector involvement was neglect for water resource conservation (Barraqué and Zandaryaa 2011). In most cases, only the managing of the piped water system was outsourced to private sector contracts, typically avoiding the costs involved in purchasing and maintaining water resources. Private sector involvement in many sub-Saharan cities was limited to management and lease contracts because of lower risk, with few incentives to include the conservation of water resources. Conservation efforts were also perceived to involve higher commercial risks, particularly in Sub-Saharan Africa (Barraqué and Zandaryaa 2011; Silva et al. 1998).

1.4.4 The 2000s to the present day: Limits to an outmoded technocratic approach

In the absence of large-scale private sector investment, the corporatized model has been promoted by international development agencies in African cities since the early 2000s (Dagdeviren

2008; McDonald et al. 2014). Corporatized utilities adopt commercial market principles with autonomy from the government and seek to secure cost recovery. Advocates of the corporatized model contend it can make public services more efficient, as it has for many utilities in the Global North.[12] In some places, the model has improved performance and service quality, increased revenue collection, and spurred more efficient reform, such as for utilities in Burkina Faso and Kampala (Eberhard 2018; Lwasa and Owens 2018). Critics argue that corporatization in African cities, and the expectation to provide returns, results in public utilities that ignore or minimize extending networks and services to informal settlements (Dagdeviren 2008; McDonald et al. 2014).

With little institutional capacity, low resources, and uneven coverage, many African cities face "splintered urbanism."[13] Splintered urbanism manifests as wide inequalities in access to infrastructure. Urban poverty and slum urbanism exist on one side, and on the other are gated communities and enclaved living for minority elites with modern infrastructure, resulting in "unsustainable and unjust patterns of resource consumption and pollution," such as in Addis Ababa, Kinshasa, Lagos, Luanda, and Nairobi (Pieterse and Hyman 2014, 192). This phenomenon is upheld by powerful political and economic elites, and it cannot be ignored when building urban resilience (Massarutto 2011; Mguni 2015).

Frustrated by the stringent and paternalistic approach of the Global North countries and the increasing challenges faced in cities, the governments in Sub-Saharan Africa have turned towards China as a development model. Lately, China has become influential in Africa, where the developmental state model[14] is adopted by many governments in Sub-Saharan Africa, which also implies a shift in the approach of the water sector (Harris and Miraftab 2015; Mulikita 2013). For instance, China's Belt and Road Initiative will have a significant impact on the infrastructure assemblage of African cities.

However, there are ongoing political and scholarly debates that this might create an antagonistic democratic environment unless a delicate balance is struck. It may threaten or worsen social fragmentation, a sense of belonging, and the ethnic diversity of sub-Saharan cities (Mulikita 2013; Nega and Schneider 2014; Watson 2002). It can also perpetuate an exclusive focus on megaprojects, undermining alternative, decentralized water management, local knowledge, and ongoing community efforts (Habtemariam 2019; Hailu et al. 2018; Parnell and Pieterse 2010).

Yet the picture is not entirely gloomy; there are signs of hope that cities can transition to a more sustainable, water-resilient future. Notably, international organizations have shifted from universal access goals to targeted initiatives for marginalized communities in the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). Many African countries have passed new water laws. Some reforms, such as pro-poor policies to achieve higher coverage and incorporation of integrated water resources management in water laws, have been successful (Eberhard 2018). The African Union's Agenda 2063 provides a key framework as well. It aims to transform the continent into a global powerhouse by emphasizing people-centered, inclusive pan-Africanism as well as the right to self-determinism. Goal 7 of the agenda aims to build "environmentally sustainable and climate resilient economies and communities" (AU 2015). Under this goal, priority areas include ensuring sustainable consumption and production patterns; water security for

With little institutional capacity, low resources, and uneven coverage, many African cities face "splintered urbanism."

domestic use, industry, and agriculture; and building climate resilience and natural disaster preparedness and prevention. It sets ambitious targets, such as to recycle 90 percent of wastewater and use for industry and agriculture (AU 2015; DeGhetto et al. 2016).

The Agenda 2063 and high-level commitments from other institutions, such as the African Development Bank (AfDB), signal the importance of water resilience as a priority and a shift towards envisioning a water-resilient future. At best, this shift will foster stronger urban-rural linkages, reduce the harmful regional impacts of the urban water system, and depart from conventional water management. Instead of more and more interbasin transfers that exploit distant water sources, the urban water system must find ways to maintain a water balance from input and output, including rainwater, surface water, groundwater, and wastewater from the city. How the city can reduce its hydrological footprint will have cascading impacts on all of its hydrologically linked regions, near and far.

1.5 A New Approach for Africa's Changing Context

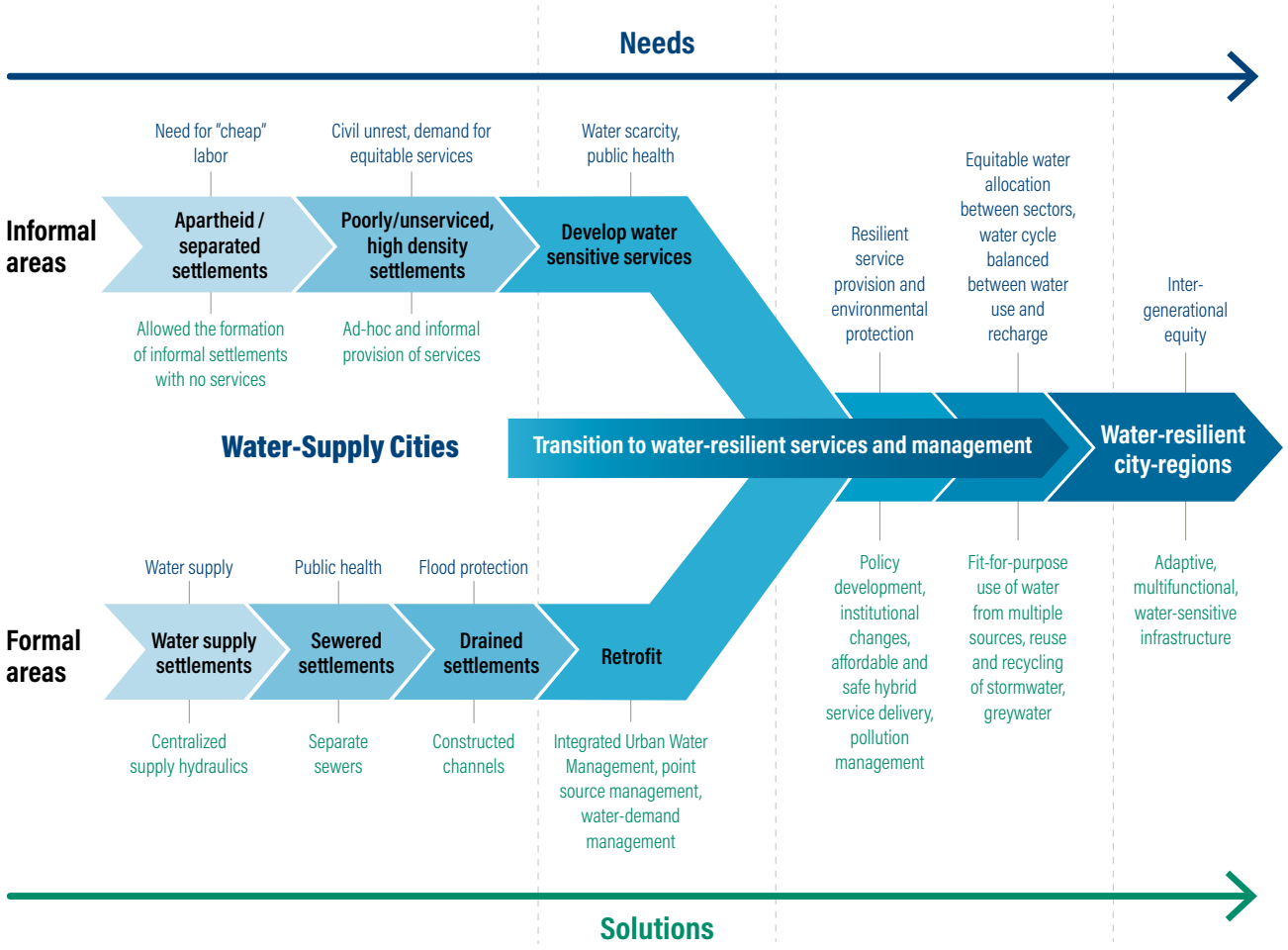
Based on our research, we propose a new approach for African cities. First, we situate what it means to transition to a water-resilient city in the African context. Then, given the challenges, drivers, and political economy, we summarize how a new approach needs to emphasize an inclusive vision, action on a regional scale, and the emerging role for cities. Ultimately, a new approach to building urban water resilience must connect the local realities of city dwellers with basin-level issues and link water to crosscutting urban issues such as land use and equity as well as to local practices of water service delivery.

1.5.1 Transitioning to a water-resilient city

For the African urban context, any approach for building water resilience must consider the history of urban water management, high levels of informality, and current institutional capacities. A look at the urban water transition framework offers a helpful starting point.

The urban water transition framework documents six stages of urban water management: the water supply city, the sewered city, the drained city, the waterways city, the water cycle city, and the water-sensitive city (Brown et al. 2009). The first three stages encapsulate a business-as-usual approach through supply-oriented expansion of gray infrastructure. The last three stages call for a paradigm shift that is not only about infrastructure changes but also requires behavioral and institutional changes. This framework is now widely referred to for city-level benchmarking of the different stages. However, it was originally developed in the context of Australian cities and requires reframing for the African context.

Figure 7 | Transitioning from a water supply city to a water-resilient city-region



Source: Adapted from Fisher-Jeffes et al. 2017.

Fisher-Jeffes et al. (2017) build on Brown et al.'s framework by adapting it for the South African context, recognizing the reality of formal and informal urban developments and hybrid service delivery (see Figure 7). Adapting the framework to an African context requires examining existing power dynamics in urban water governance (Nastar et al. 2018). The transition for sub-Saharan cities must be contextualized with additional drivers that shape policy, such as neocolonial, geopolitical influences and the hybridity of urban water and sanitation services (e.g., ranging between centralized, large-scale, formal water systems to decentralized, informal, small-scale water service arrangements; Habtemariam 2019).

In Figure 7, we posit a water-resilient city-region as the goal, differing from Brown et al.'s original endpoint, the water-sensitive city. Water-sensitive considerations often only refer to urban design. Urban water resilience extends beyond this and brings together the hydrological context (including water basins), built infrastructure, and the socio-political-economical context. Using the lens of resilience also requires considering 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.

Compared to other cities of the world, sub-Saharan cities are generally at or near the water supply city stage. A study showed that Accra, Kampala, Kisumu, Lusaka, Maputo, and Nairobi were considered water supply cities in the continuum of the urban water transition framework (Jefferies and Duffy 2011). However, this also means they have the potential to leapfrog to the water-resilient city stage by passing the other stages. When applied to African cities, "leapfrogging" must center social infrastructure and the enabling role of governance and institutions. It cannot only center on the ability to leapfrog existing technologies and physical infrastructure (Habtemariam 2019; Kareem et al. 2020; Nastar et al. 2018). If done holistically and equitably, African cities can potentially accelerate towards a more sustainable and resilient system in a shorter period of time, and they can do so cost-effectively by diverting the investment towards nature-based infrastructure and new governance models.

1.5.2 A resilient future requires an inclusive vision

The global COVID-19 pandemic exposed how the most socially vulnerable—who usually lack safe water and sanitation access—were the first to be left behind. Guidelines for frequent handwashing, social distancing, and sheltering at home were nearly impossible for millions who were without access to enough water and safe sanitation at home, secure housing, and formal employment (Adegbeye 2020; Bhan et al. 2020). Shared and public toilets became COVID-19 hot spots, and untreated human waste dumped in waterways and/or flooded into the streets carried COVID-19 pathogens for up to a month (Sun and Han 2020). This burdened families with lower incomes living in slums or similar overcrowded living conditions. This highlights how, in the face of disasters, those with the most social and economic vulnerabilities are the first to be left behind.

Resilience in the African context will require a focus on the most socially vulnerable groups (Kareem et al. 2020). Socially, politically, and economically constructed barriers, such as tenure insecurity, have limited the ability of population groups such as informal dwellers, women, tenants, migrants, and minorities to receive services and support, leaving them disproportionately

vulnerable to water-related shocks and stresses (Grasham et al. 2019). Several different global initiatives highlight the commitment to building social equity and resilience together. SDG 1.5 is to "build the resilience of the poor and those in vulnerable situations" (UNSD n.d.). The African Union's Agenda 2063 posits inclusive, climate-resilient economies as a component of the vision for a prosperous Africa, centering on Africa's livelihoods and self-determinism (AU 2015). The AfDB also recently committed to a people-centered approach with a new division dedicated to urban development (Atchia 2020).

1.5.3 Change requires a regional approach

Urban water resilience requires a regional approach to include the watershed and explicit efforts to convene diverse stakeholders. Business-as-usual management will not be able to respond to this challenge. Many cities have already outgrown their municipal jurisdictions. Some metropolitan regions have formed large agglomerations, expanding across several municipalities (e.g., Kampala, Lagos, Nairobi). Further, many cities rely on water sources or natural flood storage far outside their boundaries, and they compete for those resources with agriculture and other industries. Our research and key informant interviews found that many watershed regions are managed by multiple entities, usually without an effective forum for actors across different municipalities, agriculture, industry, and water resources authorities to coordinate.

Thinking through the water and urban system does not only require breaking siloes; it also requires a governance system that links the city authorities to the surrounding governance and geographical context. This means working with the provincial authorities (e.g., in South Africa), the county

(e.g., in Kenya), neighboring municipalities, directly with the national authorities (e.g., in Ethiopia, Ghana, Rwanda), or across national borders (e.g., the Democratic Republic of the Congo). The challenge of managing across subnational government borders is compounded by the fact that water resources are largely managed at the national level, with specific government bodies deciding on dams, inlets, river basins, and aquifers to secure the national water supply rather than tailoring the water system to the needs of expanding metropolitan areas.

1.5.4 An emerging role for cities: Elevating water resilience across sectors and jurisdictions

Cities can drive change towards a regional approach. Although the political, regulatory, and fiscal powers of local governments vary across the continent, in many countries, such as Ethiopia, South Africa, and Uganda, where devolution is more established, the potential for cities to drive resilience is promising.[15] Cities are centers of innovation and political ambition that can lead action across stakeholders and multiple levels of government. A recent Organisation for Economic Co-operation and Development (OECD) survey on water governance across 36 African cities found that increasing the leadership of city governments in water policy has been key for overcoming silos, poor planning, and a lack of policy coherence (OECD 2021). It is imperative for cities to look beyond their own borders, moving from merely being "water suppliers" to "water managers," playing a crucial role in both the protection of the healthy watersheds that feed urban demand and providing safely managed water supply and sanitation services to all.

For urban agendas to effectively elevate water resilience, key players across sectors and industries that are not traditionally viewed as part of the water sector need to be involved.

Doing so requires a holistic water and wastewater management action plan through collaboration and engagement with the private sector, civil society, and across government agencies. The future of water is a future where strategies are cocreated by all sectors that are impacted by water and that impact the water system. Water impacts frequently cascade into other sectors and unexpected areas, meaning that decision-making in nonwater sectors can have significant consequences on the water system (Damania et al. 2017). For example, an assessment in Addis Ababa documented how water-insensitive road construction and maintenance block groundwater flows and alter the size, shape, and flow of nearby water bodies (Habtemariam 2016). Without effective roadside drainage, commutes can be interrupted or become unsafe from flooding (see Figure 8). The assessment also highlights the lack of coordination around water: new road construction resulted in damage to water and sewerage infrastructure in several instances, and the Addis Ababa roads authority rarely considered the region's watershed when planning drainage (Habtemariam 2016, 2019).

For urban agendas to effectively elevate water resilience, key players across sectors and industries that are not traditionally viewed as part of the water sector, such as construction, land development and management, roads and drainage, forestry, agriculture, food and beverage production, and energy, need to be involved. Development partners

Figure 8 | Street flooding in Addis Ababa impacts mobility

Flooding at the entrance to Addis Ababa University's main campus presents challenges for pedestrian mobility, especially for disabled people.

Source: L.W. Habtemariam, 2017.

and international financial institutions will also be key to integrating water resilience across the development agenda. For instance, the World Bank's Urban Institutional and Infrastructure Development Program in Ethiopia, which aims to provide $600 million to 117 urban local governments between 2018 and 2023, may not be considered a water program, but it has considerable potential to build urban water resilience (World Bank 2020). Though improving resilience is one of the program's stated goals, to date, most of the infrastructure funded has been for traditional road networks, with little funding committed to water-resilient infrastructure and few indicators with water-sensitive considerations (World Bank 2020). This report provides a starting point for analyzing the barriers and necessary linkages across sectors and development actors needed to elevate urban water resilience, but future work in these areas remains essential.

It is important to note that the extent of city authority and technical capacity across the continent varies widely, and in almost all cases, change without the support of noncity actors is hardly possible. This report posits the city-region as the context for action, where water resilience can build momentum and capacity. This report, therefore, places its attention on what needs to happen differently from a range of actors within the city-region context. In Section 2, we present the key barriers and priority pathways to building urban water resilience.


VIKING

2. Priority Pathways for Action with Specific Strategies

Given the historical and geopolitical factors discussed above, countries in Sub-Saharan Africa share common challenges in building urban water resilience.

We frame four preliminary, crosscutting pathways to enable a new approach to urban water resilience (see Figure 9). This report is not meant to be exhaustive on actions that can help solve all water-related challenges in Africa. Instead, it focuses on connecting different agendas and bodies of knowledge to highlight priority pathways to build water resilience in the face of increasing urbanization and climate risks across Africa. These pathways respond to the four key drivers or root causes we identified in Section 1.3, but they may not directly address the historical legacies and approaches like the corporatization of utilities. Each pathway section outlines the problems, barriers, and evidence-based strategies, each of which must be contextualized for different cities in light of differences in local conditions, capacities, and starting points.

2.1 Plan For Water: Mainstream Risk-Informed Land Management and Water-Sensitive Urban Development

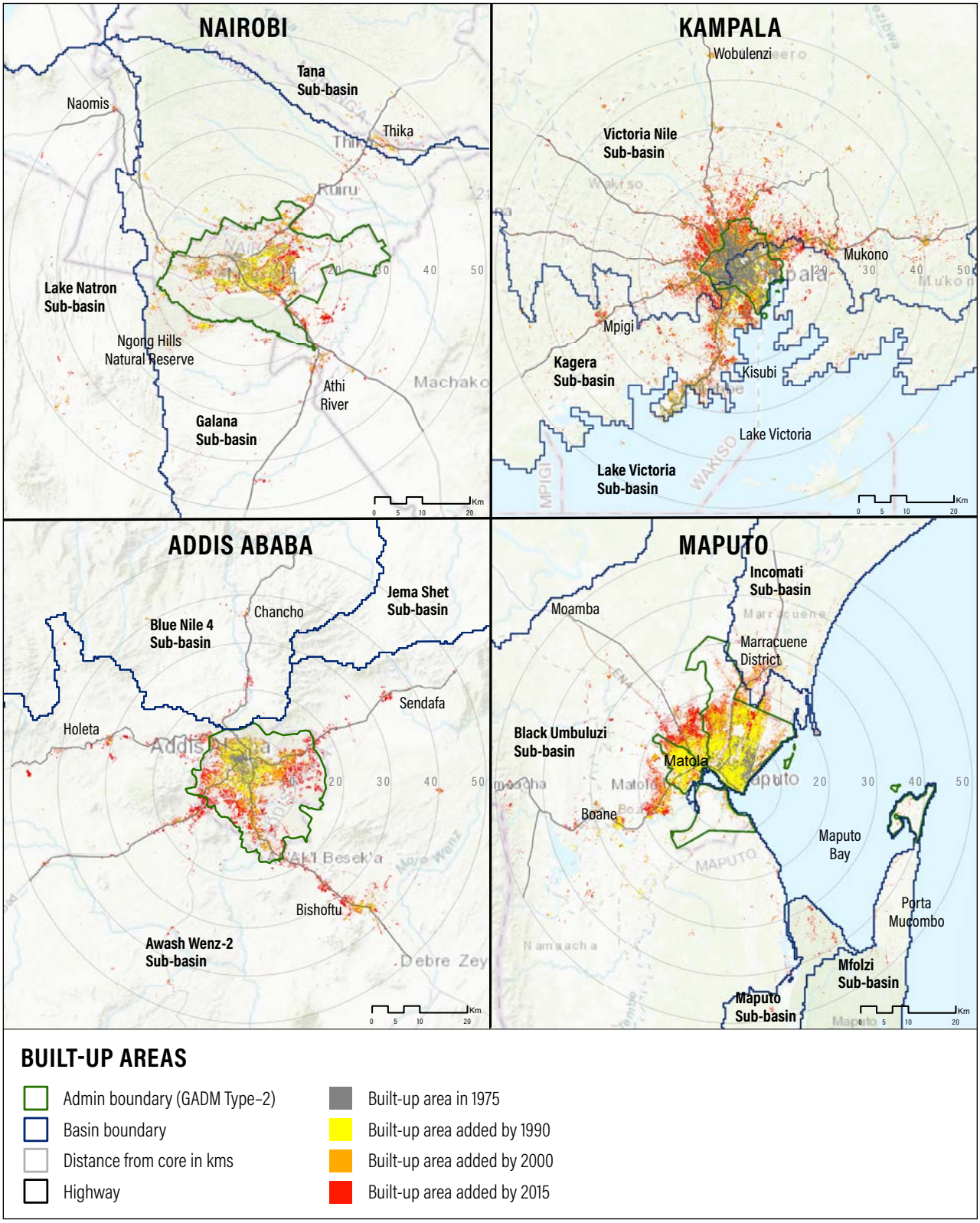
2.1.1 THE PROBLEM

As African cities grow and expand, the pressure to meet increasing water demand is compounded by the impact of unmanaged expansion in the watershed (McDonald et al. 2011). The continent's water demand is estimated to quadruple over the next 25 years, largely due to urban-rural migration and agriculture (McDonald et al. 2013). Urban expansion in Africa, typically through informal, unmanaged, or haphazard developments, is predicted to be the highest in any region in the world, with a dramatic 700 percent increase between 2000 and 2030 (McDonald et al. 2013).

Figure 9 | Priority pathways for a new approach to urban water resilience

Source: Authors.

Figure 10 | The increase in built-up areas in four African cities



Note: Administrative boundaries may not be official and are marked for reference.

Source: WRI, based on data sets from European Commission 2015; FAO n.d.; GADM 2018; WBG 2009.

Figure 10 shows the increase in built-up areas in some of Africa's major cities, expanding into ecosystems vital for the health of the watershed.

Africa's increasing urban footprint is encroaching into water catchment areas with adverse effects (TNC 2016; Wijnen et al. 2018). The assessment of 30 cities across the continent by The Nature Conservancy (TNC) has found that 39 percent of their catchment areas have been developed for agriculture or urban settlements (TNC 2016). Over 80 percent of the catchment areas in Johannesburg, Kumasi, and Nairobi have been developed (TNC 2016). This reality has increased erosion and sedimentation in surface water sources. In Kenya's Upper Tana catchments, which serve Nairobi's water supply system, water treatment costs have been estimated to increase by more than 30 percent following heavy storms due to high sediment loads (TNC 2016). Pollution and catchment degradation are estimated to cost the country at least 0.5 percent of GDP each year, equaling $32 million (TNC 2016). Box 2 illustrates the similar challenge in Addis Ababa.

Unmanaged urban expansion is compromising the protection of important surrounding ecosystems across African cities. The ecosystems in and around cities are key for building urban water resilience and biodiversity protection. Protecting and restoring these ecosystems can also provide vital services to urban inhabitants, including improving water quality; flood control; tempering the urban heat island effect; acting as a buffer to waves and wind; and stabilizing coastlines, riparian zones, and hill slopes (Chu et al. 2019). Increasing urban expansion consumes prime agricultural land and water, which impacts food production, habitats, and biodiversity. Some of the most rapid urban expansion is occurring in low-elevation coastal zones, such as coastal cities that serve as economic hubs, where it exacerbates the challenges of climate adaptation (e.g., sea level rise, storm surges) and groundwater overextraction (e.g., land subsidence; Cote and King 2017; Seto et al. 2013).

BOX 2 | The Challenge of Water Source Protection and Urban Development in Addis Ababa

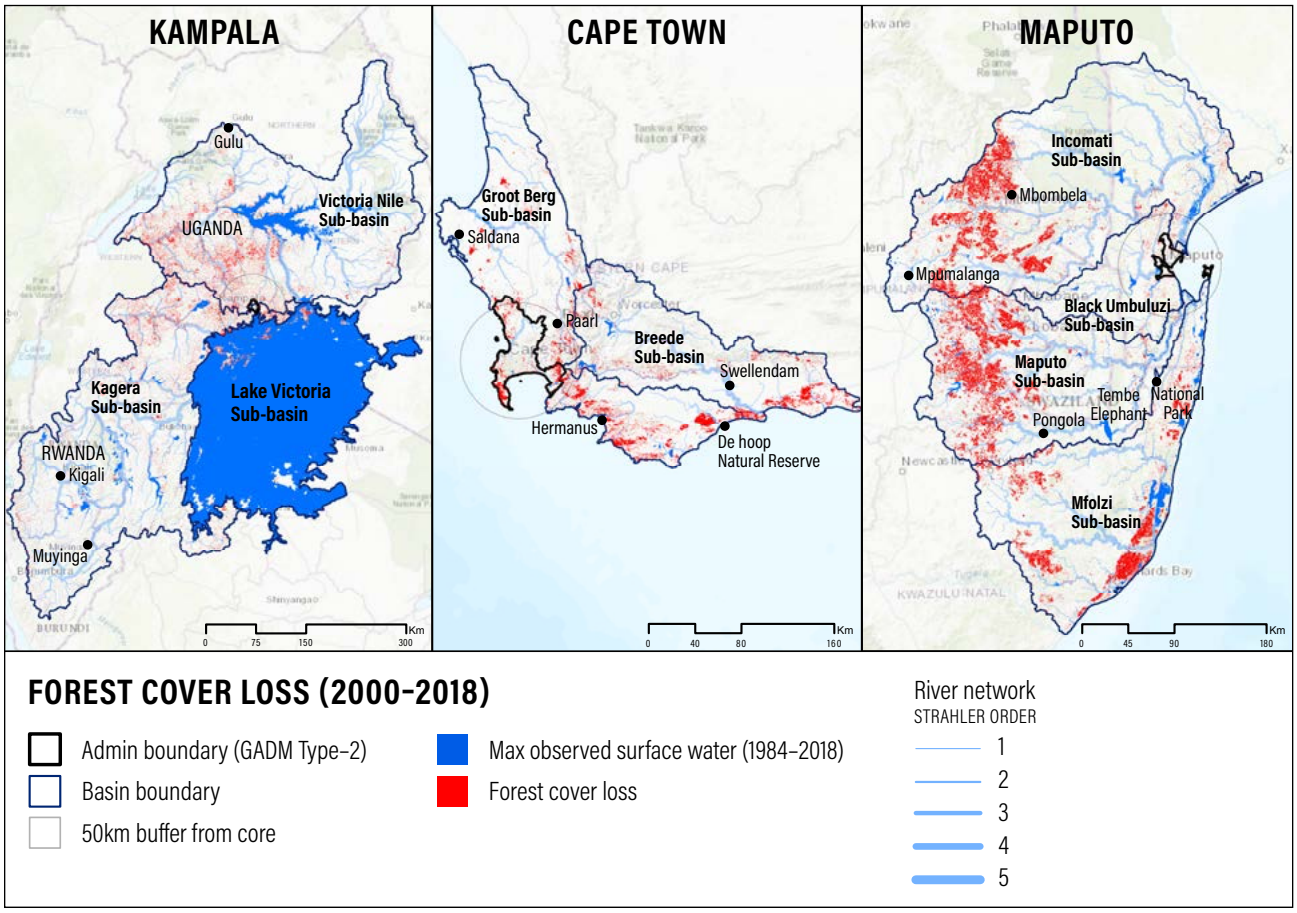
In Addis Ababa, where four-fifths of the city's water catchment area is developed, a high-level official at the city's water utility (Addis Ababa Water and Sewerage Authority) identifies unchecked urban development as the biggest stress on the city's water system.[a] Addis Ababa's main water sources (surface water) are located outside the city boundary in the Oromia region, where the development of a number of satellite towns has resulted in mass deforestation in the water catchment driven by the demand for land and agricultural products for the city. Moreover, the dire situation of water access in rural areas and Oromia towns near Addis Ababa's main water source, as well as the increasing pollution flowing downstream to Oromia localities, could intensify interregional conflict.[b]

The lack of a coordinated land-use plan with buy-in from the city, the residents of the surrounding settlements, the Oromia region, and the federal government—coupled with a bias for meeting urban development needs—has tied the hands of the utility thus far from protecting and recharging these water resources.[c] In addition, the escalating political strife and social unrest around the Oromia region in 2020 presents a major challenge. Efforts to bring all water-related stakeholders in the region together are increasingly difficult, if not unrealistic, requiring broader political negotiation and dialogue.

Notes:
a. Interview 8; TNC 2016.
b. The Oromia region surrounds Addis Ababa, so both upstream and downstream activity in relation to Addis Ababa is in Oromia.
c. Interview 8.

Source: Authors' analysis based on interviews conducted in 2020.

Figure 11 | Forest cover loss in basins around Cape Town, Kampala, and Maputo



Notes: Forest cover loss comes from a global data set, which has some limitations. This also does not capture when native forests are replaced with nonnative, water-intensive species.

Source: WRI, based on data sets from FAO n.d.; GADM 2018; Hansen et al. 2013; Pekel et al. 2016.

Trees, forests, and other green infrastructure inside, near, and far from cities contribute to increased water security, through more reliable supply and improved quality, and reduce flooding. A study by TNC found that restoring upland forests in watersheds could save water utilities in the world's 534 largest cities an estimated $890 million each year (McDonald and Shemie 2014). Yet such areas are diminishing due to unplanned urban expansion and unmanaged rural land use (e.g., poor agricultural practices, unregulated irrigation, and land conversion). Deforestation and forest degradation in watersheds jeopardize water availability by altering local hydrology and reducing the interseasonal stability of water supplies (Juno and Pool 2020). For example, the West African rain forest, accounting for over 30 percent of global tropical rain forest, drives precipitation patterns around Africa (Gebrehiwot et al. 2019). Since 2001, tree cover in the Congo Basin has decreased by 20.6 percent, mainly due to clearing for agriculture. Continued forest loss in this region could have serious implications on precipitation patterns across the continent (Tyukavina et al. 2018). Figure 11 illustrates the forest loss from 2000 to 2018 in Cape Town, Kampala, and Maputo, leaving their catchment areas vulnerable.

The loss of natural land cover due to increasingly intensive land-use activities is detrimental to plant and animal biodiversity. Studies of global urban expansion show that rapid growth in urban land cover is expected in biodiversity hot spot areas by 2030, with 40 percent of strictly protected areas projected to be within 50 kilometers of an urban area (McDonald et al. 2018; Seto et al. 2012). Within the catchments areas in sub-Saharan regions assessed by TNC, at least 5.8 million hectares of priority biodiversity areas have likely been impacted by such land conversion (TNC 2016).[16] Approximately 20–30 percent of African mangroves, which are vital for coastline protection, have been lost during the past 25 years (Cormier-Salem et al. 2018). The Ruvu River catchment of Dar es Salaam, which encompasses the Uluguru Mountains, is a critical habitat for several endangered bird, amphibian, and mammalian species that is also under threat due to land-use activities (TNC 2016).

Water resources development is also putting a strain on aquatic biodiversity. The high levels of freshwater biodiversity found in the Rift Valley Great Lakes of East Africa are currently decreasing due to development and associated demands on water resources, putting many species under severe threat (Sayers and Smith 2018). Too often, biodiversity concerns are seen as independent of and less important than other urban pressures, such as poverty; unemployment; and access to food, energy, water, sanitation, and housing (McDonald et al. 2011). Yet even in instances where biodiversity concerns are recognized, conservation efforts still use ineffective colonial practices that employ a top-down approach to resource conservation and protection without the engagement and buy-in of local stewards (McDonald et al. 2011).

2.1.2 THE BARRIERS

Indiscriminate development, compounded by interbasin conflicts, pushes limits

As public infrastructure fails to keep pace with increasing urban in-migration, population growth, and urban land expansion, resource-constrained cities tend to react haphazardly instead of proactively planning for growth. It is clear that the lack of public services does not deter population growth or new settlements; rather, it spurs informal arrangements in low-income areas and

costly arrangements in middle- and high-income areas, negatively affecting household budgets and productivity (Mahendra and Seto 2019). Under- or unserviced areas must often wait until their population densities reach a threshold to justify the cost of infrastructure provision. The process can also be political; over time, unauthorized expansion reaches a scale where it acquires electoral strength, prompting elected representatives to consider regularizing such developments and providing public services (Mahendra and Seto 2019).

Moreover, in many rapidly urbanizing countries, public and private sector actors influence land development decisions and incorporate new areas as urban, leveraging information about future development to realize gains from increased land value in specific locations (Mahendra and Seto 2019).[17] Recent research in Kigali and Addis Ababa shows much of the construction as purely speculative, drawing much-needed public investment away from affordable housing and towards under- and unused high-end properties (Goodfellow 2017). Local decision-makers, the private sector, and other influential actors form public-private coalitions that act as "growth machines" (Logan and Molotch 2007). Their shared vision of urban development is aimed at spurring investment and maximizing economic growth through higher land and property prices while ignoring other environmental and social objectives (Logan and Molotch 2007; McGranahan et al. 2016a).

On a regional scale, land-use changes involved in interbasin water transfers are pushing ecological limits. Many cities across Africa source their waters from far distances and, at times, from other basins. On average, the 30 cities assessed by TNC withdraw their main water source from a distance of more than 50 kilometers, with some cities transferring water over several hundred kilometers (TNC 2016). Pretoria and Johannesburg in South Africa, for instance, depend heavily on a series of interbasin transfers from the Senqu River basin in Lesotho to the Vaal River system in Gauteng Province to deliver adequate supply to residents (Mgquba and Majozi 2020). These transfers of water to meet growing demands increase pressure on natural resources, reverberating across regional and basin boundaries. The pressure is multiplied with increasing forest degradation and water-intensive plantations and intensifying competition for water between municipal, industrial, and agricultural sectors. In South Africa, for example, water-intensive eucalyptus trees have stressed limited water resources (Hirsh 2019). Water stress in fertile peri-urban agricultural lands can also affect food security for the city and region (Kareem et al. 2020).

Lastly, the extractive sector's activities, such as quarrying materials for construction and mining sand from riverbeds to serve the demand for urban construction, can disrupt watershed environments (Koehnken et al. 2020). In Addis Ababa, construction companies illegally dumped silt in rivers, which accumulated along riverbanks and ultimately led to increased flooding on nearby farms (Habtemariam 2019). If this affects regional water supply and resources, secondary and small cities, especially if downstream, are the most impacted because they have less constituency power than large cities.

It is clear that the lack of public services does not deter population growth or new settlements; rather, it spurs informal arrangements in low-income areas and costly arrangements in middle- and high-income areas, negatively affecting household budgets and productivity.

Poor waste management aggravates risk beyond borders

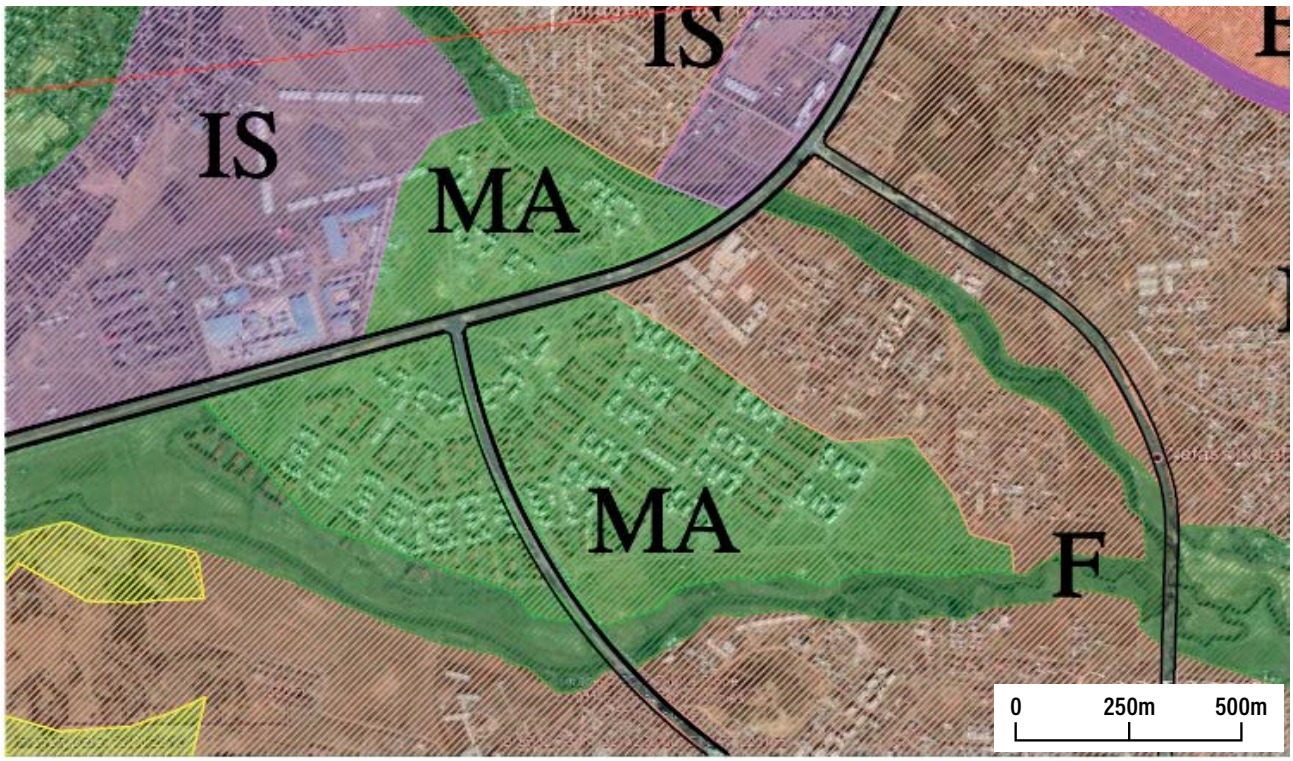
Poor solid waste, wastewater, and stormwater management, as well as an increase in land use–related pollutants, are adding to the degradation of water resources. In Harare, untreated discharge resulted in costly pollution for Lake Chivero, the city's main water source. In 2013, the city spent an additional $2 million per month on chemicals needed to treat the water (Jacobsen et al. 2013). In 2012, reports found that Lagos, which was responsible for 40 percent of Nigeria's industrial output, suffered from heavy industrial water pollution. Cotonou in Benin and Accra in Ghana also suffered from heavy industrial pollution (Bloch 2012). In Dakar, an increase in nitrates, coupled with sea water intrusion, was found to be contaminating the city's groundwater resources (Bloch 2012). The extent of the contamination and risk are underreported and likely to worsen for many African cities as open-air and electronic waste sites become more commonplace, yet few studies capture the full impact on the urban water system.

The pollution from urban areas often gets exported to surrounding peri-urban and rural areas. In Accra and Addis Ababa, despite some improvements in meeting water demand, the limited availability of wastewater treatment has turned the cities' rivers into open sewer drains. These contaminated waters, which were used for irrigation by urban farmers across the cities, resulted in a highly contaminated and hazardous vegetable supply (Van Rooijen et al. 2010). The contaminated rivers of Addis Ababa flowed south, across the city's boundaries and into the Awash River basin, which was responsible for 70 percent of Ethiopia's large-scale irrigated agriculture, spreading the risk far beyond the borders of the city (Achamyeleh 2003). Across African cities, there are major wastewater implications as slum and urban areas continue to expand and densify without adequate fecal sludge, wastewater, and solid waste management (Satterthwaite et al. 2019).

A lack of infrastructure, capacity, and contingency planning for flooding and droughts

The urban environment is prone to problems with flooding, yet most urban development plans, policies, and regulations do not consider flooding risks. Cities contain extensive built-up infrastructure and impervious surfaces, which means more runoff during rain events and decreased groundwater recharge (Douglas et al. 2010; Juno and Pool 2020). A study in the United States estimated that for every additional percentage of impermeable surfaces, such as parking lots, streets, and tin roofs, the peak of the highest flood flow of the year increases by 3.3 percent (Blum et al. 2020). For cities in developing countries, this is coupled with poor planning practices, developments in risk-prone areas (e.g., wetlands), and an increase in informal settlements, often along rivers or lakes, resulting in devastating consequences. For instance, in Douala, increased construction and impermeable surfaces in the higher elevations resulted in higher discharge to the creeks and rivers draining to the sea. This is creating more frequent flooding events for low-income residents who live in the low-lying coastal area—even with relatively low levels of precipitation (Jacobsen et al. 2013). Mismanaged solid waste also blocks natural water channels and stormwater drains (if they exist), resulting in exacerbated flooding.

Figure 12 | An aerial view of built condominiums in the wetland area originally zoned for urban agriculture



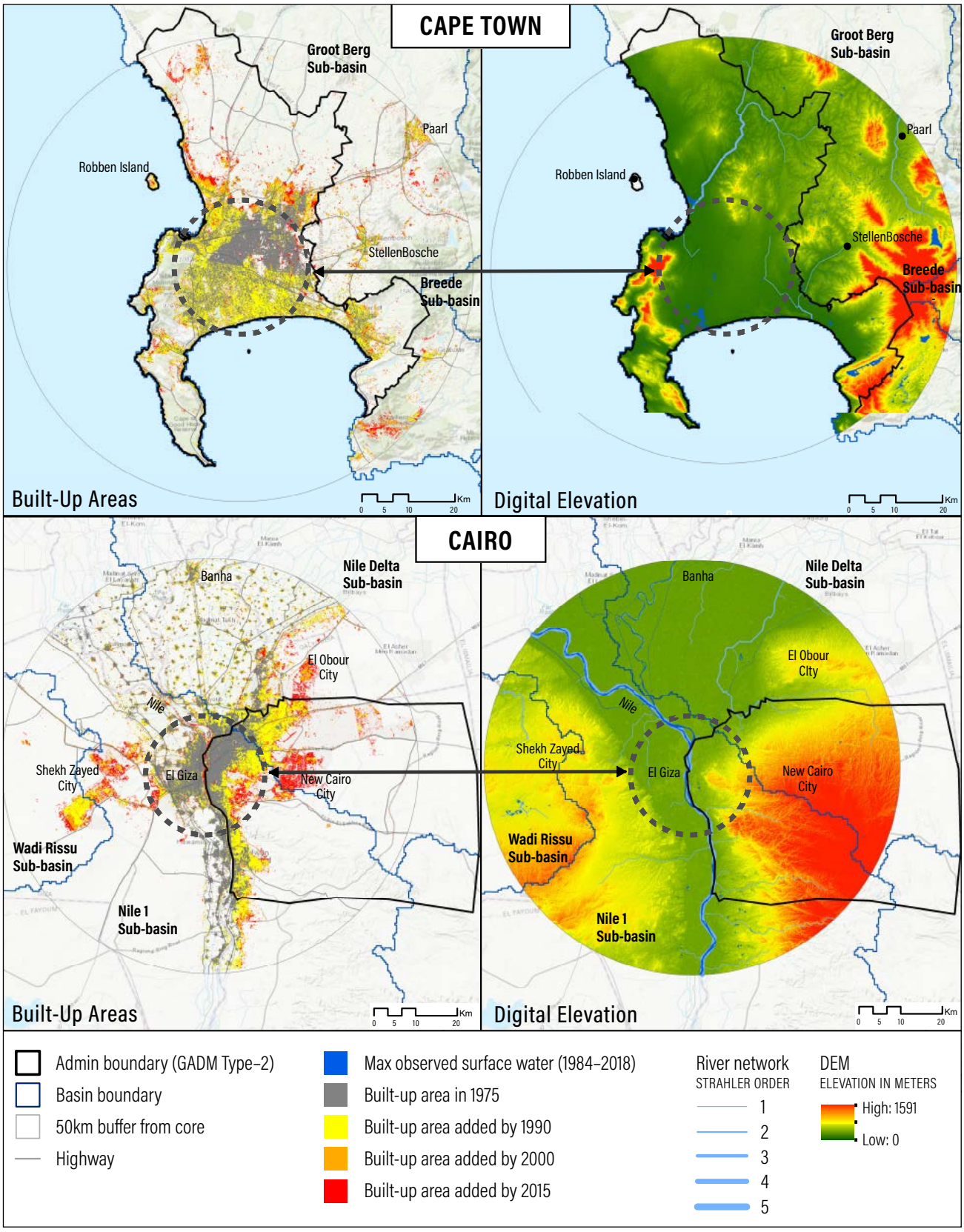
Notes: Land-use codes = F: forest, IS: industrial and storage; MA: mixed agriculture.

Source: Habtemariam 2019, 141.

Despite this, land-use decisions seldom incorporate urban flooding risks effectively. For instance, Addis Ababa gains four to five square kilometers of impermeable surfaces per year and deals with worsening flooding issues every year (Spaliviero and Cheru 2017). Although the city's master plan has begun to incorporate risk-based zoning decisions, there is little enforcement in implementation. It is only loosely linked to the budgetary process and thus has little influence in protecting low-lying and flood-prone areas from settlements. A wetland area (known as Jemo) was zoned for mixed agriculture, yet decision-makers influenced by national programs, targets, and developers bypassed this regulation in order to build mass housing condominiums in the area (see Figure 12; Habtemariam 2019). After they were built, the condominiums' foundation became susceptible to subsidence and cracks due to excessive underground water—a natural function of wetlands (Endale 2013)—which led to the evacuation of the residents.

The challenge is even more urgent for coastal urban areas. Low-elevation coastal zones between 0 and 10 meters above sea level face the compounding risks of sea level rise, storm surges, and urban flooding. In 2012, they were home to a disproportionate amount of city dwellers, as this zone covers 2 percent of global land cover yet is home to over 13 percent of the world's urban population (McGranahan et al. 2007). Figure 13 visualizes the urbanization patterns in Cairo and Cape Town, low-lying coastal cities that have significantly increased vulnerability to sea level rise and seasonal floods.

Figure 13 | Built-up areas in Cape Town and Cairo are mostly in low-lying areas vulnerable to flooding



Source: WRI, based on global data sets from EORC and JAXA n.d.; European Commission 2015; FAO n.d.; GADM 2018; WBG 2009.

Limited capacity and data to prepare for risks

Local and regional governments are ill prepared to manage disasters and lack capacity for contingency planning in the face of flooding or droughts. They have seldom put in place systems and measures for early warning systems, disaster preparedness, and resilience given the common conditions of growing informality, poverty, and limited resources (WMO 2020). In existing systems, data infrastructure and the capacity to manage, report, and monitor data may already be limited. For instance, despite increasing instances of heat waves, only two were recorded in Sub-Saharan Africa by the Emergency Events Database, managed by the Centre for Research on the Epidemiology of Disasters, during the past 120 years, compared to 83 heat waves recorded in Europe during the past four decades (Harrington and Otto 2020).

Karonga in northern Malawi experienced annual floods between 2009 and 2016, which disproportionately affected the informal settlements and farms built on floodplains. Yet despite the consistent incidents of flooding, the local government's lack of funds and lack of risk-informed urban development have resulted in continued and worsening flooding (WMO 2020). In Nairobi, increased rains have resulted in mudslides that are creating sludge in treatment plants, making adequate water treatment difficult and causing water shortages even in the rainy season (Interview 5). In Addis Ababa, the city's utility has failed to consider well-documented water shortages and plan for emergencies. In fact, groundwater resources that are reserved for drought contingencies are already overextracted (Interview 8). When Cape Town was hit by severe droughts in 2018, the city's dependence on a single source of water made managing the risk difficult, pushing the city to the edges of Day Zero, where it would have completely run out of water (Interview 13).

Lastly, data relating to deaths, socioeconomic and spatial profiles of vulnerable groups, localized information on climate risks, and potential economic losses are limited across African cities. This, along with limited capacity to manage and use the data for resilience planning, is a major barrier for anticipating and preparing for risks (WMO 2020). Additionally, there is limited availability of planning processes that involve community input and local knowledge and data to effectively prepare for water-related disaster risks. Despite having the capacity to help mitigate everyday risks, most residents in African cities have less ability and few resources to prepare for or recover from shocks (Kareem et al. 2017).

2.1.3 STRATEGIES FORWARD

Strategy A: Shift urban planning and decision-making to account for hydrologically linked regions and climate risks

City decision-makers need to bolster research to identify future risks in hydrologically linked regions and build capacity to use this information in a transparent and inclusive manner. Hydrologically linked regions refer to areas across the region on which the city relies for functions such as water supply, water quality, drainage, and flood buffering. These areas can include urban and nearby forests, river basin buffers, wetlands, and coastal zones. In order to fully understand risk in these interconnected regions, city decision-makers can leverage partnerships with local, national, and global actors to make the latest modeling technologies and data on climate and water risks available. City governments urgently need to update topographic and elevation maps, weather and climate information, and vulnerability assessments for specific population groups and spatial areas (Chu et al. 2019). For example, Deltares, a research institute, created flood projections in Dar es Salaam using participatory modeling and community mapping (Deltares n.d.). Other global tools include Aqueduct Floods,[18] which provides riverine and coastal flood projections, and the Urban Community Resilience Assessment,[19] which offers an evaluation framework and bottom-up process to measure community and social resilience.

City governments can then use this information to incentivize development in less hazard-prone areas, protect vital ecosystems that mitigate risk, and retrofit existing infrastructure and services. For example, the municipality of Hawassa, Ethiopia, has been working with New York University to map and project future growth areas. This data, to a

degree, has helped inform long-term development plans for road networks, service delivery, and ecosystem protection (Angel et al. 2013). In 2018, Hawassa's local government, in partnership with academics and other researchers, designed grids of arterial roads and public open spaces in expansion areas. Existing informal settlements in those areas were regularized and resettled in less hazard-prone, serviced plots, and given formal leases (Lamson-Hall et al. 2019).

In addition to mainstreaming information on risks, land-use decision-making needs to fundamentally integrate incentives that decrease indiscriminate development and interbasin conflicts. One strategy is to direct development towards specific locations within cities with regulations and planning (Mahendra and Seto 2019). For example, in 2003 South Africa passed a law providing tax incentives to developers to build, extend, or improve buildings located within demarcated Urban Development Zones (UDZs) in selected cities, including Johannesburg (Republic of South Africa 2004). The aim was to encourage economic development and affordable housing in inner-city areas, focusing on servicing underutilized land within the city, which helps ease informal expansion in peripheral ecosystems and watershed areas (King et al. 2017; Mahendra and Seto 2019). However, it is important to note that outside of South Africa and Rwanda, urban planning laws and regulations are weaker and reform efforts have had mixed results (Berrisford and McAuslan 2017; Goodfellow 2013). To shift towards more resilient practices, urban planning will need to work in tandem with regional planning and be strategic about seizing opportunities within the complexities and limitations of existing processes (Berrisford and McAuslan 2017).

Local agencies tasked with enforcing land-use regulations must accordingly increase their governance capacity so that plans and regulations that disincentivize land development that is fragmented and occurs in watershed areas can be enforced. This is a challenge for many cities in the Global South because they often do not have complete spatial databases of land records and transactions and lack the necessary authority to make decisions about land or the political will to regulate the private market (Goodfellow 2017). Information asymmetries must be reduced to minimize the potential to make vast returns from insider knowledge of future urban investments. For Johannesburg's UDZ, the largest in South Africa, a comprehensive, publicly available property database has been developed in partnership with the South African Property Owners Association (City of Johannesburg 2004).

Together, city and regional decision-makers will need to consider development patterns and potential adaptation actions along the urban-rural continuum. For example, peri-urban agriculture and forest regions in Sub-Saharan Africa have an important role to play in local livelihoods, food security, and climate adaptation and mitigation (Lwasa et al. 2015; Padgham et al. 2015). In Kampala, one-third of urban residents depend on peri-urban agriculture for their food supply (Lwasa et al. 2015). In Ibadan, up to 75 percent of food supplied to the city is from the city-region (Lwasa et al. 2015). Efforts to preserve these areas have encouraged tree planting, greening drainage channels, and increasing crop canopy to reduce runoff and flooding risks (Lwasa et al. 2015). Understanding and protecting the role of existing peri-urban agricultural areas within local hydrological regions is crucial for African cities.

Strategy B: Diversify water supply sources and management options, starting with increasing investments in water resource conservation and water demand management strategies

City decision-makers should embrace water management systems that utilize a mix of gray and green infrastructure and decentralized water sources to strengthen resilience. The dependence on singular water sources, most of which rely on rainfall, can leave cities especially vulnerable as climate change intensifies. There is no better example of this than Cape Town's Day Zero crisis in 2017—a date where the city would officially run out of water at its main reservoir from the worst drought in years (Rodina 2019). At that time, 95 percent of Cape Town's water supply came from rain-fed dams shared regionally in the Western Cape (City of Cape Town 2020).

Cities must not only diversify water supply sources but also diversify how water is managed and conserved. The immediate response to dangerously low reservoir levels in Cape Town was to institute

water-saving measures and water augmentation projects at all levels. Residents who could afford to do so installed rainwater harvesting tanks and drilled boreholes. Residents who could not afford such measures struggled more and were subject to long water queues and/or nonpotable water sources from nearby shallow wells or surface water. Gray water from limited shower use was used for flushing toilets. Some corporate entities went off the grid and extracted groundwater or invested in desalination. This strategy helped take the burden off the city's water supply, but it also raised questions about ensuring cost recovery. Learning from this, Cape Town's new Water Strategy commits to developing new, diverse water supply sources and management options, including groundwater, gray water reuse, and desalination (City of Cape Town 2020).

In many cities, investments in water resource conservation are underfunded yet well positioned to improve water storage, quality, drainage, and sanitation systems. One exception is Windhoek, Namibia, which was one of the first cities in the world to produce drinking water from wastewater. The city has also successfully found a way to recharge aquifers with its surface and reclaimed water to diversify water supply sources (see Box 3). Alternative infrastructure, ranging from natural ecosystems to engineered landscapes, can also be used to conserve water and energy resources. For example, constructed wetlands have proved to help control floods, improve water quality, and increase aquifer recharge and groundwater infiltration. In Tanzania, a school implemented a constructed wetland to treat overflow from septic tanks. During the first decade, it spent 75 percent less on septic tank emptying, but a visit in 2018 documented that savings had decreased due to poor maintenance and a change in school management (Sayers and Smith 2018). Constructed wetlands have also been implemented in Egypt, Kenya, Morocco, South Africa, Uganda, and Zanzibar (Sayers and Smith 2018). Coupled with local water storage tanks, rainwater harvesting, and green areas for aquifer recharge, communities would have many more options in the face of droughts.

BOX 3 | Innovative Water Resource Conservation in Windhoek, Namibia

Namibia is one of the most arid countries in Africa: the heat causes 83 percent of annual rainfall to evaporate—only 1 percent of rainwater infiltrates the ground.[a] Consequently, Windhoek has suffered from severe water shortages, largely dependent on boreholes and three rain-fed dams located far away. To cope with shortages, the city has sought alternative solutions to secure its water supply.

First, since 1968 the city has been recycling water from wastewater treatment plants. The wastewater plant uses a series of treatment processes that eliminate all pollutants and contaminants. Recycled water is then mixed into a one-to-three ratio with water from reservoirs. Surplus water from this mixture is then stored in a groundwater aquifer. Between 2006 and 2012, the recharge rate doubled and allowed for the aquifer to fully recharge. According to studies, a fully recharged aquifer could theoretically provide enough supply for a three-year drought.[b]

It is important to note that despite these improvements, water is still not accessible to all urban residents. Over one-third of residents in Windhoek live in informal settlements.[c] Informal residents must rely on shared water access points and toilets, but there are not enough, and many are too far for some residents to access. One study of the Goreangab settlement documented that only 11 percent of residents live within one kilometer of a safe drinking water source. The city did provide an alternative prepaid system to increase access, but some low-income residents could not afford to recharge their card and instead used nearby polluted surface water.[d] This underscores how water resource conservation, spatial planning, and affordability must go hand in hand to improve water resilience for all.

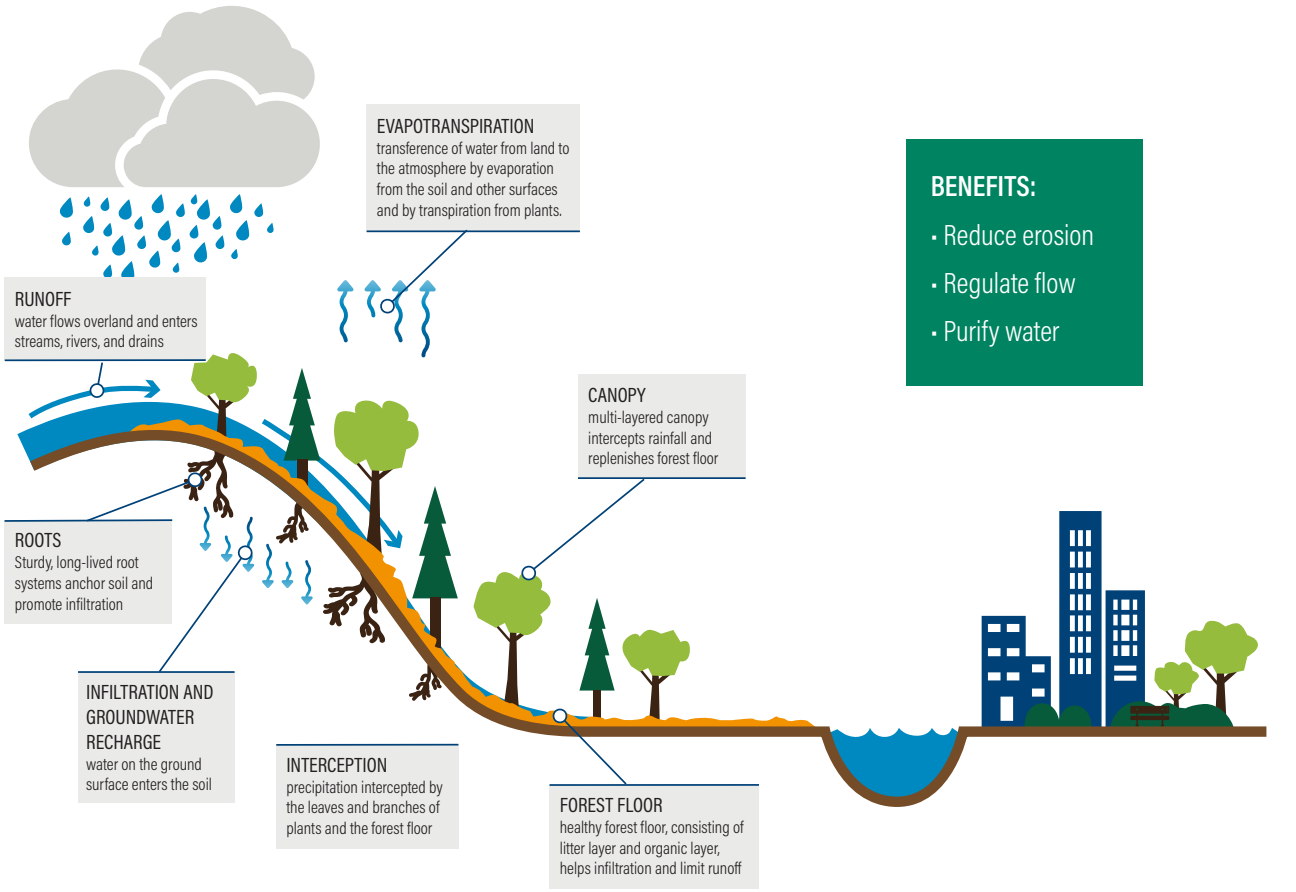
Sources: a. Sayers and Smith 2018; b. Murray 2017; c, d. Lewis et al. 2018; Karuaihe 2019.

Strategy C: Invest in water-sensitive infrastructure design as part of mainstreaming water-resilient city development, with a focus on nature-based solutions

Ultimately, African cities need strategic investments that view water as a resource that supports urban, rural, and ecosystem functions. A "strategic" approach recognizes the ability of natural landscape features to complement built infrastructure in managing water-related issues at multiple scales (local to whole basin; short to long term) and across multiple demands (from pollution, flood management, water storage and supply, water treatment, navigation, etc.; Sayers and Smith 2018). It is not a choice between water resources conservation, conventional gray infrastructure, or green infrastructure but rather how to best provide a "blended" approach that considers the local context (Browder et al. 2019). Cities can anticipate and design their spaces to live with water in all its forms rather than constantly reeling from its wrath.

It is crucial that city decision-makers, financiers, and national and regional authorities mainstream water-sensitive considerations into how water infrastructure is designed, built, and upgraded. Such actors should draw on nature-based solutions to proactively address flooding, sea level rise, water scarcity, and protection of water sources. Nature-based solutions can contribute to clean, reliable water supply and protect against floods and drought (see Figure 14). Wetlands, mangroves, urban trees,

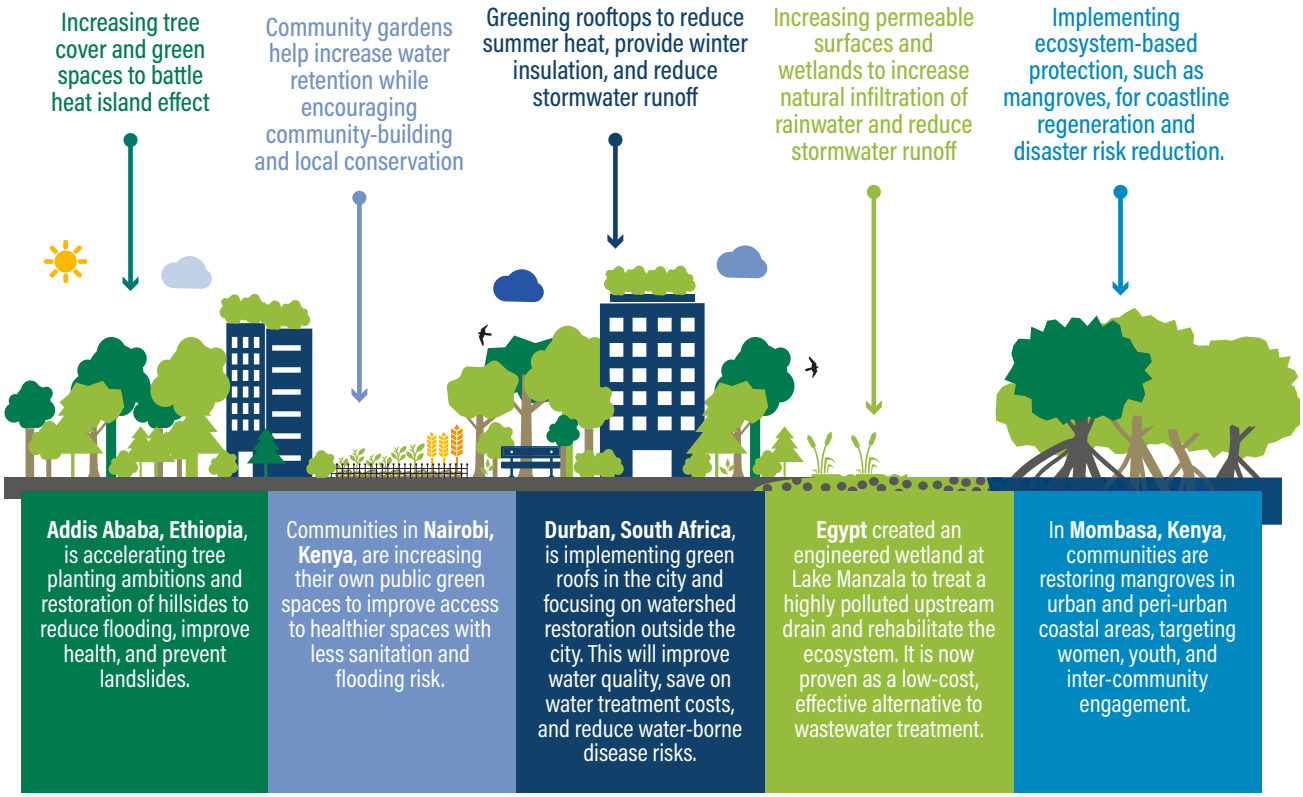
Figure 14 | How green infrastructure supports water resilience



Notes: Green or *natural infrastructure* refers to ecological systems, natural or engineered, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.

Source: Adapted from Qin and Gartner 2016.

Figure 15 | How cities integrate nature-based solutions for water resilience in urban planning



Source: Authors, based on Ceriops n.d.; Chu et al. 2019; IUCN 2020; KDI n.d.; Sayers and Smith 2018; Sutherland et al. 2019; UNEP 2020a.

green roofs, and community gardens allow cities to leverage natural ecosystems and capital based on the principle that intact and healthy ecosystems are more resilient to climate stressors and provide more social benefits (Scarano 2017; see Figure 15).

Fortunately, cities and residents across Africa are already beginning to think creatively about how to integrate nature-based solutions to build climate-resilient water systems and improve their relations with water. In Makoko, one of Lagos's coastal communities, local designers collaborated with the United Nations Development Programme to design floating infrastructure using local materials and resources to function as schools. Its architectural design responds to the needs and culture of people while also keeping up with the effects of climate change and sea level rise (ArchDaily 2013). Despite initial setbacks from structural failures from an early version, the project's aim to generate sustainable, ecological, alternative building systems and urban water cultures for the local residents is noteworthy, providing encouragement for others to invest in resilient architecture.

Recent national and city-level commitments to nature-based approaches are also promising. In 2019, Ethiopia's prime minister, Abiy Ahmed, began the Green Legacy Campaign to encourage Ethiopians across the board—from major cities to small towns—to plant trees to fight environmental degradation and preserve the country's water resources from erosion and contamination. A record of nearly 354 million trees were planted by 20 million Ethiopians in a single day in July 2019 on what the government named Green Legacy Day (Getahun 2020). This campaign, now a yearly event, is an example of how political commitments can mobilize masses in the protection of natural assets.

Similarly, in 2020, the mayor of Freetown, Sierra Leone, committed to planting 1 million trees over the next two years to reduce erosion, landslides, and runoff from flooding as well as to absorb greenhouse gases that cause urban heat islands (UNEP 2020a; see Box 4).

In addition to investing in nature-based solutions at the city scale, it is also crucial to invest in green and water-resilient interventions for buildings, which have significant impact on how cities grow and keep up with shocks such as flooding and drought. Cities thus need to weave water-sensitive and sustainable design into the building codes that govern the planning, design, construction, and operation of buildings. Building codes can be designed to include and encourage innovations that minimize water use both within (e.g., water-conserving fixtures, water reuse mechanisms) and around the building (e.g., water retention facilities, dedicated green space for recharging water aquifers). It should be noted that a fundamental problem in low- and middle-income countries is the lack of funding and support for building regulations and enforcement at the local level (Moullier and Krimgold 2015). This can be a hurdle in understanding the current water footprints of the built environment, requiring further investment in regulatory bodies to form a baseline understanding of water use. In Freetown, the mayor's office recognized this as a crucial obstacle and has been working to devolve authority on building permits to the city level (Soulé and Toulmin 2021).

Transitioning to a water-resilient future will require a major shift in how urban development is imagined, departing from the dominance of monofunctional, large-scale, and gray infrastructure investment.

It is important to note that nature-based approaches can bring a multitude of benefits beyond environmental and climate benefits. For instance, an experience in Addis Ababa highlights the importance of presenting the multifunctionality of nature-based solutions and linking the approach to daily livelihood concerns to foster community buy-in. In a workshop, university researchers presented various nature-based solutions to address the water challenges for a community living in five-story condominiums. The researchers highlighted design proposals for rainwater harvesting, rain gardens, infiltration trenches, community farming, and a playground. The community members were most interested in the playground proposal, which included developing a new fenced and central public space. There was consensus that this would help address existing complaints from ground-floor residents of children playing in backyards. Community members also thought that this would create a safe environment for children from surrounding traffic (Habtemariam et al. 2018, 2019).

At the same time, nature-based approaches can also bring unintended consequences (Sekulova and Anguelovski 2017; Toxopeus et al. 2020). Marginalized groups are most likely to be pushed out by changing conditions resulting from more greenery, such as an increase in housing prices and rents, often characterized as green gentrification (Anguelovski et al. 2019). In a global assessment, urban greening initiatives that have shown positive environmental outcomes are often also associated with the displacement of low-income residents (UN-Habitat 2020). Adequate measures, such as antidisplacement and risk mitigation policies, are needed to both ensure that the needs of the most vulnerable are prioritized and that they do not exacerbate inequality and social vulnerability (Toxopeus et al. 2020; UN-Habitat 2020).

Transitioning to a water-resilient future will require a major shift in how urban development is reimagined, departing from the dominance of monofunctional, large-scale, and gray infrastructure investment.

BOX 4 | Reforesting Hillsides and Restoring Mangroves to Protect Freetown's Residents from Floods and Landslides

Freetown, the capital city of Sierra Leone, has suffered extensive deforestation in its surrounding hills as a result of unplanned urbanization and illegal logging. Since the country's civil war in 1991, the city has grappled with growing water threats, such as flooding, landslides, and shortages.[a] Between 1986 and 2015, tree cover in the immediate surroundings and coastal mangrove forests declined by 44.7 percent and 23.5 percent, respectively.[b]

Deforestation at this scale, coupled with Freetown's average of 2,500 millimeters of rainfall per year (the 12th highest global average) poses huge risks to the city.[c] Heavy rainfall is unable to infiltrate the ground when land is deforested, increasing surface runoff and soil erosion, leading to dangerous floods and landslides. Today, Freetown is characterized by yearly flooding events.

In August 2017, Freetown suffered a major landslide following heavy rainfall in Lumley Creek on Sugar Loaf Mountain. The landslide claimed the lives of at least 500 people, but some estimates put the death toll above 1,000 when accounting for the 600 missing people. Most of the casualties were Freetown's poorest residents—slum dwellers with limited access to traditional drainage systems and whose families' have the least capacity to recover from the socioeconomic impacts of the disaster on their livelihoods.[d] The economic toll of the disaster has been estimated at US$82.41 million.[e] Experts have since concluded that the landslide was caused by a mix of natural factors and human activity, with soil on steep and unconsolidated slopes devoid of the tree cover they once had unable to absorb the excess rainfall.[f] The incident drove home the need for urgent and systemic urban infrastructure reform in Freetown.

In response, Freetown's mayor, Yvonne Aki-Sawyerr, launched a comprehensive action plan titled "Transform Freetown" in January 2019. A major pillar of the initiative is the "Freetown the TreeTown" campaign, which aimed to plant 1 million trees in 2020.[g] By restoring Freetown's hillsides and increasing the amount of green space and vegetation cover in the city, the campaign hopes to reduce the likelihood and severity of future flood events and increase the ability of the city's soils to absorb excess rainfall when it occurs. The Freetown the TreeTown initiative invites residents to take part in tree-planting efforts, and simultaneously aims to raise their awareness about the role of reforestation as a nature-based solution in disaster risk reduction. It has especially mobilized many young residents to help clear drainage channels from silt and solid waste and plant native, fast-growing trees to prevent runoff. In the long term, the campaign hopes to educate the city's residents about the risks of deforesting the hillsides. The case of Freetown could provide inspiration for other city decision-makers yet to realize the full potential of nature-based solutions to mitigate urban water challenges.

Notes: This box was written by John-Rob Pool, Cities4Forests Implementation Manager, Natural Infrastructure Initiative, WRI, and Michael Chen, Brown University.

Sources: a, b. Mansaray et al. 2016; c. Gibbens 2017; d. Cui et al. 2019; e. WBG 2017; f, g. Meghji 2020.

2.2 Prioritize the Most Vulnerable: Increase Equitable Access to Safe Water and Sanitation

2.2.1 THE PROBLEM

A city is only as water resilient as its least water-resilient households. The number of water-insecure urban residents in Africa is rising, even when dams are full and aquifers are replenished by the wet season (Asante-Wusu 2020; We Are Water Foundation 2017). The sheer size of the population living in slum areas in Sub-Saharan Africa with inadequate water and sanitation services has doubled from 1990 to 2012, from 102.6 million to 213.1 million people (Chitonge 2014). Service provision, including water, is a function of existing community and power relationships, gender dynamics, and the realities of who has access and control over resources. As a result, even when public water and sanitation services are provided, they are often too expensive, intermittent, or

controlled by intermediaries or brokers. These social and political barriers make it difficult for households to acquire adequate quantities of water for safe and healthy livelihoods during nonemergency times. And when emergencies do happen, the most socially vulnerable households—those without access to water, sanitation, and hygiene (WASH)—are most impacted.

Evidence using waterborne disease burden as an indicator shows that the toll on the urban poor is high and complex (UN-Water 2019). Studies correlate cholera outbreaks in African cities with both high rainfall events and periods of drought, the latter commonly associated with behavioral changes (e.g., being forced to fetch from contaminated surface water; Grasham et al. 2019). Although the disease risk is higher for households without access to a tap, communities connected to the piped water network also experienced outbreaks. An area in KwaZulu-Natal, South Africa, was the center of an outbreak (2000–01) despite having piped water connections. This is partly because many found the piped water service unaffordable; consequentially, they relied on contaminated surface water (Grasham et al. 2019).

Studies show that the disease burden of poor household water insecurity is gendered and age dependent. Women are exposed more often to unsafe water and most affected by the lack of adequate sanitation facilities. For instance, in a study of 25 countries in Sub-Saharan Africa, women collectively spent a combined total of at least 16 million hours each day collecting drinking water, compared to 6 million hours for men and 4 million hours for children (UNICEF and WHO 2012). Children are also particularly vulnerable to cholera (Sasaki et al. 2008; Sevilimedu et al. 2016). During an outbreak in Lusaka in 2004, more than a fifth of all patients were younger than age five, and one-third were younger than nine (Sasaki et al. 2008).

Diarrheal disease, largely from inadequate water and sanitation services, is the second-leading cause of death in children under the age of five globally (UN-Water 2019).

2.2.2 THE BARRIERS

Little coverage, complex burdens

Across most sub-Saharan countries, municipal water and sanitation networks only cover a small portion of the city. There is little official data on alternative methods of service provision, particularly in informal settlements. For instance, a study that looked at city-level data in five cities in Sub-Saharan Africa estimated that only 22 percent of residents receive piped water to their premises (Mitlin et al. 2019). Residents who do not receive piped water have numerous complex ways of accessing water and sanitation services. The report shows that 70 percent of households in the informal settlements studied in Kampala and 69 percent in Lagos accessed water from a variety of sources off their premises (Mitlin et al. 2019).

There are also spatial and temporal inequities in access to these services within informal settlements that affect residents disproportionately. In the Mukuru settlements of southwest Nairobi, households near main circulation routes are able to access public water supply points, whereas households farther within slum clusters have more difficulty. This pattern also coincides with access to sanitation services, mostly through shared facilities, underscoring the need to understand the nuances within settlements (CURI and Muungano wa Wanavijiji 2014). In KaTembe, Maputo, residents interviewed also cited the time burden of queuing for water, sometimes up to two hours, at a communal tap that is only 10 minutes from their residences (Carolini 2012). This burden falls even more heavily on women, who are typically responsible for unpaid domestic labor, spending more energy and time for personal sanitation management and for managing the household's water needs (Jaglin 2014; Miraftab and Kudva 2015). Moreover, the existence of public water and sanitation points in informal settlements is often precarious due to the lack of coordination between city agencies. For example, community-generated data in Nairobi shows that public water access points were removed by road construction a few years after installation. Experts in Nairobi cite this lack of coordination and planning as a common occurrence (Interviews 2 and 5).

The poverty penalty

The lack of affordability of water is a crucial barrier in residents' ability to access adequate quantities for health and security. Although water from the public utility is subsidized and relatively affordable, large swaths of the city, mostly informal and without access to the public network, face prohibitive costs. For example, the residents of the Mukuru settlements suffer a staggering "poverty penalty" whereby households must pay more for less and lower-quality water than Nairobi's formal settlements. Mukuru residents pay 172 percent more per cubic meter of water than residents living in formal areas or with direct access to public water kiosks (AMT 2015). This reality also exists in Addis Ababa, with residents paying 14 times more to use publicly provided water fountains than those connected to water lines (Interview 8). In the informal settlement of Kalimali, Kampala, over 80 percent of households source water from private vendors. These households spend over 10 percent of their income to pay three times as much as water from the piped network. In Lagos, tanker water is 29 times more expensive than water from the piped network. In the informal settlement Nhlamankulu D in Maputo, water resold from neighbors is nearly 13 times the price of water from the piped network (Mitlin et al. 2019).

When residents cannot afford water from private and informal vendors, they resort to surface water, groundwater, and/or rainwater that can be obtained for "free," typically at the cost of quality, health, and safety. For example, in KaTembe, Maputo's largest and poorest peri-urban district, residents resort to using unsanitary and contaminated sources such as uncovered wells and rainwater unsuitable for potable use (Carolini 2012). In many cases, low-income urban dwellers, recent migrants, and seasonal workers will need to use their limited or variable income on other pressing needs, so cutting costs and avoiding up-front payments for water and sanitation services becomes a survival strategy.

Affordability for sanitation services is complex due to high up-front costs, maintenance, and the prevalence of cheaper, less safe options (e.g., dumping directly into waterways). For instance, there have been several one-time sanitation improvement projects in KaTembe, but little was done to make sure the maintenance of ventilated improved pit latrines was also affordable to residents. Despite the health benefits, most residents returned to using the cheaper option of unlined pits, which risk groundwater contamination and become a vector for disease during flooding events (Carolini 2012).

Power dynamics are constantly being negotiated through informal service providers, often at the expense of lowest-income users. For instance, a case study of small-scale informal water providers in the peri-urban areas of Maputo concluded that the formation of water associations concentrated regulatory power and decision-making, such as water distribution paths, to politically connected providers. These water associations influence the entry of new providers into the market as well as pricing, creating a system akin to the cartel system which has consequences for water access for socially vulnerable populations (Ahlers et al. 2013). This cartel system also exists in Nairobi, controlling the availability, pricing, and quality of water provision, which reduces affordability and access for low-income residents (Interviews 1, 4, and 5).

Intermittent water, increasing scarcity

Intermittent water supply causes major household burdens and will likely worsen without changes in water resources management. Households fortunate enough to connect to the piped network face issues of water availability due to the prevalence of intermittent water supply. Although the SDGs define safely managed water as available 12 hours a day in some cities across Africa, this reality is far from being achieved. In Kampala and Maputo, residents across the city had an average of 8–10 hours of water supply per day in their pipes (Mitlin et al. 2019). Water stress has also caused severe water rations in Addis Ababa, Bulawayo, and Harare (Interview 8; Niasse and Varis 2020). Demonstrations and riots expressing dissatisfaction with chronic water scarcity and water cuts have taken place in all of Africa, from Abidjan, Bamako, Conakry, Dakar, and Lagos in the west to Nairobi and Dar es Salaam in the east and multiple cities in South Africa, Bulawayo in Zimbabwe, and Antananarivo in the southern parts of the continent (TNC 2016).

Intermittent water supply increases the risk of water contamination and, ultimately, the disease and financial burdens for water consumers. In cities in the Global South, it is expected that the number of people receiving intermittent water will likely increase due to rapid urbanization and the lack of planning, increased water scarcity as a result of climate change, irregular electricity supplies, and general underinvestment in water infrastructure (Mitlin et al. 2019). Thus, ensuring sufficient data on levels of intermittency in water supply and its causes is essential for understanding the true levels of access and developing a strategy for water resources management.

Misleading and incomplete data and indicators

Lastly, how access is measured and defined informs interventions, financial flows, and policy decisions. In the absence of robust water and sanitation access data, the United Nations's global benchmarking platform established for the SDGs is critical in shaping WASH interventions by development banks, financiers, and nongovernmental organizations (NGOs) in Sub-Saharan Africa. However, the SDGs and global monitoring efforts managed by the Joint Monitoring Programme do not adequately account for "access" in the urban African context. SDG monitoring for water and sanitation is not specifically designed for urban contexts; thus, their universal and broad categories for access do not account for affordability, intermittency, and the change in quality in between the source and point of consumption (Adams et al. 2019; Mitlin et al. 2019). Recently, the Joint Monitoring Programme has improved its data collection methodology to acknowledge the complexities of how people access services, but challenges remain on acquiring the necessary local data for policy design. Some countries have begun to collect their own data for this purpose. For example, in Kenya and Zambia, regulators have been publishing utility-reported water and sanitation data—a helpful start for specific cities and utility service providers (Eberhard 2018).

In addition, the monitoring tools need to capture the holistic issues related to water security, such as spatial and temporal variables specific to local situations (e.g., not only access to safe water but also sanitation as well as safety from stormwater surge and flooding). Due to these limitations, policymakers overestimate access and face challenges in designing effective interventions, policies, or investments to improve household water security as a key component of building urban water resilience.

2.2.3 STRATEGIES FORWARD

Strategy A: Target policies to increase water connections, affordability, and availability for the most socially vulnerable

Given the growing social disparities in access to water and sanitation in cities of Sub-Saharan Africa, city decision-makers should design policies to target the most socially vulnerable populations. For instance, utilities can price services using means-tested subsidies, increasing block tariffs, cross subsidization, or "free basic water" policies (Heymans et al. 2016; Muller 2008; Ying et al. 2010). They can also subsidize or provide free connection costs, increase payment flexibility, or partner and expand community-managed kiosks and taps to keep prices affordable, as seen in Dakar, Kampala, Maputo, and Nairobi (Heymans et al. 2016; Mitlin et al. 2019). Some of these strategies can be rapidly deployed, relying on existing infrastructure to expand access. For example, in response to COVID-19, many cities quickly expanded water kiosks, taps, and sanitation services to strengthen public health measures (see Box 5 on Kigali). Water and sanitation authorities will need to work with city, regional, and/or national governments to find an optimal balance between financing water services and targeted subsidies for socially vulnerable groups. Above all, water and sanitation services should be governed as a public good (Langford and Russell 2017; Makwara 2011; Special Rapporteur 2015).

Public water and sewerage networks and other affordable options should be expanded based on need and vulnerability, prioritizing under-served communities. City decision-makers will need to strengthen the spatial planning capacity to design targeted infrastructure in coordination with other sectors. A spatial analysis on four major African cities by WaterAid (2012–15) compared the current state of water and sanitation services, urbanization patterns, environmental risks, and current city master plans in order to identify top spatial priorities (WaterAid and Sheppard Robson International 2015). For example, in Maputo, the analysis identified extending key sanitation infrastructure to the densest slum areas as a top priority. In Lusaka, it compared water and sewerage infrastructure with the proposed transport routes in existing master plans. In Lagos, the analysis found slum communities in flood-prone areas to be the most vulnerable, and any water and sanitation solutions would need to account for the region's high water table (WaterAid and Sheppard Robson International 2015). The capacity to analyze, plan, and respond to long-term needs will enable strategic and cost-effective policies that are urgently needed.

International financiers and donors can utilize and coordinate pooled funding schemes with program-based approaches targeted to improve water and sanitation access for the urban poor (see Section 2.4 for more examples and discussion). In addition, the budget approval process can be an opportunity to coordinate cross-sectoral programs, projects, and activities. Open budgeting initiatives with a detailed publication of budgets (such as disaggregated into donors, utilities, private investors, NGOs, including fees and taxes) and the expenditure, participatory budgeting,[20] and independent oversight institutions could help to increase transparency and reduce corruption in the water sector. For example, the International Budget Partnership works with civil society in various countries and provides technical support to conduct open budget surveys and influence priorities in favor of marginalized community groups. Community budget advocacy, participation, and training of residents in Baringo County, Kenya, has led to a sustained growth in government allocations for the water sector since 2017 (International Budget Partnership n.d.).

Strategy B: Support upgrading of water-insecure areas and localized innovations that increase access to safe water infrastructure and healthy spaces

Given the low resources and capacity of most utilities, African cities will need innovative short- and medium-term solutions to improving household water security in addition to expanding coverage of the public network. For many African cities, a complex web of alternative services already exists with a number of actors—some formalized and some not—influencing the service delivery networks (Cirolia 2020). Some examples include water tanker trucks, small-scale vendors, neighborhood water kiosks, septic tank vacuum trucks, and pit latrine emptiers that can reach dense slum households with no paved road access. These small-scale, decentralized, and/or informal networks play an important role in providing water services to less conventional or accessible areas of the city, such as hillside settlements that lack formal roads, peripheral areas outside of the utility's jurisdiction, and households within large, dense slums. In many of these cases, the centralized system may not work.

BOX 5 | Kigali's Response to COVID-19: Hygiene in Public Places

In response to the global pandemic of COVID-19 in early 2020, Kigali implemented several key actions related to water, sanitation, and hygiene to safeguard against community spread. Even before the first case was documented, the city of Kigali deployed portable and free sinks for handwashing at a handful of public spaces, such as transit centers. To expand the program, city officials engaged civil society groups to support an increase in handwashing stations and provide supplies to low-income areas. They also engaged local businesses to meet the demand for face masks as well as local communities, religious leaders, and trade cooperatives to raise awareness of hygiene measures. Due to previous preparations for potential Ebola outbreaks, the city already had strong communication channels and robust preparedness measures, such as a community health workers program in operation since 1995. These community health workers played a key role in contact tracing and water, sanitation, and hygiene improvements at the community level.

Within a few months, the public health measures showed signs of early success. The spread of infection fell, and lockdowns were lifted. Many activities resumed, with prevention measures in place. City officials also highlight how this public health emergency underscored the urgency of addressing Kigali's water challenges, such as shortages, aged pipes, lack of pressure management, limited distribution, and insufficient water and wastewater treatment. Strategies moving forward include ensuring 100 percent access to safe, reliable, affordable, and high-quality water and sanitation services, reducing water-shortage areas, improving pressure control, and increasing finance for infrastructure improvements.

Source: Habinshuti N. 2020.

It is becoming increasingly clear that urban authorities need to invest in localized innovations, off-grid providers, and comprehensive upgrading efforts (Cirolia 2020; Lawhon et al. 2014; Pieterse et al. 2020). This should happen within the legal and regulatory framework of cities, and it may require investments that increase regulatory capacity and the integration of hybrid service provision (discussed further in Sections 2.3 and 2.4). For instance, in Nairobi, water sector agencies are working to integrate more small-scale water companies into public service management. They note this is one way to counter cartels (Interview 1; Lines and Makau 2017). Innovations ranging from physical interventions to financial models to social processes fit for the local context will be critical for a city's water-resilient transition.

One of the most effective and inclusive approaches is to comprehensively upgrade core services in the most water-insecure areas, such as dense informal settlements (McGranahan et al. 2016b; Satterthwaite et al. 2020). The success of government- and community-led informal settlement upgrading schemes to improve access to water, sanitation, and drainage are well documented (Archer 2012; CODI 2011; Papeleras et al. 2012). For instance, in Gobabis, Namibia, community-led upgrading, supported by the Shack Dwellers Federation of Namibia, resulted in resulted in 25 times more communal water points, new sewerage connections, and stronger community partnerships with local authorities (Delgado et al. 2020). Box 6 provides another example of innovative community-led upgrading in Kibera, Nairobi—home to over 250,000 slum dwellers. Many governments are beginning to prioritize the upgrading of informal settlements. In Rwanda, the national government published the National Urban Informal Settlements Upgrading Strategy in 2017, then the city of Kigali created a citywide upgrading strategy in 2019, both in response to urgent urban resilience challenges (Hitayezu et al. 2018).

Upgrading efforts play an essential role, particularly for city-regions where policy reform in the water sector has limited impact. Utilities may face limitations within existing policy frameworks related to housing, land, and tenure security. A key informant highlighted how Nairobi's utility has a

BOX 6 | Community-Managed Upgrading in Kibera, Nairobi, Improves Access to Safe Water Infrastructure and Healthy Spaces

In 2006, a local nonprofit, Kounkuey Design Initiative, began working with residents to upgrade slum neighborhoods in Kibera, Nairobi. Known as the Kibera Public Space Project (KPSP), it focused on implementing community-led solutions to tackle severe flooding, poor drainage, and the lack of waste disposal and sanitation services. Layering in local knowledge, the project mixes gray and green infrastructure to provide water taps, toilet blocks, public green spaces, playgrounds, and laundry facilities; it also remediates rivers and reduces the flood risk affecting over 8,000 households. This also created new sources of microfinance and jobs. Over 70 percent of new employees and entrepreneurs are women, managing the public spaces, kiosks, sanitation centers, and other businesses. After several years, a network of over 250 community leaders continues to increase access to safe services and healthy spaces, leading to several other community and government partnerships.

By putting public space and community voices at the heart of development, the KPSP has helped pave the way for resilient and inclusive slum upgrading efforts. The community has gained political capital and new relationships with existing institutions. For example, it was able to negotiate with the city not only for the new sewer line to cut through Kibera but also for connections to the community's toilet blocks. In fact, in 2020, the government launched a new integrated slum upgrading effort that could bring key water, sanitation, and hygiene infrastructure and secure tenure to most of the informal settlements, drawing upon Kibera's experience and involving KPSP as a key partner.

Sources: KDI n.d.; Mulligan et al. 2020.

pro-poor policy to subsidize new water connections in informal settlements, but this can only be used for settlements on public land. This means that at least half of Nairobi's informal settlements residing on privately owned land were unable to access this subsidy (Interview 14).

In many cities, off-grid and local alternatives have been implemented with varying success. For example, a social enterprise in Kumasi, Ghana, worked to offer container-based sanitation[21] options to densely populated neighborhoods reliant on public toilets. This program introduced a freestanding, urine-diverting chemical toilet, requiring periodic emptying, serving over 500 households in 2016 (Greenland et al. 2016). The social enterprise collected and transported the sealed and removable containers to a treatment plant, charging a monthly fee. On average, a household of four spent less on container-based sanitation than the amount spent on pay-per-use public toilets. However, studies show that this option was still unaffordable for the lowest-income households. It is also unclear whether the scale of operation is economically viable in the long term without public financing (Greenland et al. 2016). Another similar example is Sanergy, a social enterprise based in Nairobi. It offers container-based sanitation units to urban slums, collecting waste using handcarts to navigate narrow pathways, then convert human waste into farm products. The current business model is supported by grants, and it is unclear whether it can reach financial viability and remain affordable in the long term (Auerbach 2016; Ravelo 2019; Waldman-Brown and Flatter 2018).

There are other emerging off-grid innovations better fit for the conditions of peri-urban areas, such as composting toilets and rainwater harvesting, which require more space (Banana et al. 2015; SIWI 2007). The feasibility of these typically depends on the cost of land, the affordability and footprint of particular models, and, for composting toilets, the availability of markets for biosolids. In Kenya, efforts to harvest rainwater at schools, farms, and households in peripheral areas have reduced flood risks and recharged local underground water stores (Wambui 2020). Ensuring that local wells are adequately recharged and maintained eases the pressure to extend municipal supplies while also increasing the capacity of peri-urban areas to buffer floods for the entire region (discussed further in Section 2.2).

There are wide-ranging financial innovations in the water sector, which can be adapted depending on the local context. Microfinance institutions (MFIs) in Lomé, Togo; Abidjan, Côte d'Ivoire; and Kenya have facilitated increased access to water and sanitation (WIN 2016b). MFIs were able to deliver funds, guarantees, project finance, and insurance to poor people and small-scale providers with affordable costs over protracted payment periods. They also enabled the local community and households to manage the capital costs for connection and water bills with more flexible payment arrangements.

Digital solutions that increase payment flexibility have seen early success as well. In Niamey, Niger, the local water utility and CityTaps, a program funded by the Groupe Speciale Mobile Association's Utilities Innovation Fund, launched a pay-as-you-go system through digital, mobile payments for prepaid water meters (White and Morais 2020). Pay-as-you-go approaches make water services more affordable for low-income users because they can pay for water incrementally, giving them more control over their budgeting. Now with an accessible connection to publicly provided water, users who were previously queuing for high-cost water from private vendors saw substantial time and cost savings. The utility saw an improvement in revenue collection and trust from consumers. CityTaps has plans to scale to Burkina Faso, Kenya, Mali, and Senegal (White and Morais 2020).

Another example is how the National Water and Sanitation Office (ONEA) of Burkina Faso financed the uptake of safely managed on-site sanitation and its maintenance, an area that is typically left to the burden of households (Trémolet et al. 2007). They introduced a cross-subsidy on water bills to the users with sewer connections in Ouagadougou to accomplish several purposes: subsidizing on-site sanitation facilities for poor households, training masons about on-site sanitation, creating awareness and promotion campaigns, and funding construction of school latrines (Trémolet et al. 2007). The funds generated were reportedly too low to cover all necessary resources, but they represent ONEA's advanced involvement in fecal sludge management—a key arrangement that is often neglected in African cities (Eberhard 2018).

Overall, these innovative, off-grid approaches should not be seen in opposition to publicly provided, centralized services. Rather, city and regional decision-makers should seek to integrate and partner with such providers, strengthening the role of public resources to ensure affordability and, ultimately, better access and water security for the most vulnerable areas (Cirolia 2020).

Strategy C: Integrate local data, knowledge, and community participation in decision-making

Solutions that are codesigned with local knowledge and community participation will be the most effective in achieving social and community resilience towards water-related shocks and stresses. Understanding and recognizing the diversity and varying capacity of resilience to shocks of the different social groups within the community (e.g., tenants, landlords, traditional leaders, women, politically affiliated groups, specific families and clans, local authorities) and their power to mobilize resources is essential. For instance, the Household Water Insecurity Experiences (HWISE) scale[22] goes beyond measures of water availability and quality to capture the unique experiences of water-secure individuals using a cross-culturally validated scale. The HWISE scale provides data that can be used to assess the prevalence of water insecurity at the household level, identify vulnerable populations, monitor and evaluate interventions, and determine cost-effectiveness.

Many communities have already been adapting to water-scarce conditions. Integrating local knowledge and community participation could help leverage existing creative adaptation mechanisms (Habtemariam et al. 2019). For instance, building on small-scale innovative practices, such as a delegated management model;[23] makeshift technologies available in local and informal markets; community bulk metering; and prepaid meters could increase resilience and livelihood opportunities for the entire community (Adams et al. 2019). Empowering the most vulnerable groups with their own leadership and space for coalition building is essential for building water resilience so that communities are able to self-organize against water-related shocks and exploitative practices.

More accurate and nuanced city- and subcity-level data are needed to understand the complex set of challenges faced by urban dwellers and the increasing risk from climate change and other potential disasters. Studies have shown how utilities routinely collect and aggregate data to benchmark their performance, but this leaves out the reality and consequences of spatial inequalities present in many African cities (Carolini and Raman 2020; McDonald 2016). More accurate and nuanced data also requires the capacity to manage, analyze, and maintain data in order to be effective. In Nairobi, the Water Services Regulatory Board and Water Sector Trust Fund have begun to map out water-insecure areas based on their location and population on a platform called MajiData (Interview 4).[24] This also includes utility coverage data, performance data for service providers, and service quality in informal settlements. The goal is to refine this data capability by disaggregating it further to inform key pro-poor indicators for low-income areas (Interview 4).

Data generated by communities can play a crucial role in revealing nuanced vulnerability and investment needs. Box 7 highlights the efforts of Slum/Shack Dwellers International (SDI) to elevate the role of slum communities across the continent. In Rwanda, the International Council for Local Environmental Initiatives (ICLEI) undertook risk and vulnerability assessments in three districts and found that incorporating the lived experiences of community members was critical to filling data gaps often encountered in African cities (ICLEI 2019). In Zambia, the regulator established "water watch groups," where consumers monitor water and sanitation services and providers at a community level (Nwasco n.d.). In Lilongwe and Maputo, community residents are utilizing creative approaches, such as participatory videography, to capture everyday realities (Rusca 2018). With Africa's lack of historic data availability, there is still a nascent understanding of the effects of climate change at the regional, city, and neighborhood levels. The current lack of such nuanced data is a major hindrance, not just in addressing the urgent needs of water access but also in contingency planning for shocks and climate change adaptation (discussed further in Section 2.2).

BOX 7 | Slum/Shack Dwellers International: Know Your City Initiative

Many existing development indicators fail to capture the complex and locally specific conditions of slums. They therefore lead to policies and programs that do not respond to the most pressing needs of the urban poor and can direct investments away from realistic and affordable improvements. Without accurate information and a deeper understanding of the needs and priorities of informal settlements, slum dwellers remain invisible, and efforts to reduce urban poverty and inequality will fail.

To remedy this problem, Slum/Shack Dwellers International (SDI) has been building capacity for people in slums to profile and self-enumerate their own communities for decades. SDI later launched the Know Your City program (2018) to facilitate processes across several regions to provide the detailed information needed to reframe adaptation issues from a local perspective and identify practical solutions for informal settlements. The central role of slum dwellers in collecting and processing data, such as on demographics, water risks, and access to basic services, ensures a focus on the poor and local knowledge. As a result, several cities, including Durban, have partnered with SDI federations to codevelop adaptation plans and institutionalize participatory mechanisms.

Sources: Beukes 2015; SDI 2018.

Community engagement and participation are best leveraged when strong community-based coalitions exist. Such coalitions do not often exist in places where power dynamics between private actors (such as land developers, water vendors, or water mafias), political officials, and marginalized communities are the most uneven. The formation and ongoing work of Muungano wa Wanavijiji, a social movement of Kenya slum dwellers started in 1996, can offer lessons on how to build community power.[25] It was initially started by slum communities in Nairobi to resist the brutal evictions and land grabs of the 1990s in Kenya. Since then, its community-led approach has spread across Kenya, working with many different partners and improving slums (including water and sanitation access) for over 40,000 families. Lines and Makau (2018) trace a few aspects key to Muungano wa Wanavijiji's success. First, the early presence of community savings groups, which are a tool to pool funds for community investments, amplified resident voices to coalesce around collective action and communal responses to specific issues. Second, in 2001 the group became a federation and joined the global SDI network, linking with other slum dweller movements (Lines and Makau 2018). This enabled access to capacity-building methods, such as slum profiling and self-enumeration, urban poor funds, women-centered community organizing, and slum upgrading models. Third, over the years the Kenyan state created more space for civil society participation, consultation, and partnership. The Muungano alliance was able to influence pro-poor policy development, perceptions towards slums, and eventually slum upgrading strategies (Lines and Makau 2018). For example, in 2017 the Nairobi City County officially designated Mukuru—the previously mentioned informal settlement home to over 100,000 residents—a "special planning area." This effectively froze development there for two years, until an integrated development plan—including improvements to water, sanitation, and drainage—was produced by the Muungano alliance and a coalition of actors (Dodman 2017; Horn et al. 2020; Lines and Makau 2018).

Integrating community participation and local knowledge in decision-making is only one small part of addressing unbalanced power dynamics and corruption. However, it is a step that can be implemented now by any level of government. While much depends on a city-region's political economy and local context, it is crucial to ground inclusive processes and the co-production of strategies as part of the water-resilient transition.

2.3 Create Change at Scale: Develop Innovative Institutions and Pursue Partnerships for Water Resilience

2.3.1 THE PROBLEM

Fragmented governance and siloed institutions are major barriers to building resilience into water systems, particularly in times of chronic stress or acute shock. They limit meaningful engagement between key stakeholders for building water resilience in urban Africa. Ranging from a lack of coordination between governing bodies and stakeholders to corruption and the politicization of water, these issues can be major obstacles for cities in strengthening their water systems. Efforts to build urban water resilience, from upstream regional-level protection of water sources to ensuring inclusive access to water and sanitation downstream in cities, will require input and engagement from a wide range of actors. These include national and regional agencies; sectoral agencies; city agencies; and local community groups, such as community-based organizations (CBOs) representing informal settlements, NGOs, and private sector actors involved in water services—few of which interact routinely with each other on key decisions (Interviews 1, 4, 7, 9, and 12). Therefore, streamlining water governance and developing new kinds of institutions and partnerships for integrated water management are perhaps the most crucial aspects of improving water resilience.

2.3.2 THE BARRIERS

Misaligned agendas and lack of coordination among city agencies

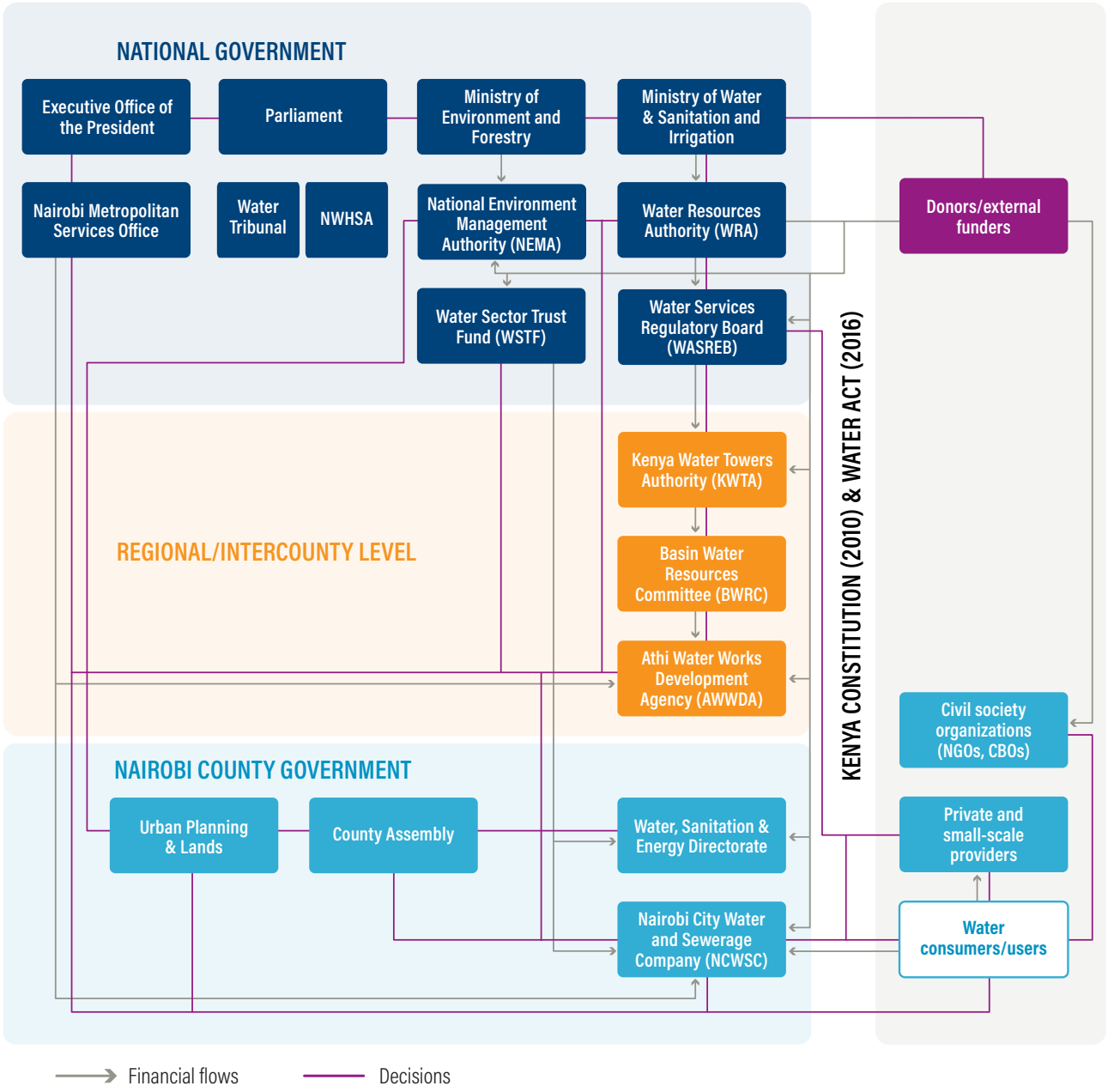
Misaligned agendas and incentives between sectoral agencies and city departments can exacerbate the environmental, health, and social vulnerabilities. Based on key informant interviews, we analyzed the institutional landscape of the water system in Nairobi. Multiple governing entities at the national, regional, and county level, in addition to donors, civil society groups, and private and small-scale providers, determine how water is provided, accessed, and, ultimately, how it affects livelihoods (see Figure 16).

A major challenge is the lack of coordination between urban planning and water services. The Nairobi City County's Urban Planning Department has been approving building permits without any coordination mechanism with the city's utility, Nairobi City Water & Sewerage Company (NCWSC), to ensure that there is sufficient access to water in the area of construction (Interview 2). A planning representative cites that it is the responsibility of developers to figure out access to water, which then results in developers digging unregulated boreholes (Interview 2). This contributes to Nairobi's groundwater crisis. A representative from the NCWSC cites some of the city's groundwater sources as unsafe for consumption due to high levels of fluoride, and boreholes should not be used in such areas. New and formally recognized developments not only contribute to the overextraction of groundwater but also increase impermeable surfaces, lessening the area's capacity for natural drainage and aquifer recharge (Interview 5). There has been little resolve thus far, despite agencies recognizing that this is a problem.

A similar lack of coordination between the wastewater and solid waste management services of Douala is also leading to blocked drainage systems that worsen flooding in rainy seasons. Mismanaged or ill-disposed solid waste ends up in city drainage channels, preventing polluted stormwater, sometimes mixed with sewage, from draining (Jacobsen et al. 2013).

Streamlining water governance and developing new kinds of institutions and partnerships for integrated water management are perhaps the most crucial aspects of improving water resilience.

Figure 16 | The institutional landscape of water sector actors in Nairobi



Notes: CBO = community-based organization; NWHSA = National Water Harvesting and Storage Authority; NGO = nongovernmental organization.

Source: Interview with Baraka Mwau, a key informant from Nairobi, 2020.

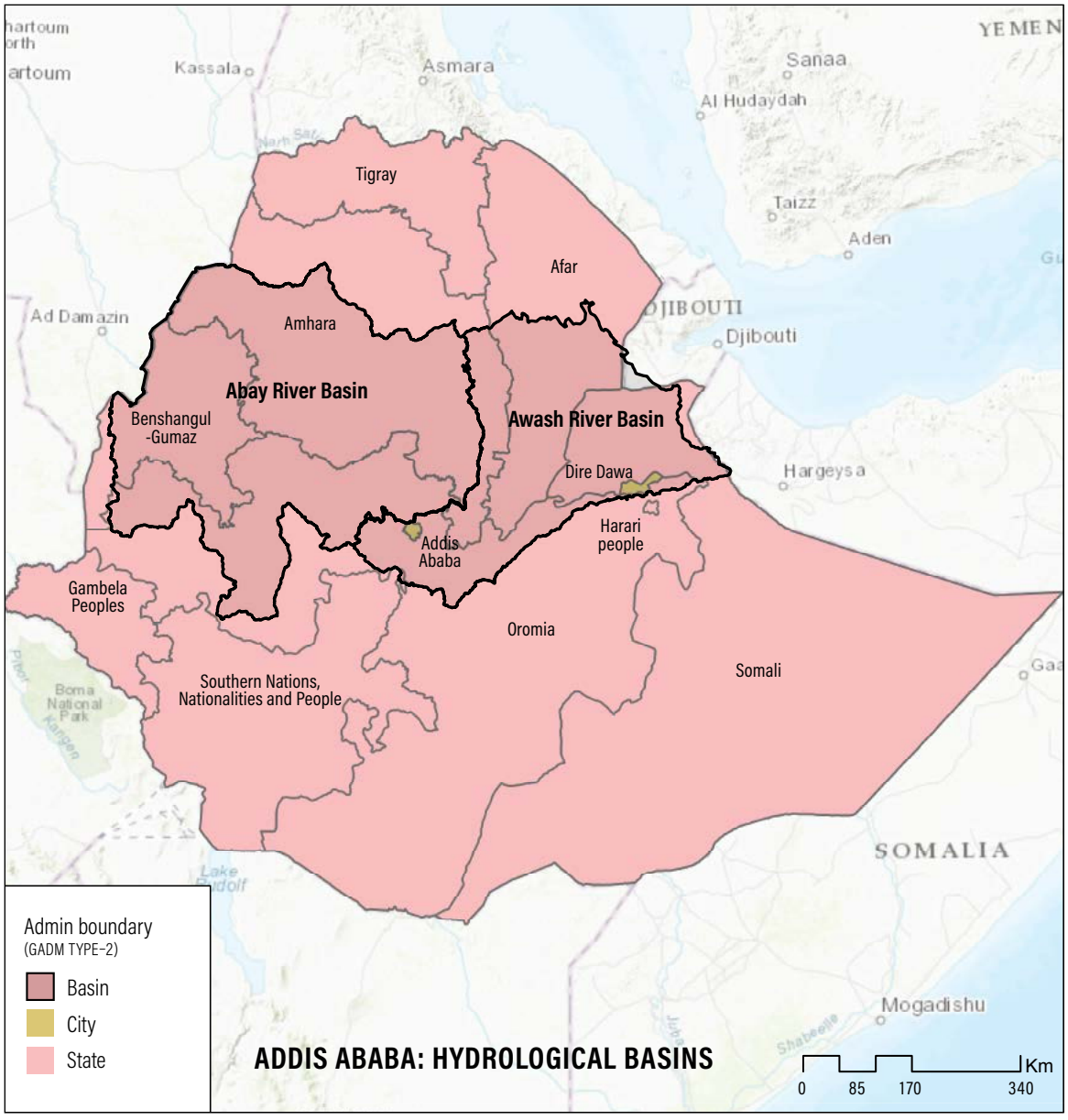
Overlapping mandates, local-to-national disconnect

Political jurisdictions often do not correspond to water system boundaries. The location, scale, and scope of challenges can make water risks difficult to manage for city actors alone. The city may lack authority or responsibility because of how power is divided and distributed between national/regional and local governments or between municipalities and traditional power systems.

In Ethiopia's Awash River basin, which flows through five regional states and two administrative cities (see Figure 17), different institutions, such

as the Awash Basin Authority (AwBA) and Water Works Design and Supervision Enterprise, were created to regulate the distribution of water across the basin. However, Hailu et al. (2018) argue that the top-down nature of these institutions, which did not create sufficient coordination between relevant stakeholders, undermined grassroots customary water institutions and failed to create equitable water-sharing mechanisms (Hailu et al. 2018). For example, the national government has been investing in large-scale, state-owned plantations that extract high quantities of water in a number of towns in the basin (Hailu et al. 2018; Interviews 7 and 8). There has also been outright conflict between regional states, AwBA, and the national government. Regional states posit that the powers of the basin authority are unconstitutional because they conflict with the powers and duties given to the regional states (Hailu et al. 2018).[26] Because of overlapping mandates and conflicting interests, coordination

Figure 17 | Ethiopia's Awash River basin must be coordinated by five regional states



Disclaimer: This map was developed before Sidama became an independent region.
Source: WRI, based on GADM 2018 and the basin boundary as provided by the local authority in 2020.

on water resources is almost nonexistent between AwBA and the city government of Addis Ababa, resulting in downstream pollution. Consequently, the ideals of achieving equitable water distribution and resilience in the Awash River basin are still out of reach.

Africa has a history of developing regional institutions to manage transboundary waters. The first river basin organization, the Niger Basin Authority (formerly the Niger River Commission), was established in 1964 (Foster and Briceño-Garmendia 2010). Other intergovernmental examples include the Nile Basin Initiative and the Lake Victoria Basin Commission. However, similar to the AwBA, many faced challenges in effectively and sustainably managing water resources. A World Bank study found that they struggled from waning political commitment, insufficient capacity, political instability in member states, a lack of strong government ownership, and a lack of dispute resolution mechanisms (Foster and Briceño-Garmendia 2010).

Tensions that exist between national and local governments will require the need to create clear paths of communication and platforms for collaboration (Barraqué and Zandaryaa 2011). In 2020, Kenya's national government passed a major governance change, approving the formation of the Nairobi Metropolitan Services Office, which transferred county functions related to water and sanitation to the national level. This resulted in legal battles, illustrating the ongoing contestation between national and local governments (Interview 2; Walter 2020). When Cape Town was facing its most severe drought in 2018, one of the main issues that hindered the response was the difficulty for the city to work with the national government, both of which are from different political parties. The political gap between the two governing bodies made allocating funds for response arduous at a time when the city was fast approaching Day Zero (Interview 13; Muller 2018). Returning to Addis Ababa, where the main water sources lie outside the city's borders, the tension between the city's identity as the capital and economic engine of the country as well as the capital of the Oromia region is putting a major strain on water governance. As politics-based altercations and social unrest bubble up across the city and its surrounding towns, the instability in regional politics is affecting projects in the pipeline (Interview 8). The complexity of Addis Ababa's identity is a major sociopolitical factor that needs a more careful and sensitive approach that considers the broader emerging context in Ethiopia (Ayenew 1999; Habtemariam 2019).

Using water for shortsighted political gain and corruption

Water used as a tool for political gain is a major hindrance in instituting resilient and equitable water governance practices. Prior to Zimbabwe's 2013 election, politicians canceled the debt of water users to gain votes and weaken the opposition party, resulting in serious financial consequences for water supply institutions (Muller 2016). Similarly, in Cairo's Ezbet El-Haggana informal settlement, parliament members aggressively buy votes using water provision during election times, creating overlapping water lines that do not end up receiving water postelection, leaving residents in a limbo of having formal access but without the availability of water (Khalil 2019). In other cases, politicians in Beaufort West, South Africa, intentionally neglected water demand management measures and the use of alternative water sources in fear of short-term political risk. This eventually contributed to the over-extraction of water from the city's dam, which had serious political repercussions (Muller 2016). Studies also showed that interethnic conflict has been fueled by inappropriate and out-of-context policies (such as the privatization of public services) adopted by sub-Saharan city governments and by the increasing inequalities between community groups (Lawhon et al. 2014; Watson 2002).

Incentives for corruption in Sub-Saharan Africa are exacerbated due to the increasing water stress and competition for scarce resources. When combined with capacity gaps, lax or nonexistent regulation of water resources and services, and limited knowledge of the major actors about laws governing water issues, this creates challenges for water governance. Studies show that the water sector in Sub-Saharan Africa is mainly driven by the opaque interests of the dominant lobby groups (including the private sector, NGOs, international aid

agencies, and academia) that systematically divert attention from their sole interests, underscoring the need for transparency across all sectors of society (WIN 2016a). They also concentrate funding into centralized, large-scale projects, creating opportunities for corruption, while reinforcing the business-as-usual approach without considering synergies across different projects that may together contribute to urban water resilience (WIN 2016a, 2016b). The potential role of international NGOs and development partners in ensuring more inclusive governance is being increasingly questioned (Harris and Miraftab 2015). For example, Water For People, a prominent NGO in the water sector, is said to have been influenced by multinational and private organizations, leading it to implement water interventions unfit for the local communities (Mascarenhas 2015).[27]

Other forms of corruption range from the petty bribes affecting women and girls in their daily livelihood struggle to gain access to water and sanitation, including sexual exploitation and harassment, to larger-scale fraud and embezzlement in water projects. These can even extend to policies that allocate resources to specific interests (WIN 2016b). These situations expose poorer segments of communities, especially women and girls, to the slum lords and water mafias for exploitation.

2.3.3 STRATEGIES FORWARD

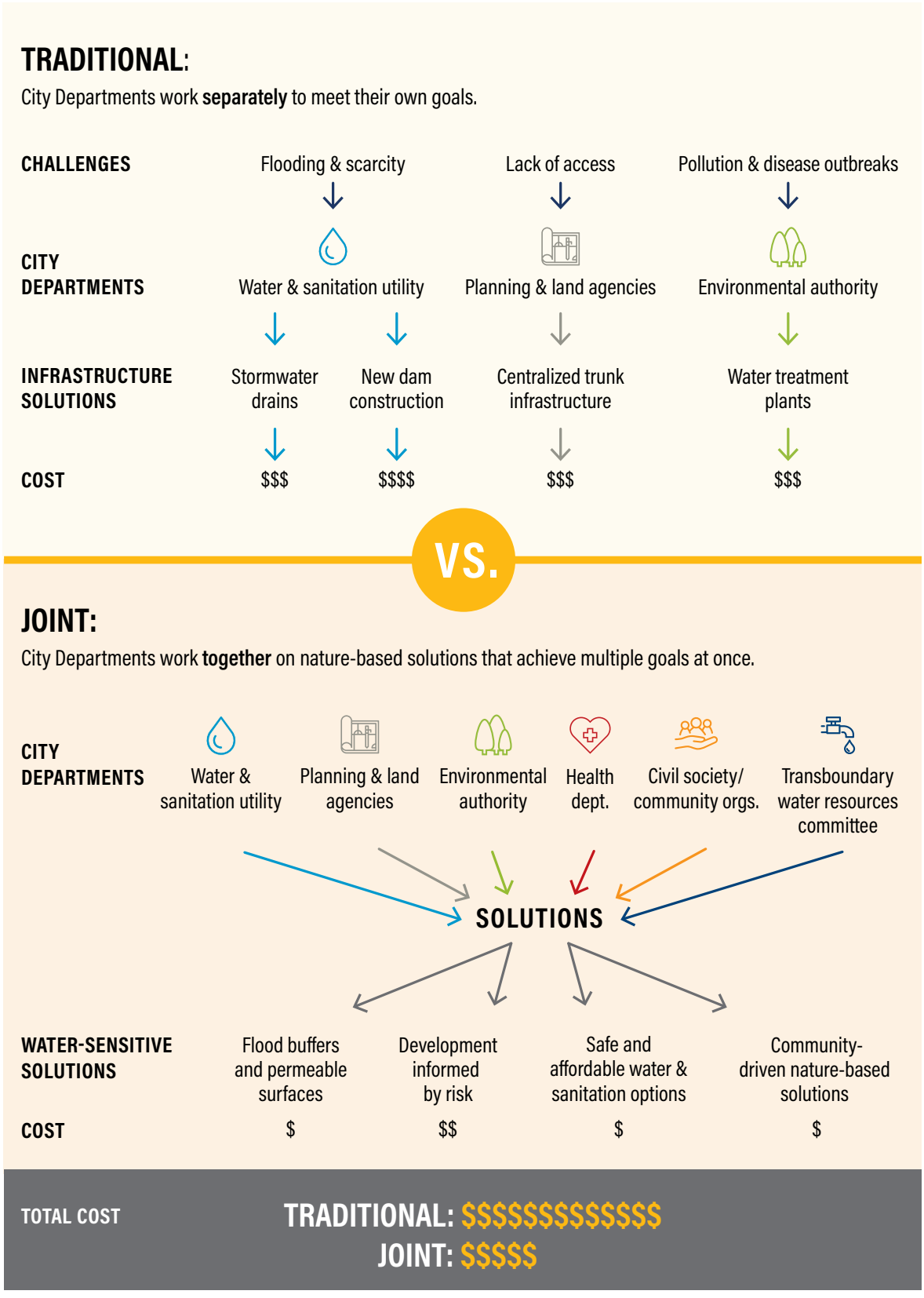
Strategy A: Incentivize collaboration across jurisdictions and agencies for more flexible and adaptive governance

Since different urban actors frame the challenge differently, often with their own agenda, cities must find a way to reconcile divergent interests and align institutional incentives. Multiple agencies at various levels of government, community organizations, and private actors need to be able to coordinate effectively to respond to challenges that transcend jurisdictional boundaries within countries. Focusing on a rights-based approach—one that treats water as a basic human right—could bridge institutions and foster wider consensus for building resilience and equitably allocating water resources (Parnell and Pieterse 2010). Other scholars argue that this can be achieved by governing water as a global commons (Bakker 2007). The bottom line is that previous global initiatives that only promised technical solutions and treated water purely as a commodity proved to be unsustainable. City and water-related stakeholders need to cultivate a shared vision grounded in the local political, social, and environmental context and in lessons learned from previous initiatives (Mumssen et al. 2018; see Box 8 for an example in Durban). This would require a new vision of governance accountability, robust institutional mechanisms to manage potential tensions and conflicts, and flexibility in local government policymaking (Bauknecht et al. 2019; Chu et al. 2019).

Water-resilient cities will need policies and practices that evolve as needed, adjusting to anticipated and unanticipated changes. Water-related and urban stakeholders should strive for "adaptive governance" (Birkmann et al. 2010; Boyd and Juhola 2015). Boyd and Juhola describe adaptive governance as decision-making that brings together formal and informal institutions and systems, all relevant stakeholders, social learning, and continuous feedback cycles to help adapt in the face of uncertainty (Boyd and Juhola 2015). Through the local governance of their own neighborhood associations, peripheral informal, low-income communities in Dar es Salaam significantly improved access to water by mutually organizing, fund-raising, and obtaining technical assistance (Kyessi 2005). Organized efforts such as this are often forgone when informal systems are not included in formal resilience planning (Pahl-Wostl 2019).

Although there may be more up-front time and cost burdens, it is possible for collaborative governance focused on resilient solutions to be more cost-effective in the long run. In practice, this may look like different city departments and community groups jointly deciding on a mix of green and gray solutions for a suite of different challenges, ultimately costing less than if each city department implemented its own solution with little buy-in and coordination (see Figure 18).

Figure 18 | Comparison of traditional and collaborative infrastructure approaches



Source: Authors.

BOX 8 | Cross-Sectoral Collaboration and Stakeholder Engagement Are Key to Durban's Resilience Building

During the early 2010s, Durban set up a multistakeholder, transmunicipal partnership to examine how ecological infrastructure could safeguard water supplies and ward off natural disasters in the uMngeni River catchment area. Aligning adaptation and biodiversity agendas has helped the city's environmental champions to become early adopters of climate adaptation and effective defenders of biodiversity. For example, these efforts helped create the Durban Metropolitan Open Space System, a 94,000-hectare nature reserve to protect biodiversity and ecosystem services.

Another key component was the leadership of the (then) head of the Water and Sanitation Unit. The cross-agency buy-in enabled a shift towards an integrated "socioecological systems approach" to managing water, biodiversity, climate, and poverty challenges. Utility and municipal officials engaged with informal settlements in floodplain areas on how to best meet their water security needs with a focus on ecosystem-based adaptation. An important lesson learned was that building resilience in high-risk areas depends on building relationships between residents, researchers, and the local state.

This lesson fed the formation of Durban's resilience strategy from 2014 to 2017. The process included extensive participatory stakeholder engagement to intentionally coproduce knowledge around resilience. Documented reflections show how—although this process took longer than expected—stakeholders from a wide breadth were able to identify and commit to cross-sectoral resilience priorities with a long-term vision for systemic and transformative change. The city is now in its implementation phase, with a focus on traditional knowledge and collaborative action with informal settlements.

Note: Durban's resilience strategy was formerly part of the 100 Resilient Cities initiative. The city officially ended its involvement in 2017.

Sources: Roberts et al. 2020; Sutherland et al. 2014, 2019

Strategy B: Increase political commitment to shift towards new, innovative institutional practices for water management

A new generation of champions and commitments are needed to shift the status quo of water management towards a more adaptive, resilient, and innovative system. Champions from both formal and informal leadership play an essential role in increasing political commitments towards a water-resilient transition for cities, regions, basins, and countries. Habtemariam et al. (2019) illustrate the different types and roles of emerging champions (see Figure 19). First, executive champions in positions of power and decision-making who are willing to be flexible and experimental towards future risk in all sectors, including water and land, will enable the necessary political will and commitment. They can also provide space for coalition building and knowledge transfers as well as streamline the sectoral programs and priorities of river basin authorities towards water-resilient development. This extends to global leadership, such as the Global Commission on Adaptation's Cities Action Track and the U.S. Agency for International Development's Sustainable Water Partnership.[28]

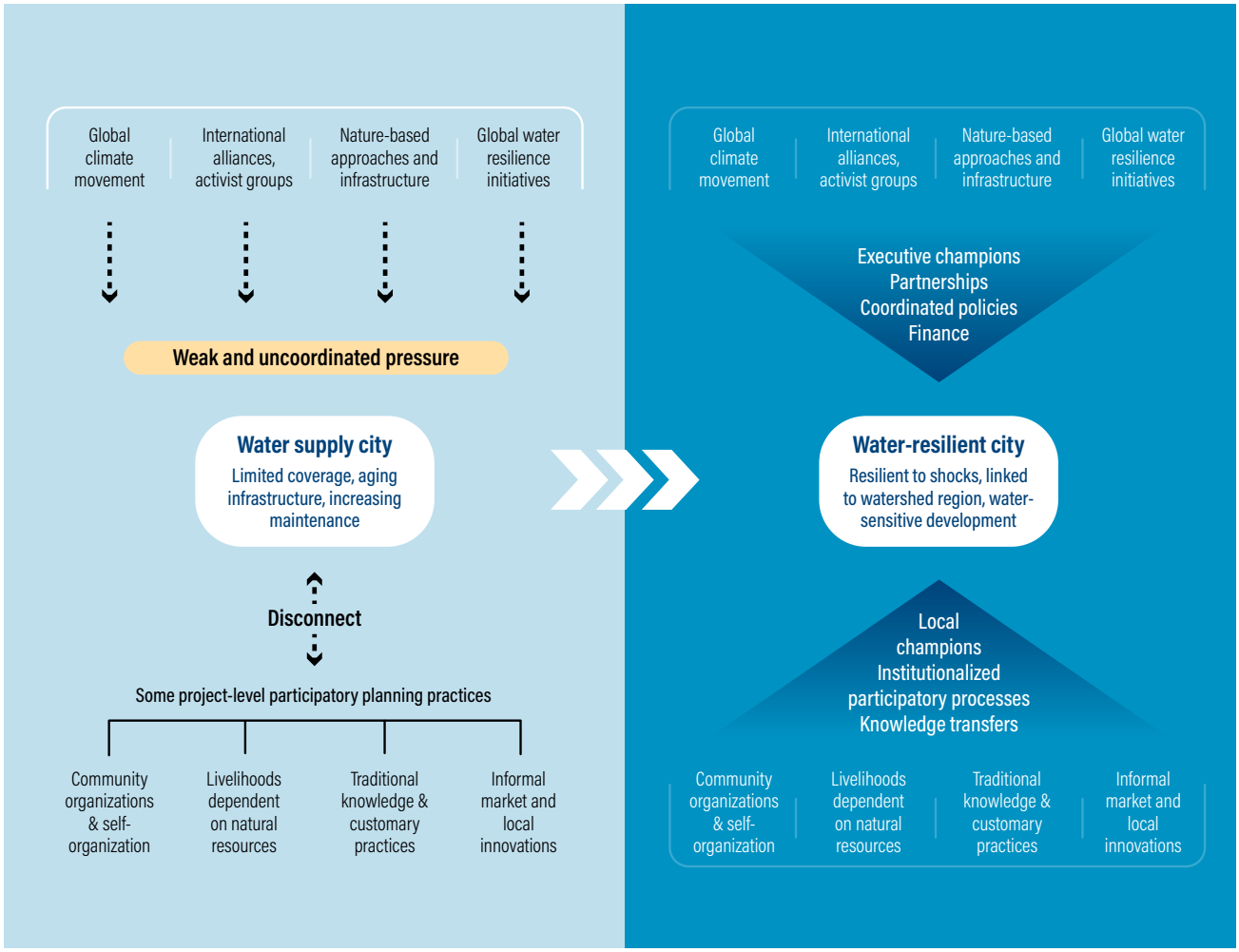
Next, leadership at the local level is essential for systemic change, especially by those who are most impacted. Local leaders can build strong social networks and advocacy at the community level, grounded in the everyday realities of water and nature. In particular, there should be an investment in building capacity and leadership among women, tenants, informal workers, migrants, and other marginalized communities. These leaders must be recognized and supported by other types of champions, such as government leaders. Collaboration on a shared vision across local, regional, and national champions is critical for shifting institutional practices away from conflicting interests and siloed management that results in extractive practices.

Furthermore, national governments need to increase their commitment to the urban development agenda. In African countries, urban development is often detached from national economic development and investment planning, rarely articulated in countries' national development policy and strategy. The United Nations Economic Commission for Africa (UNECA) cites how there is an opportunity to enable green industrialization in cities through national infrastructure. It is important to strategically target infrastructure investments for creating jobs in the green economy, generating resources and revenues for cities and residents while supporting water resilience (Yemeru 2020). A promising announcement in late 2020 from the African Green Stimulus Programme, commissioned by UNECA, the United Nations Environment Programme, and the African Ministerial Conference on the Environment, signals that governments are interested in this direction. The stimulus program was endorsed by all of the continent's ministers of environment (UNEP 2020b, 2021), and it outlines strategies for nature-based solutions, restoration and biodiversity efforts, and ambition for a green COVID-19 recovery (UNEP 2021).

In line with this, the AfDB plans to reframe its infrastructure investments in 2021, establishing a new division on urban development. For the post-COVID era, the AfDB cites forming a different approach from business as usual, shifting to a people-centered approach. There will also be an emphasis on governance rather than favoring large-scale infrastructure (Atchia 2020). Both of these developments would potentially imply a major opportunity for decentralized water projects, new institutional practices, and urban water resilience overall.

There is an urgent need to institutionalize a forum for all water-related actors, from different municipalities, from basin and other regional authorities, and from national agencies, to align water interests towards resilience. This includes considering sectors that are not traditionally thought of as part of the water sector yet impact water flows and the watershed ecosystem, such as road and transport authorities and land agencies. Gauging the political commitment and the plausibility of launching a water-resilient transition process in any specific context helps to avoid futile efforts and unnecessary risks from the start, which could eventually lead to a stalemate. Evidence shows that without political will from the local, regional, and national champions, it remains increasingly difficult to achieve resilience (Habtemariam et al. 2019; Ilunga and Cullis 2020; O'Farrell et al. 2019; Vogel et al. 2019).

Figure 19 | Top-down and bottom-up leadership, political commitments, and partnerships play a key role in enabling a water-resilient transition



Source: Authors, adapted from Brown et al. 2009; Habtemariam 2019; Mguni 2015.

Strategy C: Build institutional capacity that supports leadership, planning, experimentation, and learning

Building capacity is key to enabling an institutional transition towards urban water resilience. In this section, we cover the need to mainstream resilience in existing organizations, agencies, and service providers, as well as the capacity needed to expand institutional culture, norms, and practices.

First, institutions with clear responsibilities of risk management, contingency, and scenario planning need to be created to mainstream water resilience and adaptation across planning and infrastructure delivery. As stated in Strategy A, city decision-makers will need to coordinate across sectors and scales of government for this to work. Decision-making processes should bring together formal and informal institutions, engaging a variety of groups on how to best respond during crises, such as droughts and disease outbreaks.

To do this, city and regional decision-makers need to understand, plan, and break the cycle of risk accumulation due to water-related disasters. For water resources management, more needs to be invested in monitoring and modeling. But more importantly, recommendations from monitoring and modeling need to be integrated into political

processes—what some scholars regard as a key missing link for years preceding Cape Town's Day Zero (Muller 2018).

At the local level, there is an immediate need to invest in local institutions to enhance risk-informed planning capacity and disaster response capacity. Although a number of cities are beginning to institute resilience and contingency planning with the help of development agencies such as the World Bank and the Rockefeller Foundation, there is a significant lack of existing frameworks for a multiagency response to disasters. This reality, in the context of climate change and global disease outbreaks such as the 2020 COVID-19 pandemic, leaves African cities' social and economic structures vulnerable. The objective should be to optimize locally available resources, knowledge, culture, and leadership, empowering communities to take control of their own development agenda in a manner that best fits local conditions (UNFCCC 2018).

Another critical component is the resilience capacity of formal and informal service providers. By better understanding the potential shocks and stresses service providers may face, cities can improve and sustain services provided to all. For example, utilities in Lilongwe, Malawi, and Nairobi, Kenya, collaborated with CBOs and water user associations to oversee and manage service delivery through prepaid water kiosks in some informal settlements (Cooper 2020). Such arrangements allow communities to have a say in how the service is delivered and where facilities are built, improving utilities' capacity to integrate local knowledge, participatory processes, and partnerships. These partnerships have also helped overcome residents' mistrust of the utility. Higher levels of government can also incentivize risk management and contingency planning through supportive policies and financing (further discussed in Section 2.4).

Transitioning to water-sensitive urban development will also require constant innovation, experimentation, iteration, and reflective learning on how to best direct and integrate investments. Cape Town's director of resilience attributes the city's swift COVID-19 response to the processes established for reflective learning after the Day Zero drought and during the development of the city's recent Water Strategy (Resilient Cities Network 2020). The widespread understanding of system-wide shocks enabled quick and effective coordination from a suite of city officials, many of whom had also worked on the drought response.

International alliances, activists, and advocacy groups have important roles in leadership, experimentation, and learning. The existence of different networks and platforms provides opportunities for exchanging experiences and knowledge and building capacity. Examples of these existing initiatives include ICLEI, Future Resilience for African Cities and Lands (FRACTAL), AfriAlliance, United Cities and Local Governments of Africa, the Water Integrity Network, the Global Water Forum, and the Global Water Partnership. Box 9 describes FRACTAL's approach to an inclusive and reflexive learning approach. In addition, learning and technical assistance networks such as Disaster Risk Management Sustainability and Urban Resilience, the UNESCO Institute for Water Education, Cities4Forests, the Climate Resilient Infrastructure Development Facility, and Arup's Design with Water can potentially provide opportunities for building capacity in innovative, new-generation, nature-based technologies and infrastructure.

Equally important to technical assistance, and often neglected, is the necessity of building tacit knowledge and strategic thinking. Tacit knowledge, such as regarding contract negotiations with private companies, investors, and lawyers, is critical for public sector entities that have low capacity, particularly as more private capital enters water and sanitation industries (Carolini and Cruxên 2020). This goes beyond training opportunities that only focus on building technical capacity and may include building more strategic leadership for subnational decision-makers, especially in smaller municipalities with fewer resources (Carolini and Cruxên 2020).

Strategy D: Build new partnerships, platforms, and coalitions across levels to strengthen regional water governance, political alignment, and inclusive representation

For cities to take the lead, partnerships across levels of government and pan-African coalitions will need to identify, support, and enable new integrated solutions and access to resources. New and

BOX 9 | Coproducing Knowledge on Climate Risks with an Inclusive, Reflexive Learning Approach

Through a transdisciplinary learning approach, the Future Resilience for African Cities and Lands (FRACTAL) project has been contributing to an improved understanding of urban risks and potential responses in southern African cities by engaging scientists, engineers, government representatives, and community stakeholders to coproduce relevant knowledge to support more resilient development pathways. For many African regions, existing climate models give contradictory scenarios for trends over the next 5–40 years. This can present difficulties when applying climate science to cities, many of which are already experiencing both more arid conditions and more extreme rainfall.

Key to their learning strategy is an emphasis on methods that support reflexive, inclusive, and participatory processes. The multiyear project has been hosting transdisciplinary "learning labs" across several cities in southern Africa, using role-play, city-to-city exchanges, visioning processes, social events, and dialogues. Learning labs are carefully facilitated events designed to bring broad stakeholders together to engage in complex issues, nonclimate and climate drivers of risks, and everyday experiences. The goal has been to prevent looking singularly at entry points for climate and instead understanding how climate information can be embedded in a wider range of governance, decision, and planning processes. Documented reflections also note that the resulting relationships, trust, and comradeship from the learning labs have helped advance a collaborative approach for most of the cities.

Sources: Arrighi et al. 2016; McClure 2020.

different partnerships are sorely needed to depart from the siloed approach of water management. At the local-city level, they could push the city government to be more inclusive of community needs—especially the under-served—and also build trust and begin to address deep-rooted differences. This should be inclusive of informal vendors, producers, and workers, who compose upwards of 80 percent of an African city's workforce (Chen and Beard 2018). City-to-city and city-region partnerships can jointly raise what is needed from the national government, international organizations, and the private sector. Coalitions backed by local universities, research organizations, and relevant businesses can all contribute to how to integrate knowledge and financial resources to best prioritize investments. For example, the Global Water Partnership and the Water Integrity Network have been effective platforms for increasing political commitments and building coalitions for sustainable water management.[29]

Numerous partnerships have underpinned efforts for water source protection. For example, in Lusaka, the city government realized that it could not address the degradation of the city's water source and its major polluters alone. In 2014, a multistakeholder group supported by the Deutsche Gesellschaft für Internationale Zusammenarbeit, including Zambian Breweries, the water resources authority, and civil society organizations, convened to establish a partnership and mobilized resources to protect Itawa Springs in Ndola (LuWSi 2020). This formally became the Lusaka Water Security Initiative in 2016. A cholera outbreak in 2018—linked to poor sanitation and heavy flooding—led to over 5,000 infections; almost 100 deaths; and closed schools, markets, and social gatherings for weeks. With existing partnerships in place, the Lusaka Water Security Initiative and the FRACTAL team in Lusaka were able to work together to coproduce policy suggestions on water security challenges for ministerial representatives (Daniels 2019). Another example is the uMngeni Ecological Infrastructure Partnership (see Box 8). Since 2013, it has strengthened regional watershed governance, involving collaboration among the public and private sectors, including the eThekwini Municipality, the South African National Biodiversity Institute, and the regional office of

the Department of Water and Sanitation (SANBI 2016; Roberts et al. 2012). In Kenya, partnerships between the Kenya Water Towers Agency, Kenya Forest Service, and TNC were critical in establishing and scaling the Upper Tana Water Fund, devoted to increasing water source protection in the Upper Tana watershed (TNC 2015).

Platforms and coalitions can be useful to facilitate peer-to-peer learning and incentivize accountability. The Global Water Operators' Partnerships Alliance establishes mentorships between urban water and sanitation providers to enhance performance, extend services, and introduce new functions such as pro-poor units (GWOPA n.d.). In Harar, Ethiopia, an operator cited that this partnership helped build technical abilities for the utility during a severe water shortage.[30] Part of the United Nations Global Compact, the industry-driven Water Resilience Coalition brought together more than 20 chief executive officers from mostly large, multinational companies to make the needed investments in their operations for water resilience.[31] This global initiative is one way to galvanize action from corporations in Africa, which are also some of the largest water consumers in some regions.

Partnerships are an important yet underdeveloped mechanism for improving alignment between local and national levels for water resilience. Domestic partnerships between national and local authorities are well placed to manage capital investments for water resilience, devolve authority, and support local actors in advancing strategic projects. They need to extend beyond existing, donor-backed basin authorities and have strong government ownership behind them. A promising approach is the new partnership between South Africa's National Department for Cooperative Governance and the Coalition for Urban Transitions to achieve a more green and equitable recovery after COVID-19 by stepping up national investments in cities (WRI 2020b).

Lastly, city decision-makers should create platforms for constructive political dialogue and negotiation on how to establish the right governance mechanisms for building urban water resilience. If designed equitably, they can be key to sustaining progress in the face of short-term political cycles and corruption. Corruption relates to politics, historical accounts, inequalities, social movements, and the rights and access of individuals, groups, and communities to land and water resources. This requires a political solution, political dialogue, negotiation, cultural mediation, and arbitration. More inclusive governance is needed to address deep-rooted differences and grievances.

The leapfrogging potential of sub-Saharan cities can only be possible if the process starts with research grounded in realities of the system and opens up a critical debate on how to make a just and water-resilient city, which entails bringing new models, financing systems, organizations, and working relations across all key actors involved. However, it is important to note that this depends

on the political will at different levels and social conditions (e.g., attitudes, social relations, and capacities). Therefore, it is important to focus key political players' attention on how to prepare and self-organize vis-à-vis the inevitable calamities of climate change and water stress.

Ultimately, the extent to which a city-region can reconcile the politicization of water and corruption will depend on the local political economy, the presence of broad-based coalitions and local partnerships, and the integration of grassroots groups.

2.4 Get Finance Right: Increase and Align Water-Resilient Investments across Sectors

2.4.1 THE PROBLEM

Finance is a major constraint for cities, water resources authorities, and water and sanitation agencies when seeking to increase equitable access to safe and resilient water systems. These constraints stem from varying sources, one of which is the lack of dedicated budgets for cities at national and regional levels. There is a dire need for large, up-front investments that are predictable and sustained, and current spending is well below the level required. For example, according to a 2015 report by United Nations Water and the World Health Organization (WHO), only a small percentage of sub-Saharan countries had targeted finance for reducing inequalities in water (less than 30 percent) and sanitation (15 percent; WIN 2016b, 44). Another study assessed that at least 2.5 percent of GDP should be spent on water and sanitation to meet basic needs in Sub-Saharan Africa, yet only 0.3 percent of GDP is spent (World Water Council and OECD 2015). In 2019, the AfDB found that the continent needs to spend at least $130 billion to address an infrastructure backlog, including as much as $66 billion to provide universal access to water and sanitation, but it faces a financing gap of $68–$108 billion (AfDB 2018).

Many African cities experience fragmented fiscal authority as well as hybrid service delivery and infrastructure systems (Cirolia 2020; Pieterse 2019). Cities are serviced through diverse actors in various public, private, and informal arrangements, often in addition to a centralized system controlled by city governments. Required financial investments are not only in capital but also in operational systems that support, integrate, and coordinate across formal, informal, and other local systems (Cirolia 2020).

Climate finance is another sorely needed source, but not enough is going towards adaptation, let alone water-related adaptation (Alcayna 2020). An analysis by the OECD in 2018 found that adaptation finance fell short, compared to funding for cutting emissions, making up 21 percent of all climate finance (OECD 2020). A recent Overseas Development Institute (ODI) and WaterAid report showed that as droughts and floods hit hard, globally under 1 percent of climate investment goes to protecting water services for poor communities (Mason et al. 2020). Some of the most vulnerable countries, many in Africa, get only one dollar per person per year for water services (Mason et al. 2020).

Although the need for investment is high, the costs of inaction are higher. WHO reports that providing clean drinking water globally to all city dwellers would cost $141 billion over five years, but total global economic losses annually from unsafe water and sanitation systems are 10 times that high (Hutton 2012). The United Nations and WHO also estimate that every dollar invested in safe water and sanitation access could result in economic benefits ranging from $5 to $60 (UN DESA 2014). Yet short-term political considerations, government-borrowing constraints, and a history of poorly coordinated development investments impede infrastructure improvements that could unlock these huge societal, environmental, and health gains.

Another issue is the inability—and sometimes unrealistic assumption—for public water agencies to meet revenue projections at the local level due to low tariffs and/or nonrevenue water (Interviews 1, 5, and 12; Mitlin et al. 2019). These factors usually lead to a dependence on transfers, such as foreign aid and contingency-based loans from development partners, which force utilities and countries into debt and even potential restructuring of their mandates, priorities, and strategies. Moreover, water and wastewater projects tend to be the smallest portion (in terms of dollars) of public-

private partnership markets and project finance, compared with other infrastructure categories (e.g., transportation, energy). Potential financiers may perceive water governance as weak with a poor enabling environment for private participation (WIN and Transparency International 2010).

Some also point to the lack of "bankable" projects in the water sector to attract large-scale funding (World Water Council and OECD 2015).[32] The underlying assumption of this traditional approach is that water infrastructure must aim to be bankable, an assumption that is increasingly at odds with building resilience. Investments in water-resilient infrastructure tend to bring a major societal return that is often intangible and hard to measure rather than a financial return that can easily lend itself to "bankability" (World Water Council and OECD 2015). As such, central governments and public development banks have been most prominent in financing recent and ongoing water infrastructure projects (World Water Council and OECD 2015). Challenges still exist among public financing, as it is mostly tailored to siloed sectoral needs and may not account for the long-term benefits of resilience. Better public expenditure management, holistic selection of projects, and clear strategic guidance for investments are all key aspects and are as important as meeting the financing gap (Foster and Briceño-Garmendia 2010).

With climate uncertainty and urgency increasing, there is a new normal to which existing financing mechanisms, models, and flows must adapt, but several barriers make this a challenge.

2.4.2 THE BARRIERS

Lack of government financing at the local level

The dependence on external funding can present conflicting agendas, inefficiencies, and trade-offs that prevent equitable water-sensitive investments in cities. Service delivery across Africa is typically financed through four channels: a government's own-sourced finance, loans, public-private partnerships, and—in some regions—land value capture (Paulais 2012). Yet municipal governments most heavily depend on intergovernmental transfers and concessional loans channeled through central governments or financial intermediaries (e.g., development authorities), from multilateral financial organizations (e.g., the AfDB and the World Bank), or bilateral donors (Fjeldstad and Heggstad 2012). This is especially true for water utilities, most of which can barely cover operations and maintenance costs. To govern water as a public good, utilities need additional public investments to repair the aging infrastructure and improve access for currently unserviced communities (Interviews 5, 8, and 12). In this section, we highlight a few challenges when the city utility relies on external donor finance.

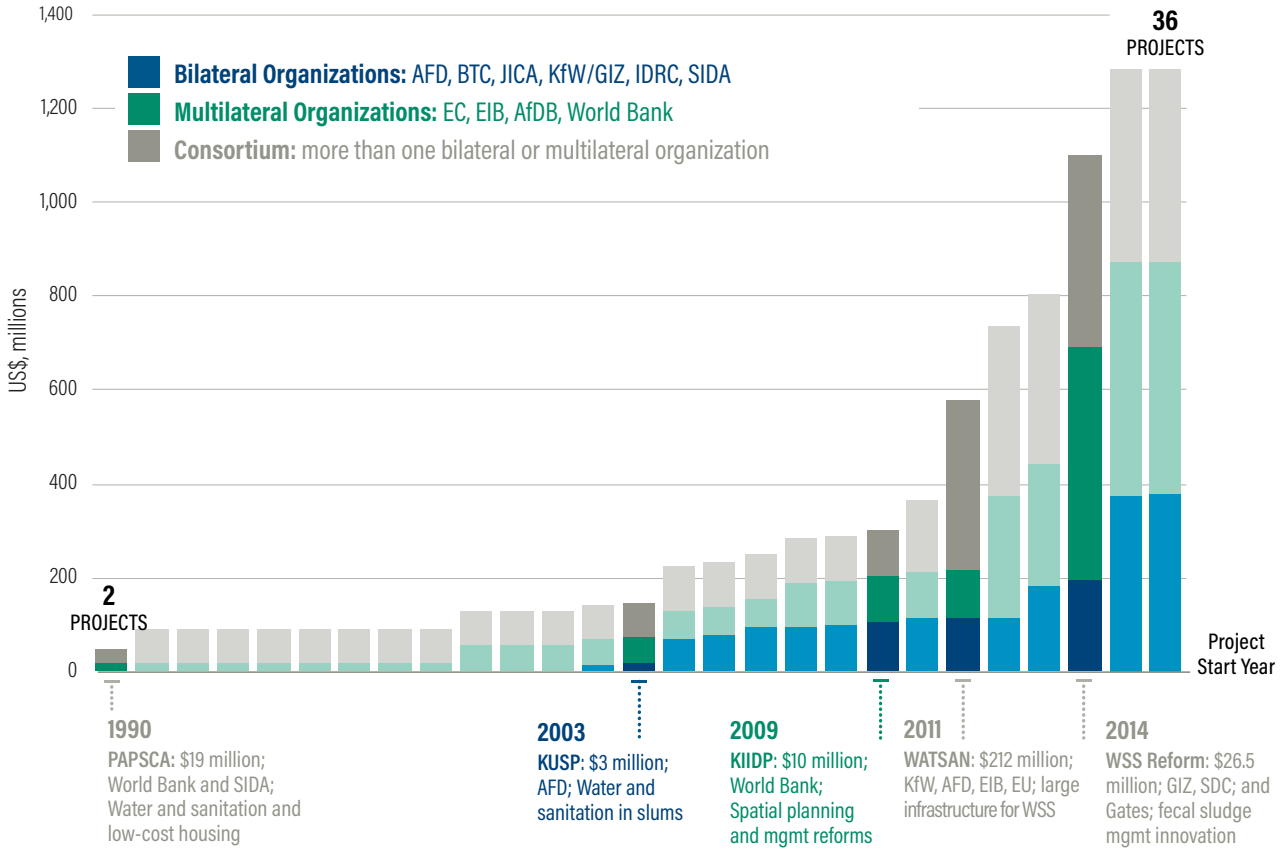
In Kenya, the NCWSC is the main utility tasked with meeting the city's SDG goal of achieving universal access to water and sanitation (Interview 5). The NCWSC's financial constraints limit the utility's ability to expand coverage to informal settlements. It has only been able to meet 50 percent of its pro-poor targets over the past 10 years. Due to a lack of funding from the county government to fill the budget deficit for capital expenditure, the NCWSC has relied on funding programs from development banks and international aid agencies. This puts the utility in a precarious position, subjecting it to mismatched planning cycles between the government and donors as well as abrupt political changes. A key informant from the Water Resources Authority (WRA) also notes as challenges the scant funding from the central government and donor coordination in the water sector. Without enough public finance from the central government, the WRA and other related agencies rely on donor funding (Interview 6). At times, the WRA and National Environment Management Authority (NEMA) are competing for the same donor resources. Both are underfunded, and the lack of funds means that the WRA is unable to effectively monitor flooding events and NEMA cannot enforce protection for wetlands (Interviews 3 and 6).

Similarly, in Kampala, which has made some strides in improving sanitation access through decentralized and nonfixed infrastructure investments, limited revenues force the utility to seek out finance from external funders (Interview 12; Lwasa and Owens 2018). In fact,

Kampala received more than a billion dollars across 36 projects between 1986 and 2016 (Lwasa and Owens 2018; see Figure 20). This dependence on donor finance risks inefficiencies and trade-offs as priorities were set by the donor, instead of comprehensively by the city, resulting in limited follow-up or effort to build on previous investments. This exacerbated inequities in water service provision in Kampala, creating pockets of serviced areas while larger parts of the city remain underserviced or not serviced at all (Lwasa and Owens 2018).

Constraints for utilities, water/environmental monitoring agencies, and water resources authorities are further compounded by institutional fragmentation of the water sector. There is a lack of reliable and comprehensive information about funding and expenditure, and financial integrity is lacking, which complicates monitoring and evaluation. There is a general lack of financial transparency, which can create loopholes for corruption. Disaggregated data on financial expenditures in water service provision does not exist, which creates challenges for improving budget allocation and oversight.

Figure 20 | Cumulative donor commitments across sectors in Kampala, 1990–2016



Notes: AFD = Agence Française de Développement; AfDB = African Development Bank; BMGF = Bill & Melinda Gates Foundation; BTC = Belgian Development Agency; EC = European Commission; EIB = European Investment Bank; IDRC = International Development Research Centre; JICA = Japan International Cooperation Agency; KfW/GIZ = Kreditanstalt für Wiederaufbau/Deutsche Gesellschaft für Internationale Zusammenarbeit; KIIDP = Kampala Institutional and Infrastructure Development Projects; KUSP = Kenya Urban Support Program; PAPSCA = Program for Alleviation of Poverty and the Social Costs of Adjustment; SDC = Swiss Development Corporation; SIDA = Swedish International Development Cooperation Agency; WSS = water supply and sanitation.

Source: Lwasa and Owens 2018, based on various sources from the World Bank, African Development Bank, European Investment Bank, European Commission, International Finance Corporation, and Water and Sanitation Program, 1990–2016.

Aging infrastructure, poor maintenance, and nonrevenue water

The lack of reliable government financing, cost recovery models, limited capacity, and disjointed networks, sometimes adopted from colonial powers, have resulted in decades of poorly maintained infrastructure. Many utilities struggle to fund their operations and maintenance through the revenue they generate from collecting tariffs, commonly due to high rates of nonrevenue water stemming from leakages and water theft.

In 2020, Nairobi's utility was not spending enough on maintenance. Yet even with collecting about 90 percent of its projected revenues, tariffs alone would barely cover its necessary operations and maintenance costs (Interview 5). This stems from the city's 40 percent nonrevenue water rates, which is partially linked to aging and fragile infrastructure (WIN 2016b, 25). Consequently, the city's water pipes break easily and frequently, requiring constant maintenance and investment in new infrastructure (Interview 5). Thus, in addition to the revenue lost, the cost of maintaining or replacing damaged infrastructure creates a heavy financial burden on the NCWSC. Water theft is also a big problem for the NCWSC, diverting both revenue and potential customers away from the utility (WIN 2016b, 25). Similarly, in South Africa, the eThekwini Municipality in KwaZulu-Natal lost more than a third of its water in one year because of illegal connections and vandalism, at a cost of $44 million (WIN 2016b, 25). In Kampala, water theft and vandalism are causing leakages and water shortages (Interview 5). In Naivasha, Kenya, the theft of steel pipes for building private water vendor carts has disrupted the water supply and has also created replacement costs for the local utility (Muller 2016).

Financial models unfit for resilience

Few financing mechanisms between city agencies and across regional and national governments exist to incentivize coordination and flexibility, especially in response to risk and uncertainty. In some cases, current financing models directly contradict the principles of water and urban resilience.

For instance, Simpson et al. (2019) use Cape Town's Day Zero experience to document how the current model for municipal finance is inflexible, uncoordinated, and constrained when shocks occur, often creating a "shock within a shock" or a "risk cascade." This refers to when a shock, such as a drought, is compounded by the shock of revenue decline brought about by off-grid or alternative water sourcing. With aggressive water-saving measures, Cape Town residents dramatically reduced their water consumption by 50 percent during the three-year drought. Much of the decrease was due to changes in behavior by high-level water consumers, such as higher-income households and businesses. These entities invested in alternative water sources to municipal supply, storage facilities, rainwater harvesting, boreholes, and gray water systems. In the short term, this affects a key source of revenue; in the long term, it questions the viability of cross-subsidization models, which help subsidize free access to water and electricity for low-income households (Simpson et al. 2019).

Water pricing has historically been centered on cost recovery and tariffs, with mandates towards a single utility to provide water and sanitation access to all

city residents. This makes it difficult to adapt to the realities of African cities, where people meet their water needs in a multitude of ways. The challenges mentioned throughout this report highlight that utilities alone cannot implement a water-resilient transition with equitable and resilient service delivery. Simpson et al. (2019) highlight how municipal water service is funded, managed, and delivered in business-as-usual conditions and needs to be reviewed in light of increasing risk and resource constraints. Ultimately, maintaining the fiscal strength of utilities and water-related authorities cannot be at odds with resilience objectives, such as diversifying water supply and drought management. Depending on the context, regulators may play an important role in ensuring this balance.

Funding for water resources management and environmental protection in African countries is often insufficient, with few structural incentives available to account for risk and uncertainties. For instance, Kenya's WRA is supposed to be supported by the national government, but recent debates over whether the agency should collect revenues to self-sustain have stalled this support. Evidence shows that the revenue model would not work, yet this funding channel remains a challenge (Interview 6). The agency has so far relied on funding from the World Bank and other international sources to meet funding gaps.

Bias towards rigid and exclusionary projects

As Africa's cities become major contenders in the global economy, interventions in the water sector have been largely biased towards large-scale and centralized projects, with rigid and exclusionary procedures (WIN 2016b, 95). These interventions, long fueled by historic forces ranging from national economic development plans to global development doctrines (see Section 1.3), lack an understanding of the urban political economy. Powerful financiers often create "solutions" and knowledge that meet the needs of the politically and economically well connected but miss the daily needs and realities of the most socially vulnerable groups (Lawhon et al. 2014; Zimmer 2015).

For example, in Addis Ababa, the World Bank supported the Addis Ababa Water and Sewerage Authority (AAWSA) on a large investment to build a sewer network intended to benefit 76 percent of the city's residents (AAWSA 2015). This project was driven by AAWSA's ambitious plan to become one of the top five water utilities in Africa, pushed by Ethiopia's Growth and Transformation Plan, which aims to use infrastructure in urban areas to fuel economic growth (Gelaye 2018). However, the project did not achieve its target due to rigid and exclusive procedures from the utility provider and low willingness to pay for sewer connection. Although AAWSA subsidized connection fees for households, it only allowed those with documentation of household water use (such as a water bill to identify those who own flush toilets) and proof of tenure to connect. This excludes almost half of the city that relies on pit latrines and lacks tenure status, mostly low-income residents who would have benefited the most (Gelaye 2018). Over the past five years, this $224.6 million project has only managed to increase access to the sewer grid from 10 percent to 20 percent of the population (AAWSA 2015; Damania et al. 2017; Interview 7). Even households that could qualify were unwilling to pay the connection cost because cheaper, unsafe alternatives were accessible, such as illegally connecting to storm drains or continuing to use leaky septic tanks. The cost of these alternatives, enabled by limited enforcement of environmental laws, comes at the expense of the entire city's public health and surrounding environment.

The bias towards "rational" technocentric planning approaches continues to be exclusionary in practice, particularly in sub-Saharan cities seeking new global branding as "smart cities" or "world-class cities" (Allen 2014; Fernández 2014). These objectives are often detached from context, producing, among others, extreme gender inequalities in access to water resources and consumption. For instance, despite their major role in water management at community and household levels, women generally have limited power and are less consulted in water projects (Allen 2014; Fernández 2014). Above all, water laws in many African countries are still influenced by colonial policies (e.g., Ghana, Kenya, South Africa, Tanzania, and Uganda), which disregard traditional practices, particularly in peri-urban areas and informal areas in the city, as viable "solutions" (such as household rainwater harvesting, on-site sanitation; Grasham et al. 2019; WIN 2016a). These inequities also extend to those affected by development-induced displacement in the name of

producing "world-class city" infrastructure, pushing residents from centrally located areas to largely unserviced peripheries, disconnected from jobs and opportunity.

What are included and valued as benefits in conventional financial analyses often lead to inequitable and shortsighted investments. The economics of adaptation are not always straightforward, and some benefits—such as preventing death, promoting livelihoods and social welfare, and avoiding disease outbreaks—provide immense benefits but are hardest to measure and often not included. For instance, a city may only consider physical assets and decide to invest in building a high-cost seawall around economically valuable property. This logic would fail to protect coastal communities if they were informal settlements or low-income areas.

Including the true cost of damage over the long term would also reveal that actions implemented now that protect livelihoods, ecosystems, and economies holistically will pay for themselves. For example, an Intergovernmental Panel on Climate Change Cities Report predicted that global damage from sea level rise, storm surges, and flooding linked to climate change could cost cities $1 trillion each year by midcentury, but financing global adaptation would be one-tenth as expensive as taking no action and dealing with the consequences (Rosenzweig et al. 2018).

As previously mentioned, coordination between national and local governments, especially with regard to infrastructure investment, is key. In Addis Ababa, which was the main focus of the federally backed Integrated Housing Development Programme, which involved the massive construction of condominium buildings over the past decade and a half, has brought on an unanticipated challenge in wastewater management (Interview 7). The Housing Development Bureau and the national government backed the use of microfiltration bioreactor technology as a potential solution for creating temporary decentralized systems while the city's sewers were being built. However, AAWSA was not consulted in this process, and this technology, funded by the World Bank and constructed by a foreign company, has currently resulted in operational challenges (Interview 7). Thus, the city's utility is now funneling a portion of its limited finances into maintaining this technology instead of expanding the sewer network, increasing the financial burden it already carries.

2.4.3 STRATEGIES FORWARD

Strategy A: Increase government funding and develop financing mechanisms to improve local and basin-level water resilience

Cities need access to sufficient financing that comes without shortsighted and overly restrictive contingencies. Water and sanitation utilities, which typically have a constitutional mandate and responsibility to provide services, need to be able to direct funds to long-standing needs, such as leaks, aging infrastructure, and maintenance. To do this, utilities, and cities as a whole, need to improve their revenue streams. One method is to create a stronger link between local taxation and infrastructure development. Experiments in property tax collection through infrastructure-related billing may provide a source of finance for cities to reinvest into basic service provision (Carolini et al. 2020; Mahendra et al. 2020). By capturing value from the city's construction boom and its access to existing services, higher-income areas can form a tax base to finance capital investments across the city, especially in under-served areas (Carolini et al. 2020). However, this may require reform in urban planning practices that better coordinate and regulate land development approvals and fees with service utilities/authorities.

Other options for cities are municipal grants and bonds. The feasibility of municipal grants and bonds vary greatly across cities in Africa and often depend on the regulatory and legal environments of national governments (Gorelick 2018a). An effective example of this is the Municipal Infrastructure Grant program in South Africa,[33] which was launched to meet the MDGs by providing grant finance to municipalities. It includes aims to subsidize the capital cost for basic water and sanitation services for lower-income communities. Such programs can also provide targeted financial incentives, such as gender budgeting in the water-related sectors and training and technical support for community and women's groups (WIN 2016b). These should build on existing knowledge and operational systems, and they can integrate sustainable financial support for localized

innovations, such as rainwater harvesting, water storage, and informal systems (Cirolia 2020; Goodfellow 2020).

At the national and regional level, governments need to ensure and encourage financing for urban climate adaptation because many cities depend heavily on national transfers and policies. For instance, cities in Kenya depend on the Water Sector Trust Fund for financing, and the national government is their largest funding source, essential to their strategic plan. Other funding comes from international sources such as the World Bank, Danida, the Bill & Melinda Gates Foundation, and EU development banks, but these are often tied to specific programs (Interview 1). Cities and water agencies depend on pooling resources from public finance, including intergovernmental transfers, multilateral support, and private investments. This will require a better understanding, long-term collaboration, and a shared vision of water resilience among upstream decision-makers, including donor agencies and ministries of finance (Chu et al. 2019). Box 10 highlights the Devolved Climate Finance Alliance, which is creating mechanisms to disburse climate finance to local levels, prioritizing the most vulnerable communities.

Often left out of conventional financing approaches is support for service providers. As mentioned previously, small-scale, informal, or alternative water and sanitation providers play a critical role in urban Africa. Yet to date, little effort has gone into developing viable financial models or mechanisms that support this mix of service delivery (Cirolia 2020). City or subnational authorities must view these service providers as complementary to the municipal network and then invest in integrating, regulating, coordinating, digitizing, and incrementally extending informal and small-scale services (Cirolia 2020; Satterthwaite et al. 2019). Supportive financing mechanisms and models fit for specific local contexts can help expand access to services, ensure affordability, and improve the organizational performance and financial sustainability of small-scale service providers and, most importantly, their resilience to shocks and stresses.

BOX 10 | Channeling Finance to Locally Led Climate Adaptation

The Devolved Climate Finance Alliance—an alliance of government and nongovernmental organizations in Kenya, Mali, Senegal, and Tanzania—recognizes that channeling climate finance to subnational governments and communities is a challenge.[a] Several avenues exist to channel international funds for climate change adaptation, but once in country, money may not flow further to subnational governments and communities that need it most.

In 2013, the Kenya National Drought Management Authority piloted a devolved climate finance and planning mechanism in five counties: Garissa, Isiolo, Kitui, Makueni, and Wajir. This allowed subnational authorities and communities to tap resources they needed to successfully build resilience, especially against severe droughts. In 2016, the mechanism was institutionalized as the County Climate Change Funds in two counties, Makueni and Wajir. The National Drought Management Authority of Kenya is now scaling out the County Climate Change Funds mechanism to additional counties as part of the national climate agenda. Similar initiatives are under way to embed the mechanism into the public finance system in Mali, Senegal, and Tanzania.

In 2021, the Global Commission on Adaptation, the World Resources Institute, and the International Institute for Environment and Development released the "Principles for Locally Led Adaptation," endorsed by over 40 organizations.[b] The principles are intended to guide the adaptation community as it moves programs, funding, and practices towards adaptation that is increasingly owned by local partners. The principles include devolving decision-making to the lowest appropriate levels; investing in local capabilities; ensuring transparency, accountability, and flexibility in programming; and addressing structural inequalities. These principles will play an important role in influencing how well-resourced organizations change current practices to channel finance to locally led adaptation.

Sources: a. IIED 2017; b. WRI and GCA 2021.

Strategy B: Increase investments to leapfrog towards equitable, water-sensitive design by partnering with national, international, and private funders

City and water-related decision-makers should cultivate a shared vision in water-resilient design among all partners and actors, especially the largest water consumers or wastewater producers. A shared vision can empower city decision-makers to prevent unnecessary overlap and trade-offs in investments. These stakeholders can represent different industries, including both informal and formal businesses, multinational companies, universities, and real estate and construction firms. Organizing private companies around corporate water stewardship programs can be one way to leverage investments to improve urban water security.[34] African universities can play an intermediary role in the production of knowledge, innovation, and capacity building.

Establishing a water fund is an example of a governance and financing mechanism that brings stakeholders together around water-sensitive investments. In 2015, TNC, the Kenya Water Towers Agency, and the Kenya Forest Service worked with key industries and thousands of smallholder farmers to establish a fund for water source protection in Nairobi's Upper Tana watershed (TNC 2015). The underlying principle is to bring downstream water users such as businesses or cities together to invest in upstream water conservation efforts, resulting in less downstream damage later on. Upstream, TNC worked with farmers to implement soil retention and water conservation practices to reduce the amount of sedimentation clogging water treatment filtration systems. TNC reports that over 27 million more liters of water supply are available daily from these efforts (Brown 2019). Cape Town, in partnership with TNC, also established a water fund

for watershed restoration activities, such as the removal of a water-intensive, invasive tree species (Brown 2019). A similar effort for a water fund is also under way for Freetown's watershed, involving the ministry of water resources, private sector companies, public utilities, and TNC (WRI 2020a). It is important to note, however, that these water funds do not have any regulatory power, and the efficacy of their programs depends on the buy-in of key city and water agencies.

For the creation of Cape Town's recent Water Strategy, it was a priority to cultivate buy-in and align political will across levels of government, development partners, and the private sector (City of Cape Town 2020). The aim was to foster cross-sectoral and integrated investments as well as new financial incentives required for a water-resilient transition. Notably, the strategy proposes the idea of a "rainless day" fund, where the city sets aside reserves to manage the financial burden of a drought, instead of the city's controversial move of raising tariffs on city residents during Day Zero to meet budget deficits (City of Cape Town 2020). A shared vision, backed by a coalition of actors, can result in more creative and inclusive funding solutions like this. Maintaining buy-in and trust across groups, including local communities, will remain crucial for ensuring an inclusive approach (Enqvist and Ziervogel 2019).

It should be noted that cultivating buy-in may be particularly difficult for cities in countries with political instability. Building consensus must be understood within the existing political economy and political relations between regions and different-sized cities. This came up as an early takeaway in the WRI Urban Water Resilience Initiative's on-the-ground assessment in Addis Ababa (see Box 11).

Another strategy is to tap into the green bond and blended finance market while driving climate finance to water infrastructure projects. In 2017 the City of Cape Town issued a green bond, the first in the country to be accredited by the Climate Bonds Initiative, a global third-party green bond certifier (Mokone 2017). The proceeds aim to fund and refinance green projects designed to safeguard against droughts, such as improving the city's emergency water supply, diversifying its water sources, and investing in water-saving procedures. Though still a nascent market in Africa, a 2016 AfDB assessment indicated that the annual financing mobilized through green bond issuance in four years (2010–14) has exceeded the annual financing mobilized by climate funds over the last 12 years, showing its potential to address financing gaps in building climate resilience and green projects (Duru and Nyong 2016).

At the same time, scholars have cautioned against overplaying the promise of green bonds and blended finance in the African context. Green bonds, in general, need to be critiqued by whether their financial risks are disproportionately placed on the urban poor (Bigger and Millington 2020). For many African countries where governance is centralized, a municipality's ability to borrow and negotiate specific contracts may be limited to the condition set by national frameworks (Gorelick 2018b). This could pose a disproportionate risk to cities. To counter this, Bigger and Millington (2020) argue that the financial debts acquired for building resilient infrastructure should fall more under national-level responsibility to distribute risk more progressively.

Blended finance also needs to be seen as complementary to public finance, grant-based aid, and official development assistance (Convergence Finance 2018). It can play a critical role in stretching scarce resources for development or private sector interventions with a proven track record, but it is limited in its ability to reach the poorest and most vulnerable. A 2019 ODI report found that expectations for blended finance to bridge SDG financing gaps are unrealistic (Attridge and Engen 2019). Recognizing its role in accelerating climate finance, however, ODI recently established the Water and Climate Finance Initiative to increase private investments and blended finance for climate-resilient water and sanitation projects (Mason et al. 2020). Efforts to increase awareness and technical capacity in the water sector to utilize such instruments should complement such efforts and can be supported by bilateral donors and regional financial institutions. This area of finance is growing and ripe for further research.

BOX 11 | Early Reflections from Building Urban Water Resilience in Addis Ababa

Part of the Urban Water Resilience Initiative of the World Resources Institute (WRI) is to partner with a cohort of six cities and their regional and national governments to provide support for advancing city water resilience agendas. The first partnership began with the city of Addis Ababa in the summer of 2020. Earlier that year, Addis Ababa had just released its first City Resilience Strategy. The project team, made up of WRI and its partners,[a] began its on-the-ground assessment for water resilience specifically, with aims to facilitate a structured multistakeholder planning process to identify priority actions, provide technical assistance, and facilitate knowledge exchange and capacity building with the cohort of city partners.

Despite the city's recent track record on resilience, the project team found that engagement and buy-in to identify priority actions was slower than expected. Early reflections on challenges are summarized below:

- Political instability has made buy-in from city officials and agencies, such as the Addis Ababa Water and Sewerage Authority (AAWSA), difficult. Taking a regional approach that aims to build consensus with stakeholders involved in the surrounding watershed is complex and challenging because officials have been preoccupied with other politically urgent matters. The frequent change of officials, including mayors of Addis Ababa, has also been an inhibiting factor to progress on resiliency initiatives in general.[b]
- The project framework approach needs to remain flexible and account for iterative processes. AAWSA representatives expressed a preference for prioritizing their own ongoing water projects, noting that many previous related studies had been conducted. This highlights the need to keep the project approach flexible, with iterative processes for adjustment and reflective learning. Finding ways to consider AAWSA's existing priorities and align agendas will be essential. This also means that adequate resources need to allow for flexibility as engagements continue with other stakeholder groups.
- Questions remain on how to best partner with community groups. The political culture in Addis Ababa does not facilitate strong community-based organizations (CBOs). The space for and capacity of CBOs is small and relatively low, and very few engage with water directly. Certain laws and regulations restrict what legally registered CBOs are able to work on, often preventing activity that creates political pressure. Also, the most water-insecure residents, such as tenants, may not be represented well in existing groups. Adequate time and resources will be needed to broker relationships and/or build capacity and trust with existing CBOs or water-insecure neighborhoods without much social infrastructure.

Although the experience of Addis Ababa is not representative of all cities, it highlights the nonlinear and iterative process of citywide change, especially for building resilience.

Notes:
a. The project team consists of partners from WRI, the Global Resilient Cities Network, and the Resilience Shift.
b. The Resilience Project Office was recently rearranged from directly reporting to the mayor's office to instead reporting to the Planning Commission. This has reportedly weakened its ability to influence city priorities set by the mayor.

Source: Authors, based on interviews with project team members conducted in 2020–21.

Strategy C: Mainstream valuation of long-term economic benefits, transparency, and criteria for equitable access to water in investment allocations

All policymakers (from national, regional, and city agencies), financiers, and donor agencies should shift mindsets from short-term economic gains from traditional infrastructure to long-term, climate-resilient investments that deliver far higher economic, environmental, and social returns. Although built gray infrastructure will play a key role in urban development, inclusive nature-based approaches have the potential to offer the following "triple dividend" of benefits (GCA 2019):

- **Economic gains,** from immediate jobs created through restoring and protecting nature, to long-term economic growth associated with increasing food and water security, business productivity, tourism, and recreation value.
- **Avoided losses** from protecting communities and infrastructure from floods, storms, and heatwaves, saving billions of dollars each year.
- **Social and environmental benefits,** from cleaner air that improves human health and mitigates climate change, to more habitat for endangered species.

An example of the potential for major returns is a study of Kenya's Upper Tana Water Fund efforts, which estimated that investing in nature-based land management practices in the delta region, which provides 80 percent of Nairobi's drinking water, would deliver an estimated return of $21.5 million over 30 years, including savings in water and wastewater treatment and agricultural crop yields (TNC 2015). A report by the Global Commission on Adaptation found that for every dollar invested in resilient water resources management, $4 are generated through benefits, globally totaling at least $1.4 trillion (GCA 2019).[35] These economic gains could generate potential sources of revenue for governments, if value from adaptation benefits were captured. For example, cities can work with the commercial development industry to ensure that governments can capture a portion of this value, recycling this into more resilient investments. For many developing cities, this will require more sophisticated taxation, value-capture measures, strengthened land management systems, and strategic investments in resilient infrastructure for greater returns (GCA 2019).

Given the presence of multilateral development banks (MDBs) in Africa, they can play an important role by adopting a whole system and long-term view in investment allocations. For example, MDBs are best positioned to challenge the false choice between green (natural) and gray (built) infrastructure and instead encourage a portfolio of natural, hybrid, and built infrastructure based on local context (Browder et al. 2019; Sayers and Smith 2018). As there has historically been bias towards one-off capital investments, development banks and financiers need to proactively recognize inclusive nature-based approaches as integral early in the planning process, during the appraisal processes, and, in some cases, in the revenue flows that will repay the resources financed.

The financing agenda from MDBs and other financiers must work with existing systems in city-regions to reflect the governance and service delivery infrastructure on the ground (Cirolia 2020; Goodfellow 2020). One way to improve this is for financiers and NGOs to organize, train, and build capacity for local city decision-makers on contract design and negotiations to reflect on-the-ground needs. Investments without a meaningful understanding of the patchwork of services and actors involved may deepen existing inequitable patterns.

Policymakers also need to increase transparency in financial processes and include parameters that ensure procedural and distributive inclusiveness and social equity. A focus on social vulnerabilities in the African context (see Sections 1 and 2.1) is only effective if backed financially. MDBs and financiers have a role in ensuring this as well. For instance, in Burkina Faso, the World Bank committed a large investment to improve universal water and sanitation access with a focus on under-served areas and women. Promisingly, it uses its program-for-results financing tool to link the disbursing of funds with equity criteria (World Bank 2018). After all, it is in the best interest of city decision-makers to ensure strong community ownership and buy-in to water interventions and resilient outcomes. Without strong ties to community organizations, independent bodies, and universities, corruption and short-winded political cycles can potentially counteract long-term plans.

3. Transitioning to a Water-Resilient City

This report frames the challenges, opportunities, and potential for urban water resilience in Africa. However, it is important to note that this framing is only a starting point.

This report offers pathways forward for water resilience with the intention that they remain flexible and contextualized at different levels (see Figure 21).

At the same time, all pathways are needed. Our research illustrates how the core challenges to urban water resilience are all interconnected and span a range of sectors, thus requiring holistic interventions. No single strategy can accelerate urban water resilience alone. Risk-informed land management must be enabled by coordinated governance and collaborative partnerships. Water-sensitive urban development must be sustained by finance aligned across sectors. Equitable access to water and sanitation must happen in tandem with nature-based solutions so that communities can live, work, and thrive, protected from flooding, water stress, and waterborne disease. How cities prioritize

Figure 21 | Key pathways for building urban water resilience in African cities

Source: Authors.

Figure 22 | Challenges at different levels for building urban water resilience in Sub-Saharan Africa

National/regional level

- Past colonial and neocolonial influence
- Rising population and urbanization
- Powerful business-as-usual, developmental state model interests
- Political instability and conflict
- Regional competition for water and interbasin conflicts
- Overlapping mandates and local-to-national disconnects
- Inadequate government financing to local levels

City level

- Low coverage to public water, sanitation, and drainage services
- Unmanaged urban expansion and indiscriminate development
- Poor waste management
- Lack of contingency and emergency planning for flooding and droughts
- Lack of capacity and data to prepare for risks
- Misaligned agendas and lack of coordination among city agencies
- Water used for short-term political gain and corruption
- Splintered urbanism
- Limitations in knowledge production and political uptake to local innovations
- Limited financial resources and accumulated debt (e.g., weak local revenue streams)
- Aging infrastructure, water theft, and high levels of nonrevenue water
- Out-of-context and unsustainable water management practices (e.g., privatization)
- Financial models unfit for resilience
- Bias towards rigid and exclusionary projects and "world-class city" ambitions

Community level

- Increasing household water stress (intermittent water supply, flooding, erosion, pollution) and water-related risks (health and safety, landslides)
- Lack of affordability and increasing costs to access safe water and sanitation services (time, transportation, treatment, storage, purchasing, investment, protection, conservation, operations, and maintenance)
- Increasing social and gender disparities in access to safe water and sanitation
- Lack of disaggregated data
- Socially constructed barriers to access safe water and sanitation (tenure insecurity and red-tape administrative procedures)
- Limited integration of local and traditional knowledge
- Disenfranchisement of most vulnerable communities and limited channels to participate in city planning processes
- Petty corruption, water theft, vandalism, sexual harassment, and water mafias

Cross-level challenges

- Climate change
- Limited coordination and capacity
- Lack of cross-level political will, leadership, and inclusive representation
- Institutional fragmentation
- Mismatch between jurisdictional boundaries and watersheds
- Economic valuation of cost and benefits that misses long-term adaptation benefits
- Water catchment degradation

Source: Authors.

and operationalize urban water resilience—and which pathways they choose to begin with first—will depend on their local context, political opportunities, and policies already on the agenda.

Figure 22 summarizes the main challenges described in Section 2 by three different levels: national/regional, city, and community. Challenges on the national and regional level include institutional and ecological factors on the basin-to-global scale that reinforce the path dependency.[36] Challenges on the city level include political, governance, financial, and societal barriers, representing underlying norms, values, and principles currently underpinning the business-as-usual approach (Mguni 2015). Challenges at the community level are the daily livelihood barriers faced by households and communities related to water as well as the barriers for scaling localized innovations to water resilience. There are also cross-level challenges that manifest at different points and add complexities.

Many of these challenges present an opportunity and lessons learned for African cities to leapfrog to new-generation infrastructure and governance models for building water resilience. This is only possible, however, by connecting national, regional, city, and community levels to enable a water-resilient transition. Table 1, located in Section 3.1, organizes these priority pathways according to the roles that different actors at different levels may play to advance implementation. It starts with government actors from city to national levels, then covers nongovernment actors such as civil society organizations, the private sector, and international financiers. Although just a start, this signifies the level of clarity needed at each level to shift towards multilevel governance and systems thinking.

However, several long-standing challenges are complex and require context-specific approaches that are beyond this framing paper. Many existing studies have highlighted the importance of considering diversity, relational historical forces (ethnicity and identity), informality, and social conflict for city-region planning because these are major factors shaping the cities of Sub-Saharan Africa (Habtemariam et al. 2018; Mguni 2015; Nastar et al. 2018). The four pathways and strategies may not comprehensively address all identified barriers to urban water resilience. Barriers such as the politicization of water and corruption in the water sector, rights to land, and the influence of powerful global actors are inextricably tied to a region's political economy. Additionally, the extent of city-level authority and municipal capacity varies widely across the continent. For example, cities in South Africa have benefited from more robust decentralization and fiscal empowerment over the last 25 years. This should be seen as more of an exception rather than the norm across the region (Cirolia 2020).

Moreover, understanding and recognizing the varying capacity of different social groups within the community (e.g., tenants, landlords, traditional leaders, women, politically affiliated groups, family and clan ties) will need to be done at a local level. These issues will not have a simple solution. There may also be other key challenges tied to broader geopolitical conflicts.

Overall, all households must be able to achieve water security with safe, affordable access to water, sanitation, and healthy spaces, with an emphasis on existing community knowledge and localized innovation. Urban development must shift away from business-as-usual practices and instead proactively plan with credible information on climate risks and physical and social vulnerabilities in mind. Land-use practices must also account for all hydrologically linked areas, understanding the larger watershed region and its ecosystems, upon which millions of people depend. Institutions at all levels will need to build in more flexibility, incentives for collaboration, and leadership that supports experimentation and learning to bridge regional- and city-level pressures. New institutional practices and partnerships will be key in forging a new and urgently needed approach to building water resilience. Water-related stakeholders need to coalesce around a shared vision for resilience and drastically increase water-sensitive investments. Instead of exclusionary, piecemeal investments, cities need to be able to access and target investments with transparency and adequate engagement from the community level.

Cities in Africa are facing unprecedented rapid urbanization and climate-related shocks and stresses. Without action, millions will be left behind without basic access to urban water services and the ability to adapt to climate risks. Increasing urban inequalities means emphasis needs to be given to building the resilient capacities of marginalized groups, such as slums and informal settlements, the urban poor, people with disabilities, and women and girls. Given the historical context of these inequalities, it is important to unlearn the practices of the neocolonial urban water management system that neglects customary practices, affordability, and the water access issues of different segments of the urban population. To redress prevailing inequalities and corruption, water must be considered a public good and human right. Water catchment areas need to be protected, conserved, and managed collaboratively. A water-resilient transition must also account for existing power dynamics and seek to empower the most vulnerable groups to build coalitions and political capital.

There is a key window of opportunity to transform the urban water pathways of cities in Africa. We must align incentives across different actors and interests to promote forward-looking measures that build resilience, recognizing that repairing damage inflicted by climate change and other water risks is far more costly than taking preventative steps now. This is the moment for African cities and countries to chart a more water-resilient approach, laying a foundation for prosperity for all.

3.1. An Action Agenda

Table 1 | Priority pathways and key actions for urban water resilience and the roles of specific actors

PLAN FOR WATER: Mainstream risk-informed land management and water-sensitive urban development	**PRIORITIZE THE MOST VULNERABLE:** Increase equitable access to safe water and sanitation	**CREATE CHANGE AT SCALE:** Develop innovative institutions and pursue partnerships for water resilience	**GET FINANCE RIGHT:** Increase and align water-resilient investments across sectors
City Government			
Mainstream information on water, climate, and health risks in urban and regional planning Recognize hydrologically linked regions, often larger than urban boundaries, to account for water resilience priorities based on ecosystems, rural-urban landscapes, and regional networks Incentivize development in less hazard-prone areas and/or areas with regulations and planning that support water-sensitive development Offer planning, policy, and regulatory incentives for floodplain restoration and watershed protection, including preservation of green spaces within and around cities Increase capacity to implement regulatory frameworks and incentives, such as building permits, limits on groundwater extraction, and ecosystem protection Draw upon nature-based solutions to proactively address water challenges and support communities Ensure the rights of the most marginalized groups are protected in existing and proposed schemes, including measures to restore floodplains, remove dams and levees, and retreat from zones subject to flooding or sea level rise	Collect and utilize data disaggregated by social groups and spatial areas, on local climate and environmental risks, and on urbanization patterns to identify the most vulnerable areas Integrate local knowledge and community participation in decision-making around improving water access and water resilience Support strategic and cost-effective policies that strengthen water resilience for the most socially vulnerable Support community-led and/or government-led upgrading of informal settlements and water-insecure areas (e.g., flooding zones, hillsides) Support the integration of small-scale, decentralized, and/or informal water and sanitation providers Strengthen the role of public institutions to ensure the safety and affordability of innovative, off-grid water and sanitation solutions	Incentivize collaboration across jurisdictions and agencies to jointly consider a mix of green and gray infrastructure and create cost-saving synergies Support cross-departmental coordination, resource support, and capacity development, including identifying strategic opportunities to advance multiple outcomes among sectors that impact and are impacted by water (e.g., roads, transport, land authority) Prioritize multistakeholder engagement processes that align agendas and build consensus, trust, and relationships crucial for building resilience Strengthen partnerships at the regional level to effectively manage the watershed region Support and recognize leadership at the community level to cocreate partnerships and knowledge grounded in the everyday realities of water challenges Build capacity to plan, implement, and operationalize resilience in long-term strategies, business plans, and investments Build leadership capacity for reflective learning and experimentation Build capacity in soft skills, such as contract negotiations and partnership building with community groups	Develop financing mechanisms to improve own-source revenue streams, such as land value capture Create a shared vision with partner organizations, donors, the private sector, and the largest water consumers to increase investments in equitable water-sensitive design Develop mechanisms and incentives to align water-sensitive priorities and investments across sectors Establish dedicated funding pathways to channel external resources to water resources conservation and nature-based solutions Revise economic valuation methods to account for long-term economic benefits, avoided costs, and livelihood gains from urban water resilience actions Implement measures to capture value from building water resilience in the medium to long term Increase transparency and equity criteria in investment allocations

Table 1 | Priority pathways and key actions for urban water resilience and the roles of specific actors (cont.)

PLAN FOR WATER: Mainstream risk-informed land management and water-sensitive urban development	**PRIORITIZE THE MOST VULNERABLE:** Increase equitable access to safe water and sanitation	**CREATE CHANGE AT SCALE:** Develop innovative institutions and pursue partnerships for water resilience	**GET FINANCE RIGHT:** Increase and align water-resilient investments across sectors
Water and Sanitation Utility			
Diversify water supply sources and management options, decreasing dependence on a singular, centralized source Increase investments in water resources conservation, in addition to leakage detection, gray water reuse, and storage capacity Invest in green infrastructure to cost-effectively improve water quality and storage, such as constructed wetlands and aquifer recharge methods Pool resources with other public agencies to strengthen integrated planning (e.g., designing water provision together with wastewater management)	Target policies and capacity to increase water connections, affordability, and availability for the most socially vulnerable (i.e., means-tested subsidies, increasing block tariffs, cross subsidization, "free basic water" policies, subsidized connection costs) Improve payment flexibility to lessen the burden of lumpy, one-time capital costs on households (e.g., pay-as-you-go models) Integrate small-scale, decentralized, and/or informal water and sanitation providers into public service management Support local and existing solutions that effectively build resilience for water-insecure areas (e.g., peri-urban areas, settlements in hazardous areas, informal settlements)	Participate in multistakeholder engagement processes that align agendas and build consensus, trust, and relationships crucial for building resilience Align priorities and planning with other agencies, such as land use and transport, to jointly improve and/or bundle service delivery for resilience Build partnerships with civil society, nongovernmental organizations, community-based organizations, and local community networks Establish robust contingency plans for shock events to ensure service provision can be maintained even during a crisis Build capacity to plan, implement, and operationalize resilience in long-term strategies, business plans, and investments Build capacity in soft skills, such as negotiating contracts and building partnerships with community groups	Improve financial performance to increase overall performance; for example, build capacity to collect tariffs efficiently, allocate revenues for maintenance, minimize nonrevenue water, gather data on financial and other performance Review cost recovery assumptions underpinning the utility's financial model in light of increasing risk and resource constraints Implementing proactive financing solutions to prevent shocks from revenue decline during water-related shocks/disasters (e.g., "rainless day" fund) Forge partnerships to institutionalize a new financial approach fit for water resilience in the long term (e.g., working with small-scale enterprises to scale decentralized approaches, financing localized solutions to ensure affordability and safety)
National Government			
Support transboundary and multilevel assessments of water risks and establish corresponding institutional bodies to design water strategies that span ecosystems, rural-urban landscapes, formal-informal institutions, and regional political economic networks	Support knowledge coproduction through the creation of multistakeholder engagement platforms Enable the participation of rural and peri-urban communities in articulating water-resilient options that protect livelihoods and security beyond the political boundaries of the city Establish national frameworks for informal settlement upgrading Establish a national framework of integrated urban planning Involve community groups or civil society organizations in monitoring, evaluation, and learning programs (e.g., water watch groups)	Develop regulations and institutional mechanisms to support interregional and cross-sectoral coordination Increase political will and commitments to shift towards new institutional practices for water management, including a forum for all water-related actors to align water interests	Step up financial support for urban water resilience and make domestic resources available for urban regions, local authorities, and frontline communities Ensure international financial institutions, donors, and the private sector prioritize valuing and incentivizing water-sensitive investments Establish and sustain channels of finance for locally led adaptation; for example, microfinance institutions that devolve funds, guarantees, and insurance to the urban poor and small-scale providers to improve water security

Table 1 | Priority pathways and key actions for urban water resilience and the roles of specific actors (cont.)

PLAN FOR WATER: Mainstream risk-informed land management and water-sensitive urban development	**PRIORITIZE THE MOST VULNERABLE:** Increase equitable access to safe water and sanitation	**CREATE CHANGE AT SCALE:** Develop innovative institutions and pursue partnerships for water resilience	**GET FINANCE RIGHT:** Increase and align water-resilient investments across sectors
National Government (Cont.)			
Offer policy and regulatory incentives for floodplain restoration, watershed protection, and other adaptation actions in peri-urban and rural areas Raise commitments and investments for water resilience strategies, recognizing the role of community and local knowledge Increase technical and financial capacity for risk management and contingency planning, with clear responsibilities across institutions	Collect independent information about services and charges to better understand the realities of service provision (e.g., the utility's service area; associated risks and vulnerabilities; detailed socioeconomic, risk, and water- and sanitation-related data) Establish pro-poor regulations and provide incentives to encourage and enable utilities to extend service provision Oversee and encourage innovative hybrid service provision models by ensuring quality, health, safety, and affordability standards (e.g., formal water provision alongside small-scale and decentralized water and sanitation providers) Monitor and report on progress for equitable service provision	Integrate water-sensitive urban development in national economic development strategies and investments Emphasize a people-centered approach in investment planning to depart from bias for large-scale, centrally built infrastructure Establish platforms and build coalitions for political dialogue, negotiation, and inclusive representation Streamline the implementation of regulatory frameworks across the multiple agencies involved in different aspects of water management and services Build capacity for the skills needed to engage with utility managers and service providers to negotiate improved outcomes	Develop financing mechanisms to improve basin-level resilience Recognize the "triple dividend" in resilience investments (economic gains, avoided losses, and social and environmental benefits) and capture value from resilience investments Revisit regulatory frameworks to allow for more effective pooling and steering of public, private, and community-based sources of adaptation finance Increase considerations for transparency and equity criteria in investment allocations Monitor and incentivize utilities to improve performance and plan for long-term resilience strategies
Civil Society			
Harness community-based knowledge and experience to guide decisions around resilience strategies, such as local service provision and nature-based solutions Ensure that the rights of the most marginalized groups are protected in existing and proposed schemes, including measures to restore floodplains, remove dams and levees, and retreat from zones subject to flooding or sea level rise Advocate for participatory arenas that emphasize the interests of marginalized communities Promote grassroots and community-based leadership and networks to advocate for the equitable distribution of benefits and community ownership	Develop metrics and data on risks and vulnerabilities at the community level as well as criteria for investment needs in relation to existing risk -management, vulnerability-reduction, and livelihood-protection schemes Articulate locally relevant indicators for ensuring climate equity and justice, taking into the account the need to distribute both adaptation benefits and losses in a fair manner Bring forth issues of representation of marginalized communities in multistakeholder engagement platforms and other decision-making forums Support strong community-based coalitions to build political and social capital, establish government partnerships, and organize with other social movements	Mobilize local leaders in decision-making arenas to advocate for citywide adaptation and resilience thinking Enable grassroots awareness and knowledge of climate science, current/future risks, and associated vulnerabilities Contest existing paradigms of climate action to offer more people-centered visions of urban development Advocate for meaningful and institutionalized participatory processes	Advocate for funding incentives or committed resources for local engagement and participatory processes Advocate for increased transparency, procedural and distributive equity, and the necessity for strong community buy-in

Table 1 | Priority pathways and key actions for urban water resilience and the roles of specific actors (cont.)

PLAN FOR WATER: Mainstream risk-informed land management and water-sensitive urban development	**PRIORITIZE THE MOST VULNERABLE:** Increase equitable access to safe water and sanitation	**CREATE CHANGE AT SCALE:** Develop innovative institutions and pursue partnerships for water resilience	**GET FINANCE RIGHT:** Increase and align water-resilient investments across sectors
Private Sector (including Local, Small-Scale Enterprises)			
Develop new models and analyze partnership opportunities with government and financial institutions to enable up-front investments in resilience strategies, such as nature-based solutions, innovative service providers, and water source protection	Provide funds and expertise for cocreation of knowledge and local strategies to build water resilience Work with the public sector and communities to provide safe and affordable water and sanitation services, especially in water-insecure areas, areas outside of the piped network, and peri-urban areas Support existing, localized innovations for safe and affordable water and sanitation service delivery, improved drainage, nature-based solutions, and healthy spaces	Support resilience planning, implementation, and water stewardship by engaging with industry and commercial trade bodies Work with government agencies to coproduce infrastructure and planned urban developments	Support processes for ensuring social accountability and financial transparency Support innovation in water-sensitive infrastructure design Support city investments in water and sanitation by financing municipal infrastructure funds
International Community and Financiers			
Revise funding and investment criteria to recognize and value resilience strategies, such as nature-based solutions Target financing to communities that face chronic water risks and other water resilience actions Strengthen networks for building leadership, capacity, peer-to-peer learning, technical assistance, and partnerships for a new generation of nature-based and water-resilient approaches	Utilize funding schemes that target improved water and sanitation access for the urban poor, considering local needs Increase transparent budgetary practices, such as open budget surveys, community budget advocacy, and participatory budgeting Articulate equity and justice criteria within multilateral arrangements that consider social, political, and economic structures of cities	Create incentives for cross-department budgeting and program development to advance multiple water resilience benefits Raise the political ambition and will for new institutional practices in water management and people-centered approaches Support multilevel coalitions, platforms, and partnerships with technical assistance, capacity building, and access to resources Allow for flexibility, uncertainty, and adaptability to local contexts Support learning, skills, and capacity development among urban and water-related actors	Encourage and fund holistic strategies that improve water and sanitation access for vulnerable communities, protect water sources, improve urban and regional planning, and other water resilience actions Revise funding and investment criteria to value resilience investments and recognize the triple dividend Increase considerations for transparency and equity criteria in investment allocations

Source: Authors.

APPENDIX A. DESCRIPTION OF INTERVIEWEES

Table 1 | Priority pathways and key actions for urban water resilience and the roles of specific actors

Interview Number	Date	City—Agency—Position
1	May 2020	Nairobi—Water Sector Trust Fund (Water Fund)—Manager
2	May 2020	Nairobi—Department of Urban Planning, Nairobi City County Government—Development Control Officer
3	May 2020	Nairobi—NEMA—Senior Officer
4	July 2020	Nairobi—Water Services Regulatory Board (WASREB)— Representative
5	June 2020	Nairobi—NCWSC—Representative
6	June 2020	Nairobi—WRA—Representative
7	February 2020	Addis Ababa—AAWSA—Sewage Department Representative
8	February 2020	Addis Ababa—AAWSA—Water Supply Department Representative
9	July 2020	Kampala—NEMA—Representative
10	July 2020	Kampala—Water For People—Representative
11	July 2020	Kampala—WaterAid—Representative
12	July 2020	Kampala—National Water and Sewerage Corporation (NWSC)—Representative
13	May 2020	Cape Town—City Government—Resilience Officers
14	December 2020	Nairobi—Akiba Mashinani Trust—Representative

ABBREVIATIONS

AAWSA	Addis Ababa Water and Sewerage Authority
AFD	Agence Française de Développement
AfDB	African Development Bank
AwBA	Awash Basin Authority
BMGF	Bill & Melinda Gates Foundation
BTC	Belgian Development Agency
CBO	community-based organization
EC	European Commission
EIB	European Investment Bank
FRACTAL	Future Resilience for African Cities and Lands
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HWISE	Household Water Insecurity Experiences
ICLEI	International Council for Local Environmental Initiatives
IDRC	International Development Research Centre
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
KIIDP	Kampala Institutional and Infrastructure Development Projects
KPSP	Kibera Public Space Project
KUSP	Kenya Urban Support Program
MDB	multilateral development bank
MDG	Millennium Development Goal
MFI	microfinance institution
NCWSC	Nairobi City Water & Sewerage Company
NEMA	National Environment Management Authority
NGO	nongovernmental organization
NWHSA	National Water Harvesting and Storage Authority
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development
ONEA	National Water and Sanitation Office
PAPSCA	Program for Alleviation of Poverty and the Social Costs of Adjustment
SDC	Swiss Development Corporation
SDG	Sustainable Development Goal
SDI	Slum/Shack Dwellers International
SIDA	Swedish International Development Cooperation Agency
TNC	The Nature Conservancy
UDZ	Urban Development Zones
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific and Cultural Organization
WASH	water, sanitation, and hygiene
WHO	World Health Organization
WRA	Water Resources Authority
WSS	water supply and sanitation

GLOSSARY

A selection of water and urban terms are defined here in simple terms. These are the terms that may be most unfamiliar to nonexperts; this is not an exhaustive list of the terminology used in this report.

aquifer: Underground water-bearing rock that acts as a reservoir for groundwater.

business as usual: What happens in the absence of an infrastructure investment or change in management, governance, and financial approach. Commonly referred to as counterfactual or baseline conditions.

corporatization: The process of transforming a public agency into a legal entity with a corporate structure and corresponding incentives.

gray infrastructure: Human-engineered or built infrastructure (Gartner et al. 2013). Examples of built infrastructure include water supply and hydropower reservoirs, dams, pipelines, and water and wastewater treatment plants.

green infrastructure: "Actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al. 2016). Green infrastructure is also sometimes referred to as natural infrastructure, nature-based solution, or ecosystem-based adaptation. Green infrastructure examples for source watershed protection include forest and ecosystem restoration, conservation, and forest and agricultural sustainable management practices. Green infrastructure can also apply to water supply infrastructure, such as natural aquifers, lakes, and wetlands.

hybrid service delivery: When core urban services are delivered through a mix of methods with respect to their material design and their governance. "In terms of material diversity, hybridity works to stitch together and connect infrastructure fragments. As people are often not physically connected to grids for water, sanitation, or energy, household and community scale technologies and retrofitting are deployed—at times precariously connected to formal networks and at other times creating alternative systems, with various degrees of network endness and durability. The issue of governance diversity is also dynamic. Local governments are but one of the many actors in these hybrid systems. Many of these actors, some formalized and others not, control service delivery networks and raise significant levels of revenue" (Cirolia 2020).

institutions: State and nonstate actors and organizations, both formal and informal rules, where interactions of actors are framed. It is not only organizations but also a set of working rules and social arrangements that provides incentives and privileged access (for this report, to water resources, water and sanitation services, and green spaces) or constraints and barriers (Habtemariam 2019; Ostrom 1990).

intermittent water supply: A piped water service that is not continuous.

nature-based solution: *See* green infrastructure.

nonrevenue water: Water that is distributed through a piped water system but is lost before it reaches the customer, often due to leaks or theft, and is therefore not paid for.

piped water: Water that is delivered through a system of pipes into a dwelling, yard, or plot.

sustainable water management: Managing water so that SDG 6—to "ensure availability and sustainable management of water and sanitation for all"—is achieved (Strong et al. 2020).

tanker truck: Trucks equipped with a tank to deliver water.

transboundary waters: "Aquifers, and lake and river basins shared by two or more countries" (UN-Water n.d.)

urban water resilience: When a city-region has equitable access to safe, reliable, and affordable drinking water and sanitation, flood-protected neighborhoods, and healthy regional watersheds resulting from water-sensitive infrastructure and aligned city and regional development, enabled by governance, planning, and finance systems that continually adapt to changing local contexts and climate risks.

WASH: Water access, sanitation, and hygiene. Improved drinking water sources are able to deliver safe water. Improved sanitation facilities can "hygienically separate excreta from human contact." Hygiene encompasses behaviors "including handwashing, menstrual hygiene and food hygiene"; access to handwashing facilities with soap and water is a top priority (WHO and UNICEF n.d.)

water cycle: "The continuous movement of water within the Earth and atmosphere" through a plethora of mechanisms, including evaporation, precipitation, transpiration, and infiltration (NOAA 2019).

water kiosk: An outlet operated by an attendant, which provides residents with pay-per-use water.

water risk: The probability of experiencing negative water challenges and impacts. Risks include the environmental hazard itself (such as floods and droughts), the exposure to said hazard, and the vulnerability of systems and populations to withstand exposure to this hazard.

water scarcity: The lack of enough water to meet demands. It can be caused by a number of factors, such as poor governance, infrastructure, physical shortage, or pollution.

water sector: Encompasses activities that provide, manage, treat, extract, and transport water resources.

water security: "The availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies" (Grey and Sadoff 2007).

water-sensitive urban design: A land planning and engineering design approach that integrates the urban water cycle, including stormwater, groundwater, and wastewater management and water supply, into urban design to minimize environmental degradation and improve aesthetic and recreational appeal.

water stress: The ratio of water withdrawals to available renewable water supply. High levels of water stress indicate competition among water users (Hofste et al. 2019).

water suppliers: Owners, operators, and managers of public, private, and informal water supply systems.

water supply system: A system for the collection, transmission, treatment, storage, and distribution of water from source to consumers (OECD 2001).

water utility: An organization responsible for providing water services (and sometimes sanitation services) and maintaining water infrastructure.

watershed (sometimes used interchangeably with *drainage basin* or *catchment*): "An area of land that [collects and] drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel." A watershed consists of both surface water and underlying groundwater (USGS n.d.).

ENDNOTES

1. The terms *leapfrog* or *leapfrogging* are often applied to the African context to describe how early-developing regions can skip traditional developmental stages seen in Global North countries.

2. The decentralization processes that started during the 1980s in Africa recognized the role local governments can play in addressing development challenges.

3. The worst-case climate scenario indicates global warming by four degrees by the end of century. Middle warming scenarios of two to three degrees by end of century projects Africa's GDP declining by 3–8 percent.

4. For more information, see the World Bank Country and Lending Groups database, https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.

5. The geospatial assessment is part of the broader project initiative and will include a deeper analysis for more cities than included at the time of this publication.

6. At the time of this publication, the initiative is working with Addis Ababa, Ethiopia, and Kigali, Rwanda. There are plans to start working with two more cities in South Africa and two additional secondary cities in Ethiopia and Rwanda.

7. This analysis is based on 18 economies in Africa, South Asia, and Latin America, primarily for firms that used water for business activities.

8. Many utilities price water using rising block tariffs, which raise the cost per unit of water when the total volume of water consumed increases. A group of households that share one tap would be considered one connection and may qualify for the higher cost per unit of water. Landlords are often unwilling to pay this and thus may restrict water usage for tenants.

9. Based on personal communication between F. Gelaye and a representative from the City of Harar, May 2016.

10. This includes Ibadan, Abidjan, Cape Town, Nairobi, Dar es Salaam, Durban, Harare, and Johannesburg.

11. Piped water connections from available monitoring data are used as the closest proxy to measure access in urban settings, though such connections do not always provide the necessary reliability, affordability, and safety required for household water security.

12. Many cities in the Global North have a different context of strong regulation and oversight by public utility boards.

13. *Splintered urbanism* refers to situations in which the "modalities and availability of affordable finance and delivery are driven by the imperatives of cost-recovery and the prioritization of economically important spaces: nodes of commerce and movement of goods and services and the residential estates that house the middle classes and elites" (Pieterse and Hyman 2014, 195).

14. The developmental state model reinstates and emphasizes the state's power in spearheading activities needed to boost economic development and establish incentives that can streamline the involvement of the private sector and other actors (Habtemariam 2019).

15. Decentralization processes that started in the 1980s in Africa recognized the role local governments can play in addressing development challenges.

16. The Nature Conservancy (2016) assessment surveyed 30 cities, including Addis Ababa, Cape Town, Johannesburg, Luanda, Nairobi, Mombasa, Dar es Salaam, Lagos, Antananarivo, and more (see TNC 2016, 9).

17. Classifying as *urban* allows for better decisions to be made by shaping, planning, and financing appropriately. This typically has differential impacts for the city and surrounding regions in terms of costs and benefits.

18. For more information the Aqueduct Floods tool, see https://www.wri.org/applications/aqueduct/floods/.

19. For more information about the Urban Community Resilience Assessment tool, see https://www.wri.org/our-work/project/urban-community-resilience-assessment.

20. Participatory budgeting is a widely acknowledged innovative approach originated in Brazil (Porto Alegre and Belo Horizonte) where different citizen assemblies were organized that allowed particularly poor communities living in favelas (slums) to set goals, outline their priorities, and monitor subsequent activities by governments in their communities. As a result of this, the cities were able to achieve transparency and successful implementation of more pro-poor investment and outcomes in the water and sanitation sector (Souza 2001).

21. *Container-based sanitation* refers to a toilet or squat plate above a removable container. This allows it to be easily transportable and usable indoors, making it an especially good fit for multistory buildings. It also uses much less water than sewerage-based sanitation.

22. For more information about HWISE, see https://sites.northwestern.edu/hwise/.

23. An institutional model in which a utility provider delegates water supply operational responsibilities to small-scale private operators or individuals in under-served areas (Adams et al. 2019, 11).

24. Some of this spatial data is publicly available on the MajiData database, http://majidata.go.ke/public-portal/.

25. For more information about the history of Muungano wa Wanavijiji, see https://www.muungano.net/history.

26. As stated in Article 52 of Ethiopia's constitution.

27. At that time, Water For People worked in 10 countries across Africa, including Malawi, Rwanda, and Uganda.

28. For more information about the Cities Action Track, see https://gca.org/global-commission-on-adaptation/action-tracks/cities; for the Sustainable Water Partnership, see https://www.globalwaters.org/swp.

29. For more information about the Global Water Partnership, see https://www.gwp.org/; to learn more about the Water Integrity Network, see https://www.waterintegritynetwork.net/.

30. Based on personal communication between F. Gelaye and a representative from the City of Harar, May 2016.

31. For more information about the Water Resilience Coalition, see https://ceowatermandate.org/resilience/.

32. A "bankable" project refers to a project that can generate sufficient cash flows to meet obligations created during capital outlay. It can also mean the ability of a project to yield optimal returns.

33. For more information about the Municipal Infrastructure Grant program, see https://www.cogta.gov.za/mig/.

34. For an example, please see WRI's Water Program, https://www.wri.org/our-work/project/corporate-water-stewardship.

35. The net benefits illustrate the approximate global net benefits to be gained by 2030 from an illustrative investment of $1.8 trillion in five areas, one of which is water resources management. Actual returns depend on many factors, such as economic growth and demand, policy context, institutional capacities, and the condition of assets.

36. The path dependency is the reactive change undertaken by cities of the Global South to water challenges following the northern cities' path, which passes through the full-fledged conventional centralized water management stage in the continuum of the urban water management transition framework, and implies an expensive, environmentally costly, and unnecessarily longer process.

REFERENCES

AAWSA (Addis Ababa Water and Sewerage Authority). 2015. *AAWSA Annual Report*. Addis Ababa: AAWSA.

Achamyeleh, K. 2003. *Ethiopia: Integrated Flood Management*. Geneva and Stockholm: Associated Programme on Flood Management, World Meteorological Association and Global Water Partnership. http://www.floodmanagement.info/publications/casestudies/cs_ethiopia_sum.pdf.

Adams, E.A., D. Sambu, and S.L. Smiley. 2019. "Urban Water Supply in Sub-Saharan Africa: Historical and Emerging Policies and Institutional Arrangements." *International Journal of Water Resources Development* 35 (2): 240–63. https://doi.org/10.1080/07900627.2017.1423282.

Adegbeye, O. 2020. "Why Social Distancing Won't Work for Us." *The Correspondent*, March 27. https://thecorrespondent.com/378/why-social-distancing-wont-work-for-us/50039243100-5409cfb5.

AfDB (African Development Bank). 2018. "Africa's Infrastructure: Great Potential but Little Impact on Inclusive Growth." In *African Economic Outlook 2018*, 63–94. Abidjan, Côte d'Ivoire: AfDB. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/2018AEO/African_Economic_Outlook_2018_-_EN_Chapter3.pdf.

Ahlers, R., K. Schwartz, and V. Perez Guida. 2013. "The Myth of 'Healthy' Competition in the Water Sector: The Case of Small Scale Water Providers." *Habitat International* 38 (April): 175–82. https://doi.org/10.1016/j.habitatint.2012.06.004.

Alcayna, T. 2020. *At What Cost: How Chronic Gaps in Adaptation Finance Expose the World's Poorest People to Climate Chaos*. Dublin and Portland, OR: Zurich Flood Resilience Alliance, Concern Worldwide and Mercy Corps. https://europe.mercycorps.org/sites/default/files/2020-07/1087-PA-ZFRA-AtWhatCost-V15c-WEB.pdf.

Allen, A. 2014. "Peri-urbanization and the Political Ecology of Differential Sustainability." In *The Routledge Handbook of Cities of the Global South*, edited by S. Parnell and S. Oldfield, 522–38. New York: Routledge.

AMT (Akiba Mashinani Trust). 2015. *Improving Access to Justice and Basic Services in the Informal Settlements in Nairobi: An Action Research Approach*. Final Technical Report. Nairobi: Akiba Mashinani Trust, Muungano wa Wanavijiji. https://static1.squarespace.com/static/58d4504db8a79b27eb388c91/t/58e6a05cebbd1a572abfff49/1491509358206/IDL-55270.pdf.

Angel, S., A.M. Blei, D.L. Civco, and J. Parent. 2012. *Atlas of Urban Expansion*. Cambridge, MA: Lincoln Institute of Land Policy. https://www.lincolninst.edu/publications/books/atlas-urban-expansion.

Angel, S., D. de Groot, R. Martin, Y. Fisseha, T. Taffese, and P. Lamson-Hall. 2013. *The Ethiopia Urban Expansion Initiative: Interim Report 2*. New York: Marron Institute of Urban Management, New York University. https://marroninstitute.nyu.edu/uploads/content/Ethiopia_Interim_Report.pdf.

Anguelovski, I., J.J.T. Connolly, M. Garcia-Lamarca, H. Cole, and H. Pearsall. 2019. "New Scholarly Pathways on Green Gentrification: What Does the Urban 'Green Turn' Mean and Where Is It Going?" *Progress in Human Geography* 43 (6): 1064–86. https://doi.org/10.1177/0309132518803799.

ArchDaily. 2013. "Makoko Floating School/NLÉ." March 14. https://www.archdaily.com/344047/makoko-floating-school-nle-architects.

Archer, D. 2012. "Finance as the Key to Unlocking Community Potential: Savings, Funds and the ACCA Programme." *Environment and Urbanization* 24 (2): 423–40. https://doi.org/10.1177/0956247812449235.

Arrighi, J., B. Koelle, M. Coll Besa, M. Spires, J. Kavonic, D. Scott, A. Kadihasanoglu, C. Bharwani, and C. Jack. 2016. "Dialogue for Decision-Making: Unpacking the 'City Learning Lab' Approach." Future Resilience for African Cities and Lands Working Paper 1. Cape Town: Future Climate for Africa. http://www.fractal.org.za/wp-content/uploads/2017/03/RCCC-FRACTAL_wps-7-City-Learning-Lab-V4.pdf.

Asante-Wusu, I. 2020. "Why Local Solutions Are Best for Urban Water Supply in Ghana." The Conversation, March 16. https://theconversation.com/why-local-solutions-are-best-for-urban-water-supply-in-ghana-133236.

Atchia, S. 2020. "Conversation 3: Sustainable Infrastructure as the Key to Success." Presented at the Reframe Conversation Series, African Centre for Cities, University of Cape Town, October 7.

Attridge, S., and L. Engen. 2019. *Blended Finance in the Poorest Countries: The Need for a Better Approach*. London: ODI. https://cdn.odi.org/media/documents/12666.pdf.

AU (African Union). 2015. *Agenda 2063: The Africa We Want.* Addis Ababa: AU Commission. https://au.int/sites/default/files/documents/36204-doc-agenda2063_popular_version_en.pdf.

Auerbach, D. 2016. "Sustainable Sanitation Provision in Urban Slums—the Sanergy Case Study." In *Broken Pumps and Promises*, edited by E. Thomas, 211–16. Cham, Switzerland: Springer.

Ayenew, M. 1999. "The City of Addis Ababa: Policy Options for the Governance and Management of a City with Multiple Identity." Discussion Paper 2. Addis Ababa: Forum for Social Studies. https://www.fssethiopia.org/wp-content/uploads/2011/01/dr-dis-paper-2.pdf.

Bakker, K. 2007. "The 'Commons' versus the 'Commodity': Alter-globalization, Anti-privatization and the Human Right to Water in the Global South." *Antipode* 39 (3): 430–55. https://doi.org/10.1111/j.1467-8330.2007.00534.x.

Banana, E., B. Chitekwe-Biti, and A. Walnycki. 2015. "Co-producing Inclusive City-Wide Sanitation Strategies; Lessons from Chinhoyi, Zimbabwe." *Environment and Urbanization* 27 (1): 35–54. https://doi.org/10.1177/0956247815569683.

Barraqué, B., and S. Zandaryaa. 2011. "Urban Water Conflicts: Background and Conceptual Framework." In *Urban Water Conflicts*, edited by B. Barraqué, 1–14. London: CRC. https://doi.org/10.1201/b11584.

Bauknecht, D., T. Bischoff, K. Bizer, D.A. Heyen, M. Führ, P. Gailhofer, T. Proeger, and K. von der Leyen. 2019. "Exploring the Pathways: Regulatory Experiments for Sustainable Development—an Interdisciplinary Approach." Working Paper 22. Göttingen, Germany: Volkswirtschaftliches Institut für Mittelstand und Handwerk. https://www.econstor.eu/bitstream/10419/208382/1/1683885708.pdf.

Bendix, A. 2019. "Africa Cities like Ghana and Mozambique Running Out of Water, and the Continent Needs $66 Billion to Avoid a Crisis of Disease and Dehydration." Business Insider, March 19. https://www.businessinsider.com/african-cities-water-crisis-2019-3.

Berrisford, S., and P. McAuslan. 2017. *Reforming Urban Laws in Africa: A Practical Guide*. Rondebosch, South Africa: African Centre for Cities; Brussels: Cities Alliance; Nairobi: United Nations Human Settlements Programme; Pretoria: Urban LandMark. https://unhabitat.org/sites/default/files/2020/05/ulr-report_final_lr.pdf.

Beukes, A. 2015. "Making the Invisible Visible: Generating Data on 'Slums' at Local, City and Global Scales." Working Paper. London: International Institute for Environment and Development. http://pubs.iied.org/10757IIED.html.

Bhan, G., T. Calderia, K. Gillespie, and A. Simone. 2020. "The Pandemic, Southern Urbanisms and Collective Life." *Society & Space*, August 3. https://www.societyandspace.org/articles/the-pandemic-southern-urbanisms-and-collective-life?fbclid=IwAR2R5To125X920ernbgFQjBp3p5zMrjGTn5fTaRsgMVjLZ_kgevB6sBRabw.

Bigger, P., and N. Millington. 2020. "Getting Soaked? Climate Crisis, Adaptation Finance, and Racialized Austerity." *Environment and Planning E: Nature and Space* 3 (3): 601–23. https://doi.org/10.1177/2514848619876539.

Birkmann, J., M. Garschagen, F. Kraas, and N. Quang. 2010. "Adaptive Urban Governance: New Challenges for the Second Generation of Urban Adaptation Strategies to Climate Change." *Sustainability Science* 5 (2): 185–206. https://doi.org/10.1007/s11625-010-0111-3.

Bloch, R. 2012. *Integrating Urban Planning and Water Management in Sub-Saharan Africa*. Report produced for the World Bank. Birmingham, UK: GHK Consultants.

Blum, A.G., P.J. Ferraro, S.A. Archfield, and K.R. Ryberg. 2020. "Causal Effect of Impervious Cover on Annual Flood Magnitude for the United States." *Geophysical Research Letters* 47 (5): e2019GL086480. https://doi.org/10.1029/2019GL086480.

Bos, J.J., R.R. Brown, and M.A. Farrelly. 2013. "A Design Framework for Creating Social Learning Situations." *Global Environmental Change* 23 (2): 398–412. https://doi.org/10.1016/j.gloenvcha.2012.12.003.

Bourblanc, M., and D. Blanchon. 2014. "The Challenges of Rescaling South African Water Resources Management: Catchment Management Agencies and Interbasin Transfers." *Journal of Hydrology* 519 (Part C): 2381–91. https://doi.org/10.1016/j.jhydrol.2013.08.001.

Boyd, E., and S. Juhola. 2015. "Adaptive Climate Change Governance for Urban Resilience." *Urban Studies* 52 (7): 1234–64. https://doi.org/10.1177/0042098014527483.

Browder, G., S. Ozment, I. Rehberger Bescos, T. Gartner, and G.-M. Lange. 2019. *Integrating Green and Gray: Creating Next Generation Infrastructure*. Washington, DC: World Bank and World Resources Institute. https://files.wri.org/d8/s3fs-public/integrating-green-gray_0.pdf.

Brown, M. 2019. "Protecting Africa's Troubled Waters: Using Nature to Improve Water Security in Africa's Fast-Growing Cities." The Nature Conservancy, April 1. https://www.nature.org/en-us/what-we-do/our-insights/perspectives/source-water-protection-in-africa-/.

Brown, R.R., N. Keath, and T.H.F. Wong. 2009. "Urban Water Management in Cities: Historical, Current and Future Regimes." *Water Science & Technology* 59 (5): 847–55. https://doi.org/10.2166/wst.2009.029.

Carolini, G.Y. 2012. "Framing Water, Sanitation, and Hygiene Needs among Female-Headed Households in Periurban Maputo, Mozambique." *American Journal of Public Health* 102 (2): 256–61. https://doi.org/10.2105/AJPH.2011.300399.

Carolini, G.Y., and I. Cruxên. 2020. "The Harmonization of an Asset Class and Implications for Local Governance." In *The Routledge Handbook of Financial Geography*, edited by J. Knox-Hayes and D. Wójcik. New York: Routledge. https://doi.org/10.4324/9781351119061.

Carolini, G.Y., F. Gelaye, and K. Khan. 2020. "Modelling Improvements to Property Tax Collection: The Case of Addis Ababa." Working Paper 103. Brighton, UK: Institute of Development Studies. https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/14988/ICTD_WP103.pdf?sequence=1&isAllowed=y.

Carolini, G.Y., and P. Raman. 2020. "Why Detailing Spatial Equity Matters in Water and Sanitation Evaluations." *Journal of the American Planning Association* 87 (1): 101–7. https://doi.org/10.1080/01944363.2020.1788416.

Cartwright, A., I. Palmer, A. Taylor, E. Pieterse, S. Parnell, and S. Colenbrander. 2018. "Developing Prosperous and Inclusive Cities in Africa—National Urban Policies to the Rescue?" Working Paper. Washington, DC: Coalition for Urban Transitions, World Resources Institute. https://urbantransitions.global/wp-content/uploads/2019/08/CUT18_Africa_NatUrbanPolicies_final.pdf.

Cassim, Z., B. Handjiski, J. Schubert, and Y. Zouaoui. 2020. *The $10 Trillion Rescue: How Governments Can Deliver Impact*. Dubai, UAE: McKinsey. https://www.mckinsey.com/~/media/McKinsey/Industries/Public%20Sector/Our%20Insights/The%2010%20trillion%20dollar%20rescue%20How%20governments%20can%20deliver%20impact/The-10-trillion-dollar-rescue-How-governments-can-deliver-impact-vF.pdf.

Ceriops. n.d. "Ceriops Environmental Organization." https://www.ceriops.org/about.html. Accessed November 10, 2020.

Chen, M.A., and V.A. Beard. 2018. "Including the Excluded: Supporting Informal Workers for More Equal and Productive Cities in the Global South." Washington, DC: World Resources Institute. https://files.wri.org/s3fs-public/towards-more-equal-city-including-the-excluded_2.pdf.

Chitonge, H. 2014. "Cities beyond Networks: The Status of Water Services for the Urban Poor in African Cities." *African Studies* 73 (1): 58–83. https://doi.org/10.1080/00020184.2014.887743.

Chu, E., A. Brown, K. Michael, J. Du, S. Lwasa, and A. Mahendra. 2019. "Unlocking the Potential for Transformative Climate Adaptation in Cities." Background Paper. Washington, DC: World Resources Institute; Rotterdam, Netherlands: Global Commission on Adaptation. https://wrirosscities.org/sites/default/files/FINAL19_GCA_Cities_Background%20Paper.pdf.

Cirolia, L.R. 2020. "Fractured Fiscal Authority and Fragmented Infrastructures: Financing Sustainable Urban Development in Sub-Saharan Africa." *Habitat International* 104 (October): 102233. https://doi.org/10.1016/j.habitatint.2020.102233.

City of Cape Town. 2020. *Our Shared Water Future: Cape Town's Water Strategy*. Cape Town: City of Cape Town Water and Sanitation Department. https://resource.capetown.gov.za/documentcentre/Documents/City%20strategies,%20plans%20and%20frameworks/Cape%20Town%20Water%20Strategy.pdf.

City of Johannesburg. 2004. *Guide to the Urban Development Zone Tax Incentive for the Johannesburg Inner City*. Johannesburg: City of Johannesburg Finance and Economic Development Department.

ClimateWire. 2020. "Climate Impacts: Africa Is Warming Fast, Hitting the Most Vulnerable Hardest." October 28. https://www.eenews.net/stories/1063717191.

CODI (Community Organizations Development Institute). 2011. "Results: Statistics January 2011." Bangkok: CODI.

Cohen-Shacham, E., G. Walters, C. Janzen, and S. Maginnis, eds. 2016. *Nature-Based Solutions to Address Global Societal Challenges*. Gland, Switzerland: International Union for Conservation of Nature. https://portals.iucn.org/library/sites/library/files/documents/2016-036.pdf.

Convergence Finance. 2018. "State of Blended Finance 2018." Background Paper. Paris: Organisation for Economic Co-operation and Development. https://www.oecd.org/water/OECD-GIZ-Background-document-State-of-Blended-Finance-2018.pdf.

Cooper, R. 2020. *Water for the Urban Poor and Covid-19*. K4D Helpdesk Report 826. Brighton, UK: Institute of Development Studies. https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/15298/826_Water_for_the_urban_poor_and_Covid19.pdf?sequence=1&isAllowed=y.

Cormier-Salem, M.-C., A.E. Dunham, C. Gordon, D. Belhabib, N. Bennas, J. Duminil, B.N. Egoh, et al. 2018. "Chapter 3: Status, Trends and Future Dynamics of Biodiversity and Ecosystems Underpinning Nature's Contributions to People." In *The IPBES Regional Assessment Report on Biodiversity and Ecosystem Services for Africa*, edited by E. Archer, L. Dziba, K.J. Mulongoy, M.A. Maoela, and M. Walters, 131–206. Bonn, Germany: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers19-04/010075060.pdf.

Cote, M., and R. King. 2017. *Urban Resilience Planning for Secondary African Cities: A Case Study of Mozambique*. Washington, DC: U.S. Agency for International Development.

Cui, Y., D. Cheng, C.E. Choi, W. Jin, Y. Lei, and J.S. Kargel. 2019. "The Cost of Rapid and Haphazard Urbanization: Lessons Learned from the Freetown Landslide Disaster." *Landslides* 16 (June): 1167–76. https://doi.org/10.1007/s10346-019-01167-x.

CURI (Centre for Urban Research and Innovations) and Muungano wa Wanavijiji. 2014. "Mukuru Situational Analysis Phase 1 Report: Improving Access to Justice and Basic Service." Research Paper. Nairobi: CURI, University of Nairobi, and Muungano wa Wanavijiji.

Dagdeviren, H. 2008. "Waiting for Miracles: The Commercialization of Urban Water Services in Zambia." *Development and Change* 39 (1): 101–21. https://doi.org/10.1111/j.1467-7660.2008.00470.x.

Damania, R., S. Desbureaux, M. Hyland, A. Islam, S. Moore, A.-S. Rodella, J. Russ, and E. Zaveri. 2017. *Uncharted Waters: The New Economics of Water Scarcity and Variability*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/28096.

Daniels, L. 2019. "Exploring the Power of Collaboration to Address Climate Change in Urban Africa." Future Resilience for African Cities and Lands, February 6. http://www.fractal.org.za/2019/02/06/exploring-the-power-of-collaboration-to-address-climate-change-in-urban-africa/.

DeGhetto, K., J.R. Gray, and M.N. Kiggundu. 2016. "The African Union's Agenda 2063: Aspirations, Challenges, and Opportunities for Management Research." *Africa Journal of Management* 2 (1): 93–116. https://doi.org/10.1080/23322373.2015.1127090.

Delgado, G., A. Muller, R. Mabakeng, and M. Namupala. 2020. "Co-producing Land for Housing through Informal Settlement Upgrading: Lessons from a Namibian Municipality." Environment and Urbanization 32 (1): 175–94. https://doi.org/10.1177/0956247820903981.

Deltares. n.d. "Dar Es Salaam: Participatory Modelling of Floods Using Community Mapped OpenStreetMap Data." https://www.deltares.nl/en/projects/participatory-modelling-of-floods-using-community-mapped-openstreetmap-data. Accessed September 15, 2020.

Dodman, D. 2017. "A Special Approach to Slum Upgrading: The Special Planning Area in Mukuru, Nairobi." Urban Africa Risk Knowledge, December 10. https://www.urbanark.org/special-approach-slum-upgrading-special-planning-area-mukuru-nairobi.

Douglas, I., D. Goode, M. Houck, and D. Maddox, eds. 2010. *Handbook of Urban Ecology*. Abingdon, UK: Routledge Handbooks Online. https://doi.org/10.4324/9780203839263.

DPPC (Disaster Preparedness and Prevention Center). 2015. *Addis Ababa City Risk Profiling Program Report*. Addis Ababa: DPPC.

Dudley, N., and S. Stolton. 2003. *Running Pure: The Importance of Forest Protected Areas to Drinking Water*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/15006.

Duru, U., and A. Nyong. 2016. "Why Africa Needs Green Bonds." *Africa Economic Brief* 7 (2). https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/AEB_Vol_7_Issue_2_Why_Africa_Needs_Green_Bonds.pdf.

Eberhard, R. 2018. *Access to Water and Sanitation in Sub-Saharan Africa: Review of Sector Reforms and Investments, Key Findings to Inform Future Support to Sector Development*. Eschborn, Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit. https://www.oecd.org/water/GIZ_2018_Access_Study_Part%20I_Synthesis_Report.pdf.

Endale, A. 2013. "Project Office to Study Jemo Condominium Site Suitability." *Addis Fortune*, August 4. https://addisfortune.net/articles/project-office-to-study-jemo-condominium-site-suitability/.

Enqvist, J.P., and G. Ziervogel. 2019. "Water Governance and Justice in Cape Town: An Overview." *Wiley Interdisciplinary Reviews: Water* 6 (4): e1354. https://doi.org/10.1002/wat2.1354.

EORC (Earth Observation Research Center) and JAXA (Japan Aerospace Exploration Agency). n.d. (Database.) *Advanced Land Observing Satellite (ALOS) Global Digital Surface Model*. https://www.eorc.jaxa.jp/ALOS/en/aw3d30/index.htm. Accessed May 20, 2021.

European Commission. 2015. (Database.) *Joint Research Centre Data*. https://data.jrc.ec.europa.eu/dataset?sort=sort_criteria+desc%2C+title_string+asc. Accessed May 19, 2021.

Evans, D.M., A.L. Browne, and I.A. Gortemaker. 2018. "Environmental Leapfrogging and Everyday Climate Cultures: Sustainable Water Consumption in the Global South." *Climatic Change* 163 (November): 83–97. https://doi.org/10.1007/s10584-018-2331-y.

FAO (Food and Agriculture Organization of the United Nations). n.d. (Database.) *GeoNetwork*. http://www.fao.org/geonetwork/. Accessed May 19, 2021.

Faurès, J.-M., and G. Santini, eds. 2008. *Water and the Rural Poor Interventions for Improving Livelihoods in Sub-Saharan Africa*. Rome: Land and Water Division, Food and Agriculture Organization of the United Nations. http://www.fao.org/3/i0132e/i0132e.pdf.

Fernández, J.E. 2014. "Urban Metabolism of the Global South." In *The Routledge Handbook of Cities of the Global South*, edited by S. Parnell and S. Oldfield, 522–38. New York: Routledge. https://doi.org/10.4324/9780203387832.ch49.

Fisher-Jeffes, L., K. Carden, and N. Armitage. 2017. "A Water Sensitive Urban Design Framework for South Africa." *Town and Regional Planning* 71 (December): 1–10. https://doi.org/10.18820/2415-0495/trp71i1.1.

Fjeldstad, O.-H., and K. Heggstad. 2012. "Local Government Revenue Mobilisation in Anglophone Africa." Working Paper 7. Brighton, UK: Institute of Development Studies. https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/2302/ICTD%20WP7.pdf.

Foster, V., and C. Briceño-Garmendia. 2010. *Africa's Infrastructure: A Time for Transformation*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/2692.

Fox, S. 2014. "The Political Economy of Slums: Theory and Evidence from Sub-Saharan Africa." *World Development* 54 (February): 191–203. https://doi.org/10.1016/j.worlddev.2013.08.005.

GADM (Global Administrative Areas). 2018. (Database) *GADM Data*. Version 3.1. https://gadm.org/data.html. Accessed May 19, 2021.

Gartner, E.T., J. Mulligan, R. Schmidt, and J. Gunn. 2013. *Natural Infrastructure Investing in Forested Landscapes for Source Water Protection in the United States*. Washington, DC: World Resources Institute. https://files.wri.org/d8/s3fs-public/wri13_report_4c_naturalinfrastructure_v2.pdf.

GCA (Global Commission on Adaptation). 2019. *A Global Call for Leadership on Climate Resilience*. Rotterdam, Netherlands: Global Center on Adaptation; Washington, DC: World Resources Institute. https://reliefweb.int/sites/reliefweb.int/files/resources/GlobalCommission_Report_FINAL.pdf.

Gebrehiwot, S.G., D. Ellison, W. Bewket, Y. Seleshi, B.-I. Inogwabini, and K. Bishop. 2019. "The Nile Basin Waters and the West African Rainforest: Rethinking the Boundaries." *Wiley Interdisciplinary Reviews: Water* 6 (1): e1317. https://doi.org/10.1002/wat2.1317.

Gelaye, F. 2018. "Converging Intentions, Diverging Realities: Rights vs. Growth-Based Approaches to Safe Sanitation Provision in Addis Ababa, Ethiopia." PhD diss., Massachusetts Institute of Technology.

Getahun, E. 2020. "Ethiopia to Grow 5 Billion Trees in the Second Green Legacy Campaign." World Agroforestry, June 9. https://www.worldagroforestry.org/blog/2020/06/09/ethiopia-grow-5-billion-trees-second-green-legacy-campaign.

Gibbens, S. 2017. "Explaining the Deadly Sierra Leone Mudslide." *National Geographic*, August 16. https://www.nationalgeographic.com/science/article/sierra-leone-mudslide-deadly-video-spd.

Goldman, M. 2015. "Development and the City." In *Cities of the Global South Reader*, edited by F. Miraftab and N. Kudva, 54–65. Abingdon, UK: Routledge.

Goodfellow, T. 2013. "Urban Planning in Africa and the Politics of Implementation: Contrasting Patterns of State Intervention in Kampala and Kigali." In *Living the City in Africa: Processes of Invention and Intervention*, edited by B. Obrist, V. Arlt, and E. Macamo, 45–62. Berlin: LIT Verlag.

Goodfellow, T. 2017. "Urban Fortunes and Skeleton Cityscapes: Real Estate and Late Urbanization in Kigali and Addis Ababa." *International Journal of Urban and Regional Research* 41 (5): 786–803. https://doi.org/10.1111/1468-2427.12550.

Goodfellow, T. 2020. "Finance, Infrastructure and Urban Capital: The Political Economy of African 'Gap-Filling.'" *Review of African Political Economy* 47 (164): 256–74. https://doi.org/10.1080/03056244.2020.1722088.

Gorelick, J. 2018a. "The Real Reason Why Cities in Sub-Saharan Africa Aren't Issuing Municipal Bonds." The Conversation, February 14. http://theconversation.com/the-real-reason-why-cities-in-sub-saharan-africa-arent-issuing-municipal-bonds-91688.

Gorelick, J. 2018b. "Supporting the Future of Municipal Bonds in Sub-Saharan Africa: The Centrality of Enabling Environments and Regulatory Frameworks." *Environment and Urbanization* 30 (1): 103–22. https://doi.org/10.1177/0956247817741853.

Grasham, C.F., M. Korzenevica, and K.J. Charles. 2019. "On Considering Climate Resilience in Urban Water Security: A Review of the Vulnerability of the Urban Poor in Sub-Saharan Africa." *Wiley Interdisciplinary Reviews: Water* 6 (3): e1344. https://doi.org/10.1002/wat2.1344.

Greenland, K., J. de-Witt Huberts, R. Wright, L. Hawkes, C. Ekor, and A. Brian. 2016. "A Cross-Sectional Survey to Assess Household Sanitation Practices Associated with Uptake of 'Clean Team' Serviced Home Toilets in Kumasi, Ghana." *Environment and Urbanization* 28 (2): 583–98. https://doi.org/10.1177/0956247816647343.

Grey, D., and C.W. Sadoff. 2007. "Sink or Swim? Water Security for Growth and Development." *Water Policy* 9 (6): 545–71. https://doi.org/10.2166/wp.2007.021.

GWOPA (Global Water Operators' Partnerships Alliance). n.d. "About WOPs." https://gwopa.org/wops/about-wops/. Accessed November 6, 2020.

Habinshuti N., J. 2020. "Kigali's Response to COVID-19: Hygiene in Public Places." Presented at the Cities on the Frontline speaker series, "Water and Sanitation: WASH in Crisis and Recovery," July 23. https://resilientcitiesnetwork.org/downloadable_resources/UR/SP/20-Japheth-Habinshuti-N.pdf

Habtemariam, L.W. 2016. "Integrated and Coordinated Physical and Transport Infrastructure Planning and Development in Addis Ababa." Unpublished Working Paper for the Addis Ababa City Government Transport Programs Management Office and Addis Ababa University.

Habtemariam, L.W. 2019. "Institutional Transition to a Water Sensitive City: The Case of Addis Ababa." PhD monograph submitted to Addis Ababa University, Ethiopian Institute of Architecture, Building Construction and City Development.

Habtemariam, L.W., L.B. Herslund, and P. Mguni. 2019. "What Makes a Champion for Landscape-Based Storm Water Management in Addis Ababa?" *Sustainable Cities and Society* 46 (April): 101378. https://doi.org/10.1016/j.scs.2018.12.006.

Habtemariam, L.W., K. Tufa, L.B. Herslund, and P. Mguni. 2018. "Taking a Livelihood Perspective to Building Urban Water Resilience: Potential and Challenges in Addis Ababa." *Progress in Development Studies* 18 (4): 235–51. https://doi.org/10.1177/1464993418786775.å

Hailu, R., D. Tolossa, and G. Alemu. 2018. "Water Institutions in the Awash Basin of Ethiopia: The Discrepancies between Rhetoric and Realities." *International Journal of River Basin Management* 16 (1): 107–21. https://doi.org/10.1080/15715124.2017.1387126.

Hamed, Y., R. Hadji, B. Redhaounia, K. Zighmi, F. Bâali, and A. El Gayar. 2018. "Climate Impact on Surface and Groundwater in North Africa: A Global Synthesis of Findings and Recommendations." *Euro-Mediterranean Journal for Environmental Integration* 3 (25): 1–15. https://doi.org/10.1007/s41207-018-0067-8.

Hansen, M.C., P.V. Potapov, R. Moore, M. Hancher, S.A. Turubanova, A. Tyukavina, D. Thau, et al. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." *Science* 342 (November): 850–53. http://earthenginepartners.appspot.com/science-2013-global-forest.

Harrington, L.J., and F.E.L. Otto. 2020. "Reconciling Theory with the Reality of African Heatwaves." *Nature Climate Change* 10 (September): 796–98. https://doi.org/10.1038/s41558-020-0851-8.

Harris, R., and F. Miraftab. 2015. "International Policy for Urban Housing Markets in the Global South since 1945." In *Cities of the Global South Reader*, edited by F. Miraftab and N. Kudva, 122–33. Abingdon, UK: Routledge.

Herslund, L., A. Backhaus, O. Fryd, G. Jørgensen, M.B. Jensen, T.M. Limbumba, L. Liu, P. Mguni, M. Mkupasi, and L. Workalemahu. 2018. "Conditions and Opportunities for Green Infrastructure–Aiming for Green, Water-Resilient Cities in Addis Ababa and Dar Es Salaam." *Landscape and Urban Planning* 180 (December): 319–27. https://doi.org/10.1016/j.landurbplan.2016.10.008.

Herslund, L., and P. Mguni. 2019. "Examining Urban Water Management Practices—Challenges and Possibilities for Transitions to Sustainable Urban Water Management in Sub-Saharan Cities." *Sustainable Cities and Society* 48 (July): 101573. https://doi.org/10.1016/j.scs.2019.101573.

Heymans, C., R. Eberhard, D. Ehrhardt, and S. Riley. 2016. *Providing Water to Poor People in African Cities Effectively: Lessons from Utility Reforms*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/25115.

Hirsh, H. 2019. "South Africa Needs a Fresh Approach to Managing Invasive Trees like Eucalyptus." The Conversation, December 5. https://theconversation.com/south-africa-needs-a-fresh-approach-to-managing-invasive-trees-like-eucalyptus-126777.

Hitayezu, P., A. Rajashekar, and D. Stoelinga. 2018. *The Dynamics of Unplanned Settlements in the City of Kigali*. Report C-38312-RWA-1. London: International Growth Centre.

Hofste, R.W., S. Kuzma, S. Walker, E.H. Sutanudjaja, M.F. Bierkens, M.J. Kuijper, M.F. Sanchez, et al. 2019. *Aqueduct 3.0: Updated Decision-Relevant Global Water Risk Indicators*. Washington, DC: World Resources Institute. https://files.wri.org/d8/s3fs-public/aqueduct-30-updated-decision-relevant-global-water-risk-indicators_1.pdf.

Horn, P., J. Kimani, J. Makau, and P. Ngoroge. 2020. *Scaling Participation in Informal Settlement Upgrading: A Documentation of Community Mobilisation and Consultation in the Mukuru Special Planning Area, Nairobi, Kenya*. Manchester, UK: Global Development Institute, University of Manchester. http://hummedia.manchester.ac.uk/institutes/gdi/publications/workingpapers/scaling-participation-horn-et-al.pdf.

Hutton, G. 2012. *Global Costs and Benefits of Drinking-Water Supply and Sanitation Interventions to Reach the MDG Target and Universal Coverage*. Geneva: World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/75140/WHO_HSE_WSH_12.01_eng.pdf?sequence=1.

ICLEI (International Council for Local Environmental Initiatives). 2019. "Lived Experience Shapes Climate Research: Using Community Insight to Understand Hazards, Risks, and Disaster Implications in Rwanda." https://africa.iclei.org/lived-experience-shapes-climate-research-using-community-insight-to-understand-hazards-risks-and-disaster-implications-in-rwanda/.

IIED (International Institute for Environment and Development). 2017. *Devolved Climate Finance: An Alliance of Government and Non-government Organisations Promoting Community-Prioritised Investment for Climate Adaptation*. London: IIED. https://greengrowthknowledge.org/sites/default/files/downloads/resource/Devolved%20Climate%20FInance.pdf.

Ilunga, R., and J. Cullis. 2020. *Bottom-Up Adaptive Decision-Support for Resilient Urban Water Security: Lusaka Case Study*. Cape Town: Future Resilience for African Cities and Lands, Future Climate for Africa. http://www.fractal.org.za/wp-content/uploads/2020/08/Ilunga-and-Cullis-Bottom-Up-Adaptive-Decision-Support-for-Resilient-Urban-Water-Security-web.pdf.

International Budget Partnership. n.d. "Kenya." https://www.internationalbudget.org/budget-work-by-country/kenya/. Accessed September 15, 2020.

IUCN (International Union for Conservation of Nature). 2020. "People, Nature and Justice: Ecosystem-Based Adaptation in Cities of the Global South." November 9. https://www.iucn.org/news/ecosystem-management/202011/people-nature-and-justice-ecosystem-based-adaptation-cities-global-south-0.

Jacobsen, M., M. Webster, and K. Vairavamoorthy. 2013. *The Future of Water in African Cities: Why Waste Water?* Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/11964.

Jaglin, S. 2002. "The Right to Water versus Cost Recovery: Participation, Urban Water Supply and the Poor in Sub-Saharan Africa." *Environment and Urbanization* 14 (1): 231–45. https://doi.org/10.1177/095624780201400119.

Jaglin, S. 2014. "Regulating Service Delivery in Southern Cities: Rethinking Urban Heterogeneity." In *The Routledge Handbook on Cities of the Global South*, edited by S. Parnell and S. Oldfield. Abingdon, UK: Routledge Handbooks Online. https://doi.org/10.4324/9780203387832.ch37.

Jefferies, C., and A. Duffy. 2011. *The SWITCH Transition Manual*. Dundee, UK: Abertay University.

Johannessen, A., and C. Wamsler. 2017. "What Does Resilience Mean for Urban Water Services?" *Ecology and Society* 22 (1). https://doi.org/10.5751/ES-08870-220101.

Juno, E., and J.R. Pool. 2020. "Forests Near or Far Can Protect Water for Cities." *Insights* (blog), September 23. https://www.wri.org/blog/2020/cities-forests-water-supplies.

Kadigi, R.M., G. Tesfay, A. Bizoza, and G. Zinabou. 2012. *Irrigation and Water Use Efficiency in Sub-Saharan Africa*. Briefing Paper 4. New Delhi: Global Development Network.

Kareem, B., S. Lwasa, D. Tugume, P. Mukwaya, J. Walubwa, S. Owuor, P. Kasaija, H. Sseviiri, G. Nsangi, and D. Byarugaba. 2020. "Pathways for Resilience to Climate Change in African Cities." *Environmental Research Letters* 15 (7): 073002. https://doi.org/10.1088/1748-9326/ab7951.

Kareem, S.D., A.K. Olusegun, O.A. Sunkanmi, L.S. Arogundade, and K.K. Ibrahim. 2017. "Climate Change and Economic Development: Sub-Saharan Africa Experience." *International Journal of Social Sciences & Humanities Review* 7 (1). https://www.ijsshr.com/journal/index.php/IJSSHR/article/view/303.

Karuaihe, S.T. 2019. "Namibia's Urban Poor Are Stuck in Limbo, without Land or Services." The Conversation, September 19. http://theconversation.com/namibias-urban-poor-are-stuck-in-limbo-without-land-or-services-122870.

KDI (Kounkuey Design Initiative). n.d. "The Kibera Public Space Project." https://www.kounkuey.org/projects/kibera_public_space_project_network. Accessed September 15, 2020.

Keivani, R., and E. Werna. 2001. "Modes of Housing Provision in Developing Countries." *Progress in Planning* 55 (2): 65–118. https://doi.org/10.1016/S0305-9006(00)00022-2.

Khalil, D. 2019. "The Flexible Governance of Water in Cairo's Informal Areas." *Water* 11 (8): 1644. https://doi.org/10.3390/w11081644.

King, R., M. Orloff, T. Virsilas, and T. Pande. 2017. "Confronting the Urban Housing Crisis in the Global South: Adequate, Secure, and Affordable Housing." Working Paper. Washington, DC: World Resources Institute. https://www.wri.org/publication/towards-more-equal-city-confronting-urban-housing-crisis-global-south.

Koehnken, L., M.S. Rintoul, M. Goichot, D. Tickner, A.-C. Loftus, and M.C. Acreman. 2020. "Impacts of Riverine Sand Mining on Freshwater Ecosystems: A Review of the Scientific Evidence and Guidance for Future Research." *River Research and Applications* 36 (3): 362–70. https://doi.org/10.1002/rra.3586.

Kyessi, A.G. 2005. "Community-Based Urban Water Management in Fringe Neighbourhoods: The Case of Dar Es Salaam, Tanzania." *Habitat International* 29 (1): 1–25. https://doi.org/10.1016/S0197-3975(03)00059-6.

Lamson-Hall, P., S. Angel, D. DeGroot, R. Martin, and T. Tafesse. 2019. "A New Plan for African Cities: The Ethiopia Urban Expansion Initiative." *Urban Studies* 56 (6): 1234–49. https://doi.org/10.1177/0042098018757601.

Langford, M., and A.F. Russell. 2017. *The Human Right to Water: Theory, Practice and Prospects*. Cambridge: Cambridge University Press. https://doi.org/10.1017/9780511862601.

Lawhon, M., H. Ernstson, and J. Silver. 2014. "Provincializing Urban Political Ecology: Towards a Situated UPE through African Urbanism." *Antipode* 46 (2): 497–516. https://doi.org/10.1111/anti.12051.

Lebling, K., M. Ge, K. Levin, R. Waite, J. Friedrich, C. Elliott, C. Chan, K. Ross, F. Stolle, and N. Harris. 2020. *State of Climate Action: Assessing Progress toward 2030 and 2050*. Washington, DC: World Resources Institute. https://doi.org/10.46830/wrirpt.20.00001.

Lewis, E.W., N. Siyambango, and S. Lendelvo. 2018. "Assessment of Accessibility of Safe Drinking Water: A Case Study of the Goreangab Informal Settlement, Windhoek, Namibia." *Water Practice & Technology* 13 (4): 871–78. https://doi.org/10.2166/wpt.2018.096.

Lines, K., and J. Makau. 2017. "Muungano Nguvu Yetu (Unity Is Strength): 20 Years of the Kenyan Federation of Slum Dwellers." Working Paper. London: International Institute for Environment and Development. https://pubs.iied.org/sites/default/files/pdfs/migrate/10807IIED.pdf.

Lines, K., and J. Makau. 2018. "Taking the Long View: 20 Years of Muungano wa Wanavijiji, the Kenyan Federation of Slum Dwellers." *Environment and Urbanization* 30 (2): 407–24. https://doi.org/10.1177/0956247818785327.

Logan, J.R., and H. Molotch. 2007. *Urban Fortunes: The Political Economy of Place, with a New Preface*. Berkeley: University of California Press.

LuWSi (Lusaka Water Security Initiative). 2020. "LuWSI's Origins." https://www.luwsi.org/index.php/about-luwsi/origins.

Lwasa, S., F. Mugagga, B. Wahab, D. Simon, J.P. Connors, and C. Griffith. 2015. "A Meta-analysis of Urban and Peri-urban Agriculture and Forestry in Mediating Climate Change." *Current Opinion in Environmental Sustainability* 13: 68–73. https://doi.org/10.1016/j.cosust.2015.02.003.

Lwasa, S., and K. Owens. 2018. *Kampala: Rebuilding Public Sector Legitimacy with a New Approach to Sanitation Services*. Washington, DC: World Resources Institute. https://files.wri.org/s3fs-public/kampala-rebuilding-public-sector-legitimacy-new-approach-sanitation-services.pdf.

Mabogunje, A.L. 1990. "Urban Planning and the Post-colonial State in Africa: A Research Overview 1." *African Studies Review* 33 (2): 121–203. https://doi.org/10.2307/524471.

Mahendra, A., R. King, E. Gray, M. Hart, L. Azeredo, L. Betti, S. Prakash, A. Deb, E. Ashebir, and A. Ibrahim. 2020. "Urban Land Value Capture in São Paulo, Addis Ababa, and Hyderabad: Differing Interpretations, Equity Impacts, and Enabling Conditions." Working Paper. Cambridge, MA: Lincoln Institute of Land Policy. http://www.wri.org/publication/urban-land-value-capture.

Mahendra, A., and K.C. Seto. 2019. "Upward and Outward Growth: Managing Urban Expansion for More Equitable Cities in the Global South." Working Paper. Washington, DC: World Resources Institute. https://files.wri.org/s3fs-public/upward-outward-growth_2.pdf.

Majale, M., G. Tipple, and M. French. 2011. *Affordable Land and Housing in Africa*. Vol. 3. Nairobi: United Nations Human Settlements Programme. https://unhabitat.org/sites/default/files/download-manager-files/Affordable%20Land%20and%20Housing%20in%20Africa.pdf.

Makwara, E.C. 2011. "Water: An Economic or Social Good?" *Journal of Social Development in Africa* 26 (2): 141. https://www.ajol.info/index.php/jsda/article/view/75632.

Mansaray, L.R., J. Huang, and A.A. Kamara. 2016. "Mapping Deforestation and Urban Expansion in Freetown, Sierra Leone, from Pre- to Post-war Economic Recovery." *Environmental Monitoring and Assessment* 188 (8): 1–16. https://doi.org/10.1007/s10661-016-5469-y.

Mascarenhas, M. 2015. "Sovereignty: Crisis, Humanitarianism, and the Condition of 21st Century Sovereignty." In *Cities of the Global South Reader*, edited by F. Miraftab and N. Kudva, 248–53. Abingdon, UK: Routledge.

Mason, N., S. Pickard, C. Watson, B. Klanten, and R. Calow. 2020. *Just Add Water: A Landscape Analysis of Climate Finance for Water.* London: WaterAid and Overseas Development Institute. https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/just-add-water-a-landscape-analysis-of-climate-finance-for-water.pdf.

Massarutto, A. 2011. "Urban Water Conflicts and Sustainability: An Ecological-Economic Approach." In *Urban Water Conflicts*, edited by B. Barraqué, 285–309. London: CRC. https://doi.org/10.1201/b11584.

McClure, A. 2020. *Towards an Inclusive, Reflexive Learning Approach for Dealing with Climate Risks in Cities*. Cape Town: Future Resilience for African Cities and Lands, Future Climate for Africa. http://www.fractal.org.za/wp-content/uploads/2020/07/Towards-an-inclusive-reflexive-learning-approach.pdf.

McDonald, D.A. 2016. "The Weight of Water: Benchmarking for Public Water Services." *Environment and Planning A: Economy and Space* 48 (11): 2181–2200. https://doi.org/10.1177/0308518X16654913.

McDonald, R.I., M. Colbert, M. Hamann, R. Simkin, and B. Walsh. 2018. "Nature in the Urban Century: A Global Assessment of Where and How to Conserve Nature for Biodiversity and Human Wellbeing." Arlington, VA: The Nature Conservancy. https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_NatureintheUrbanCentury_FullReport.pdf.

McDonald, R.I., I. Douglas, N.B. Grimm, R. Hale, C. Revenga, J. Gronwall, and B. Fekete. 2011. "Implications of Fast Urban Growth for Freshwater Provision." *Ambio* 40 (July): 437. https://doi.org/10.1007/s13280-011-0152-6.

McDonald, R.I., P.J. Marcotullio, and B. Güneralp. 2013. "Urbanization and Global Trends in Biodiversity and Ecosystem Services." In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*, edited by T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P.J. Marcotullio, R.I. McDonald, Susan Parnell, et. al., 31–52. Dordrecht, Netherlands: Springer. https://link.springer.com/content/pdf/10.1007%2F978-94-007-7088-1.pdf.

McDonald, R.I, and D. Shemie. 2014. *Urban Water Blueprint: Mapping Conservation Solutions to the Global Water Challenge*. Arlington, VA: The Nature Conservancy. https://www.nature.org/content/dam/tnc/nature/en/documents/Urban_Water_Blueprint.pdf.

McDonald, R.I., K. Weber, J. Padowski, M. Flörke, C. Schneider, P.A. Green, T. Gleeson, et al. 2014. "Water on an Urban Planet: Urbanization and the Reach of Urban Water Infrastructure." *Global Environmental Change* 27 (July): 96–105. https://doi.org/10.1016/j.gloenvcha.2014.04.022.

McGranahan, G., D. Balk, and B. Anderson. 2007. "The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones." *Environment and Urbanization* 19 (1): 17–37. https://doi.org/10.1177/0956247807076960.

McGranahan, G., D. Schensul, and G. Singh. 2016a. "Inclusive Urbanization: Can the 2030 Agenda Be Delivered without It?" *Environment and Urbanizatio*n 28 (1): 13–34. https://doi.org/10.1177/0956247815627522.

McGranahan, G., A. Walnycki, F. Dominick, W. Kombe, A. Kyessi, T.M. Limbumba, H. Magambo, M. Mkanga, and T. Ndezi. 2016b. "Universalising Water and Sanitation Coverage in Urban Areas: From Global Targets to Local Realities in Dar Es Salaam, and Back." Working Paper. London: International Institute for Environment and Development. https://pubs.iied.org/sites/default/files/pdfs/migrate/10812IIED.pdf.

Meghji, N. 2020. "From Freetown to 'Treetown': Can Urban Reforestation Build Environmental Resilience in Sierra Leone?" *Hidden Voices Salone*, August 6. https://www.hvsl.org/post/from-freetown-to-treetown-can-urban-reforestation-build-environmental-resilience-in-sierra-leone.

Mgquba, S.K., and S. Majozi. 2020. "Climate Change and Its Impacts on Hydro-politics in Transboundary Basins: A Case Study of the Orange-Senqu River Basin." *Journal of Water and Climate Change* 11 (1): 150–65. https://doi.org/10.2166/wcc.2018.166.

Mguni, P. 2015. "Sustainability Transitions in the Developing World: Exploring the Potential for Integrating Sustainable Urban Drainage Systems in the Sub-Saharan Cities." PhD diss., Department of Geosciences and Natural Resource Management, Faculty of Science, University of Copenhagen. https://ign.ku.dk/english/employees/landscape-architecture-planning/?pure=en%2Fpublications%2Fsustainability-transitions-in-the-developing-world(11b2abc8-9e32-4efd-8272-048079609ff7)%2Fexport.html.

Mguni, P., B. van Vliet, G. Spaargaren, D. Nakirya, J. Osuret, J.B. Isunju, T. Ssekamatte, and R. Mugambe. 2020. "What Could Go Wrong with Cooking? Exploring Vulnerability at the Water, Energy and Food Nexus in Kampala through a Social Practices Lens." *Global Environmental Change* 63 (July): 102086. https://doi.org/10.1016/j.gloenvcha.2020.102086.

Miraftab, F., and N. Kudva, eds. 2015. *Cities of the Global South Reader.* Abingdon, UK: Routledge. https://www.routledge.com/Cities-of-the-Global-South-Reader/Miraftab-Kudva/p/book/9780415682275.

Mitlin, D., V.A. Beard, D. Satterthwaite, and J. Du. 2019. "Unaffordable and Undrinkable: Rethinking Urban Water Access in the Global South." Working Paper. Washington, DC: World Resources Institute. https://files.wri.org/s3fs-public/unaffordable-and-undrinkable_1.pdf?0uVIZD2e049wT2jmVmghaDcGL8RnEt2B.

Mokone, A. 2017. "City of Cape Town Green Bond." Water Online, November 20. http://www.waterafrica.co.za/index.php/features/water-usage/102-city-of-cape-town-green-bond.

Moullier, T., and F. Krimgold. 2015. *Building Regulation for Resilience: Managing Risks for Safer Cities*. Washington, DC: Global Facility for Disaster Reduction and Recovery, World Bank. https://openknowledge.worldbank.org/bitstream/handle/10986/24438/Building0regul0sks0for0safer0cities.pdf.

Muggah, R., and K. Hill. 2018. "African Cities Will Double in Population by 2050. Here Are 4 Ways to Make Sure They Thrive." World Economic Forum, June 27. https://www.weforum.org/agenda/2018/06/Africa-urbanization-cities-double-population-2050-4%20ways-thrive/.

Mugo, K., S. Metcalfe, and J. Du. 2020. "Urban Sanitation Is a Climate and Economic Issue Too." *TheCityFix* (blog), November 19. https://thecityfix.com/blog/urban-sanitation-is-a-climate-and-economic-issue-too/.

Mukhtarov, F., and K.A. Daniell. 2018. "Transfer, Diffusion, Adaptation, and Translation of Water Policy Models." In *The Oxford Handbook of Water Politics and Policy*, edited by K. Conca and E. Weinthal, 594–616. New York: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199335084.013.30.

Mukwazhi, T. 2020. "Virus Diary: Staving Off the Virus while Our Water Runs Out." AP News, May 5. https://apnews.com/article/bb11704ee824dc6d8b1996ea3a577824.

Mulikita, N.M. 2013. "Creating Capable Developmental States in Africa: An Essential Driver for Realization of Agenda 2063." *Cahiers Africains d'Administration Publique* 81 (December): 121–37. https://search.emarefa.net/detail/BIM-788341.

Muller, M. 2008. "Free Basic Water—a Sustainable Instrument for a Sustainable Future in South Africa." *Environment & Urbanization* 20 (1). https://doi.org/10.1177/0956247808089149.

Muller, M. 2016. "Urban Water Security in Africa: The Face of Climate and Development Challenges." *Development Southern Africa* 33 (1): 67–80. https://doi.org/10.1080/0376835X.2015.1113121.

Muller, M. 2018. "Lessons from Cape Town's Drought." *Nature*, July 12. https://media.nature.com/original/magazine-assets/d41586-018-05649-1/d41586-018-05649-1.pdf.

Mulligan, J., V. Bukachi, J.C. Clause, R. Jewell, F. Kirimi, and C. Odbert. 2020. "Hybrid Infrastructures, Hybrid Governance: New Evidence from Nairobi (Kenya) on Green-Blue-Grey Infrastructure in Informal Settlements." *Anthropocene* 29 (March): 100227. https://doi.org/10.1016/j.ancene.2019.100227.

Mumssen, Y., G. Saltiel, and B. Kingdom. 2018. *Aligning Institutions and Incentives for Sustainable Water Supply and Sanitation Services*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/29795.

Municipality of Beira. 2019. *Beira Municipal Recovery and Resilience Plan—Volume 1, Main Report*. Beira, Mozambique: Municipality of Beira. https://www.dutchwatersector.com/sites/default/files/2019-06/Summary%20Beira%20Municipal%20Recovery%20and%20Resilience%20Plan.pdf.

Murray, R. 2017. "An Introductory Guide for the SADC Groundwater Management Institute Including the Windhoek Case Study." Cape Town: Groundwater Africa.

Nastar, M., S. Abbas, C. Aponte Rivero, S. Jenkins, and M. Kooy. 2018. "The Emancipatory Promise of Participatory Water Governance for the Urban Poor: Reflections on the Transition Management Approach in the Cities of Dodowa, Ghana and Arusha, Tanzania." *African Studies* 77 (4): 504–25. https://doi.org/10.1080/00020184.2018.1459287.

Ndaruzaniye, V., L. Lipper, D. Fiott, A. Flavell, and J. Clover. 2010. "Climate Change and Security in Africa." Vulnerability Discussion Paper. Rome: Food and Agriculture Organization of the United Nations; Nairobi: United Nations Environment Programme; Columbus, OH: Global Water Institute; Brussels: Madariaga—College of Europe Foundation; Grand-Saconnex, Switzerland: International Organization for Migration.

Ndaw, F. 2020. "COVID-19: Solving Africa's Water Crisis Is More Urgent than Ever." *Nasikiliza* (blog), April 30. https://blogs.worldbank.org/nasikiliza/covid-19-solving-africas-water-crisis-more-urgent-ever.

Ndege, P. 2017. "'We Are Praying It Rains Soon'—Nairobi on Severe Water Rations." Climate Home News, April 20. https://www.climatechangenews.com/2017/04/20/praying-rains-soon-nairobi-severe-water-rations/.

Ndhlovu, L. 2020. "Families Sleep in Water Lines as Drought Grips Zimbabwe's Bulawayo." Reuters, June 17. https://www.reuters.com/article/us-zimbabwe-water-drought-climate-change-idUSKBN23O06T.

Nega, B., and G. Schneider. 2014. "NGOs, the State, and Development in Africa." *Review of Social Economy* 72 (4): 485–503. https://doi.org/10.1080/00346764.2014.958901.

Niasse, M., and O. Varis. 2020. "Quenching the Thirst of Rapidly Growing and Water-Insecure Cities in Sub-Saharan Africa." *International Journal of Water Resources Development* 36 (2–3): 505–27. https://doi.org/10.1080/07900627.2019.1707073.

Njoh, A.J. 2013. "Colonization and Sanitation in Urban Africa: A Logistics Analysis of the Availability of Central Sewerage Systems as a Function of Colonialism." *Habitat International* 38 (April): 207–13. https://doi.org/10.1016/j.habitatint.2012.07.001.

NOAA (National Oceanic and Atmospheric Administration). 2019. "Water Cycle." https://www.noaa.gov/education/resource-collections/freshwater/water-cycle.

Nwasco (National Water Supply & Sanitation Council). n.d. *Water Watch Groups: Involving Consumers in Monitoring Water Supply and Sanitation Services in Zambia.* Lusaka, Zambia: Nwasco. https://www.gwp.org/globalassets/global/toolbox/case-studies/africa/zambia.-water-watch-groups-340.pdf.

OECD (Organisation for Economic Co-operation and Development). 2001. "OECD Glossary of Statistical Terms: Water Supply System Definition." https://stats.oecd.org/glossary/detail.asp?ID=2913.

OECD. 2020. *Climate Finance Provided and Mobilised by Developed Countries in 2013–18*. Paris: OECD. https://doi.org/10.1787/f0773d55-en.

OECD. 2021. *Water Governance in African Cities*. Paris: OECD. https://doi.org/10.1787/19effb77-en.

O'Farrell, P., P. Anderson, C. Culwick, P. Currie, J. Kavonic, A. McClure, G. Ngenda, et al. 2019. "Towards Resilient African Cities: Shared Challenges and Opportunities towards the Retention and Maintenance of Ecological Infrastructure." *Global Sustainability* 2: e19. https://doi.org/10.1017/sus.2019.16.

Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.

Padgham, J., J. Jabbour, and K. Dietrich. 2015. "Managing Change and Building Resilience: A Multi-stressor Analysis of Urban and Peri-urban Agriculture in Africa and Asia." *Urban Climate* 12 (June): 183–204. https://doi.org/10.1016/j.uclim.2015.04.003.

Pahl-Wostl, C. 2019. "The Role of Governance Modes and Meta-governance in the Transformation towards Sustainable Water Governance." *Environmental Science & Policy* 91: 6–16. https://doi.org/10.1016/j.envsci.2018.10.008.

Papeleras, R., O. Bagotlo, and S. Boonyabancha. 2012. "A Conversation about Change-Making by Communities: Some Experiences from ACCA." *Environment and Urbanization* 24 (2): 463–80. https://doi.org/10.1177/0956247812453247.

Parnell, S., and E. Pieterse. 2010. "The 'Right to the City': Institutional Imperatives of a Developmental State." *International Journal of Urban and Regional Research* 34 (1): 146–62. https://doi.org/10.1111/j.1468-2427.2010.00954.x.

Paulais, T. 2012. *Financing Africa's Cities: The Imperative of Local Investment*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/12480.

Pekel, J.-F., A. Cottam, N. Gorelick, and A.S. Belward. 2016. "High-Resolution Mapping of Global Surface Water and Its Long-Term Changes." *Nature* 540, 418–22. https://doi.org/10.1038/nature20584.

Pieterse, E. 2019. "The Potential for Sustainable Urbanisation in Africa." Berlin: Alfred Herrhausen Gesellschaft. https://www.africancentreforcities.net/wp-content/uploads/2019/04/Paper_Edgar-Pieterse_The_Potential_for_Sustainable_Urbanisation-in-Africa_2019.pdf.

Pieterse, E., L. Cirolia, and A. Cartwright. 2020. *Reframing the Potential of Sustainable Urbanism for Africa*. Cape Town: African Centre for Cities, University of Cape Town.

Pieterse, E., and K. Hyman. 2014. "Disjunctures between Urban Infrastructure, Finance and Affordability." In *The Routledge Handbook on Cities of the Global South*, edited by S. Parnell and S. Oldfield, 213–27. Abingdon, UK: Routledge Handbooks Online. https://www.taylorfrancis.com/chapters/edit/10.4324/9780203387832-29/disjunctures-urban-infrastructure-finance-affordability-edgar-pieterse-katherine-hyman.

Qin, Y., and T. Gartner. 2016. "Watersheds Lost up to 22% of Their Forests in 14 Years. Here's How It Affects Your Water Supply." *Insights* (blog), August 30. https://www.wri.org/insights/watersheds-lost-22-their-forests-14-years-heres-how-it-affects-your-water-supply.

Ravelo, J.L. 2019. "Q&A: WASH Business: A Mixed Business Model in Waste-to-Value." Devex, December 5. https://www.devex.com/news/q-a-wash-business-a-mixed-business-model-in-waste-to-value-96122.

Republic of South Africa. 2004. "Urban Renewal Tax Incentive Launched in Johannesburg and Cape Town." National Treasury, Press Release, October 14. http://www.treasury.gov.za/comm_media/press/2004/2004101401.pdf.

Resilient Cities Network. 2020. "The Art of Reflective Learning in Cape Town—Protecting the Vulnerable during the COVID-19 Pandemic." *Resilient Cities Network* (blog). https://resilientcitiesnetwork.org/urban_resiliences/cape-town-rapid-response/.

Roberts, D., R. Boon, N. Diederichs, E. Douwes, N. Govender, A. McInnes, C. McLean, S. O'Donoghue, and M. Spires. 2012. "Exploring Ecosystem-Based Adaptation in Durban, South Africa: 'Learning-by-Doing' at the Local Government Coal Face." *Environment and Urbanization* 24 (1): 167–95. https://doi.org/10.1177/0956247811431412.

Roberts, D., J. Douwes, C. Sutherland, and V. Sim. 2020. "Durban's 100 Resilient Cities Journey: Governing Resilience from Within." *Environment and Urbanization* 32 (2): 547–68. https://doi.org/10.1177/0956247820946555.

Rodina, L. 2019. "Water Resilience Lessons from Cape Town's Water Crisis." *Wiley Interdisciplinary Reviews: Water* 6 (6): e1376. https://doi.org/10.1002/wat2.1376.

Rosenzweig, C., W. Solecki, P. Romero-Lankao, S. Megrotra, S. Dhakal, and S. Ali Ibrahim. 2018. "Commissioned Paper 6 Urban Climate Change Science, Impacts and Vulnerabilities: State-of-the-Art Findings and Key Research Gaps." Presented at the Intergovernmental Panel on Climate Change's Cities & Climate Change Science Conference, March 5–7, Edmonton, Canada.

Rusca, M. 2018. "Visualizing Urban Inequalities: The Ethics of Videography and Documentary Filmmaking in Water Research." *Wiley Interdisciplinary Reviews: Water* 5 (4): e1292. https://doi.org/10.1002/wat2.1292.

SANBI (South African National Biodiversity Institute). 2016. *The uMngeni Ecological Infrastructure Partnership (UEIP): A Strategy.* Pretoria: SANBI. http://biodiversityadvisor.sanbi.org/wp-content/uploads/2017/05/UEIP-Strategy-July2016.pdf.

Sasaki, S., H. Suzuki, K. Igarashi, B. Tambatamba, and P. Mulenga. 2008. "Spatial Analysis of Risk Factor of Cholera Outbreak for 2003–2004 in a Peri-urban Area of Lusaka, Zambia." *American Journal of Tropical Medicine and Hygiene* 79 (3): 414–21. https://pubmed.ncbi.nlm.nih.gov/18784235/.

Satterthwaite, D. 2016. "Missing the Millennium Development Goal Targets for Water and Sanitation in Urban Areas." *Environment and Urbanization* 28 (1): 99–118. https://doi.org/10.1177/0956247816628435.

Satterthwaite, D., D. Archer, S. Colenbrander, D. Dodman, J. Hardoy, D. Mitlin, and S. Patel. 2020. "Building Resilience to Climate Change in Informal Settlements." *One Earth 2* (2): 143–56. https://doi.org/10.1016/j.oneear.2020.02.002.

Satterthwaite, D., V.A. Beard, D. Mitlin, and J. Du. 2019. "Untreated and Unsafe: Solving the Urban Sanitation Crisis in the Global South." Working Paper. Washington, DC: World Resources Institute. https://files.wri.org/s3fs-public/untreated-and-unsafe_0.pdf?X_83xkygR4k0PcXLXNfJ0nI2Y3lFcwMc.

Sayers, P.B., and A. Smith. 2018. *Can Africa Take the Lead on Sustainable Water Infrastructure?* Report prepared for the African Development Bank. Watlington, UK: Sayers and Partners. http://www.sayersandpartners.co.uk/uploads/6/2/0/9/6209349/2018_sayers_and_smith_-_sustainable_water_infrastructure_in_africa_-_final_v4.0.pdf.

Scarano, F.R. 2017. "Ecosystem-Based Adaptation to Climate Change: Concept, Scalability and a Role for Conservation Science." *Perspectives in Ecology and Conservation* 15 (2): 65–73. https://doi.org/10.1016/J.PECON.2017.05.003.

SDI (Slum/Shack Dwellers International). 2018. *Know Your City: Slum Dwellers Count*. Edited by J. Byrne. Cape Town: SDI. https://sdinet.org/wp-content/uploads/2018/02/SDI_StateofSlums_LOW_FINAL.pdf.

Sekulova, F., and I. Anguelovski. 2017. *The Governance and Politics of Nature-Based Solutions*. Deliverable 1.3. Durham, UK: Naturvation, University of Durham. https://naturvation.eu/sites/default/files/news/files/naturvation_the_governance_and_politics_of_nature-based_solutions.pdf.

Seto, K.C., B. Guneralp, and L.R. Hutyra. 2012. "Global Forecasts of Urban Expansion to 2030 and Direct Impacts on Biodiversity and Carbon Pools." *Proceedings of the National Academy of Sciences of the United States of America* 109 (40): 16083–88. https://doi.org/10.1073/pnas.1211658109.

Seto, K.C., S. Parnell, and T. Elmqvist. 2013. "A Global Outlook on Urbanization." In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*, edited by T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P.J. Marcotullio, R.I. McDonald, S. Parnell, et al., 1–12. Dordrecht, Netherlands: Springer. https://doi.org/10.1007/978-94-007-7088-1_1.

Sevilimedu, V., K.D. Pressley, K.R. Snook, J.V. Hogges, M.D. Politis, J.K. Sexton, C.H. Duke, B.A. Smith, L.C. Swander, K.K. Baker, et al. 2016. "Gender-Based Differences in Water, Sanitation and Hygiene-Related Diarrheal Disease and Helminthic Infections: A Systematic Review and Meta-analysis." *Transactions of the Royal Society of Tropical Medicine and Hygiene* 110 (11): 637–48. https://doi.org/10.1093/trstmh/trw080.

Showers, K.B. 2002. "Water Scarcity and Urban Africa: An Overview of Urban-Rural Water Linkages." *World Development* 30 (4): 621–48. https://doi.org/10.1016/S0305-750X(01)00132-2.

Silva, G., N. Tynan, and Y. Yilmaz. 1998. *Private Participation in the Water and Sewerage Sector: Recent Trends*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/11540.

Simpson, N.P., K.J. Simpson, C.D. Shearing, and L.R. Cirolia. 2019. "Municipal Finance and Resilience Lessons for Urban Infrastructure Management: A Case Study from the Cape Town Drought." *International Journal of Urban Sustainable Development* 11 (3): 257–76. https://doi.org/10.1080/19463138.2019.1642203.

SIWI (Stockholm International Water Institute). 2007. *Planning for Drinking Water and Sanitation in Peri-urban Areas*. Stockholm: SIWI. https://www.siwi.org/publications/planning-for-drinking-water-and-sanitation-in-peri-urban-areas/.

Soulé, F., and C. Toulmin. 2021. "Mayor Yvonne Aki-Sawyerr, OBE, Freetown City Council, Sierra Leone." Institute for New Economic Thinking, February 22. https://www.ineteconomics.org/perspectives/blog/mayor-yvonne-aki-sawyerr-obe-freetown-city-council-sierra-leone.

Souza, C. 2001. "Participatory Budgeting in Brazilian Cities: Limits and Possibilities in Building Democratic Institutions." *Environment and Urbanization* 13 (1): 159–84. https://journals.sagepub.com/doi/abs/10.1177/095624780101300112.

Spaliviero, M., and F. Cheru. 2017. *The State of Addis Ababa 2017: The Addis Ababa We Want*. Nairobi: United Nations Human Settlements Programme. https://unhabitat.org/sites/default/files/download-manager-files/State%20of%20Addis%20Ababa%202017%20Report-web.pdf.

Special Rapporteur. 2015. *Report of the Special Rapporteur on the Human Right to Safe Drinking Water and Sanitation*. Geneva: United Nations Human Rights Council. https://undocs.org/A/HRC/30/39.

Stren, R., and M. Halfani. 2001. "The Cities of Sub-Saharan Africa: From Dependency to Marginality." In *Handbook of Urban Studies*, edited by R. Paddison, 466–85. Thousand Oaks, CA: SAGE. http://dx.doi.org/10.4135/9781848608375.n29.

Strong, C., S. Kuzma, S. Vionnet, and P. Reig. 2020. "Achieving Abundance: Understanding the Cost of a Sustainable Water Future." Working Paper. Washington, DC: World Resources Institute. https://files.wri.org/d8/s3fs-public/achieving-abundance.pdf.

Sun, S., and J. Han. 2020. "Open Defecation and Squat Toilets, an Overlooked Risk of Fecal Transmission of COVID-19 and Other Pathogens in Developing Communities." *Environmental Chemistry Letters* (November): 1–9. https://doi.org/10.1007/s10311-020-01143-1.

Sutherland, C., M. Hordijk, B. Lewis, C. Meyer, and S. Buthelezi. 2014. "Water and Sanitation Provision in eThekwini Municipality: A Spatially Differentiated Approach." *Environment and Urbanization* 26 (2): 469–88. https://doi.org/10.1177/0956247814544871.

Sutherland, C., D. Roberts, and J. Douwes. 2019. "Constructing Resilience at Three Scales: The 100 Resilient Cities Programme, Durban's Resilience Journey and Water Resilience in the Palmiet Catchment." *Human Geography* 12 (1): 33–49. https://doi.org/10.1177/194277861901200103.

TNC (The Nature Conservancy). 2015. *Upper Tana-Nairobi Water Fund: A Business Case*. Version 2. Nairobi: TNC. https://s3.amazonaws.com/tnc-craft/library/upper-tana-nairobi-water-fund-business-case.pdf?mtime=20180115013122.

TNC. 2016. *Sub-Saharan Africa's Urban Water Blueprint: Securing Water through Water Funds and Other Investments in Ecological Infrastructure*. Nairobi: TNC. https://www.nature.org/content/dam/tnc/nature/en/documents/Urban_Water_Blueprint_Region_Africa_Aug2016.pdf.

Toxopeus, H., P. Kotsila, M. Conde, A. Katona, A.P. van der Jagt, and F. Polzin. 2020. "How 'Just' Is Hybrid Governance of Urban Nature-Based Solutions?" *Cities* 105 (October): 102839. https://doi.org/10.1016/j.cities.2020.102839.

Trémolet, S., R. Cardone, C. da Silva, and C. Fonseca. 2007. "Innovations in Financing Urban Water and Sanitation." Prepared for the Center for Sustainable Urban Development Summit, "Financing Shelter, Water and Sanitation," July 1–6. http://csud.ei.columbia.edu/files/2012/04/Week1_Finance_IRC.pdf.

Tyukavina, A., M.C. Hansen, P. Potapov, D. Parker, C. Okpa, S.V. Stehman, I. Kommareddy, and S. Turubanova. 2018. "Congo Basin Forest Loss Dominated by Increasing Smallholder Clearing." *Science Advances* 4 (11): eaat2993. https://doi.org/10.1126/sciadv.aat2993.

UN DESA (United Nations Department of Economic and Social Affairs). 2014. "Financing Water." July 2. https://www.un.org/waterforlifedecade/financing.shtml.

UN DESA. 2018. *World Urbanization Prospects: The 2018 Revision*. New York: United Nations. https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf.

UN DESA Population Division and World Bank. 2019. "Urban Population (% of Total Population)." World Bank Development Indicators. https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS.

UNEP (United Nations Environment Programme). 2020a. "Transforming Sierra Leone's Capital." August 19. http://www.unenvironment.org/news-and-stories/story/transforming-sierra-leones-capital.

UNEP. 2020b. "African Ministers of the Environment Commit to Support a Green COVID-19 Recovery Plan." December 4. http://www.unenvironment.org/news-and-stories/press-release/african-ministers-environment-commit-support-green-covid-19-recovery.

UNEP. 2021. "African Green Stimulus Programme." Draft, January 8. Nairobi: UNEP. https://wedocs.unep.org/bitstream/handle/20.500.11822/34409/AGSP.pdf?sequence=3.

UNFCCC (United Nations Framework Convention on Climate Change). 2015. Roadmap to US$100 Billion. Bonn, Germany: UNFCCC. https://unfccc.int/sites/default/files/resource/climate-finance-roadmap-to-us100-billion.pdf.

UNFCCC. 2018. *Developing and Enhancing Endogenous Capacities and Technologies: Technology Stakeholders' Perspectives*. Bonn, Germany: Technology Executive Committee, UNFCCC. https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/endogenous_index/783d7125afec404da1bef315fe3be600/861a47c1627244deabca4b12e949ebfa.pdf.

UNFCCC. 2020. "Climate Ambition Summit Builds Momentum for COP26." United Nations Climate Change, December 12. https://unfccc.int/news/climate-ambition-summit-builds-momentum-for-cop26.

UN-Habitat (United Nations Human Settlements Programme). 2020. *World Cities Report 2020: The Value of Sustainable Urbanization*. Nairobi: UN-Habitat. https://unhabitat.org/sites/default/files/2020/10/wcr_2020_key_findings_and_messages.pdf.

UN-Habitat and World Bank. 2018. "Population Living in Slums (% of Urban Population)—Sub-Saharan Africa." World Bank Development Indicators. https://data.worldbank.org/indicator/EN.POP.SLUM.UR.ZS?locations=ZG&name_desc=false.

UNICEF (United Nations Children's Fund) and WHO (World Health Organization). 2012. *Progress on Drinking Water and Sanitation: 2012 Update*. New York: UNICEF; Geneva: WHO. https://reliefweb.int/sites/reliefweb.int/files/resources/JMPreport2012.pdf.

UNSD (United Nations Statistics Division). n.d. "SDG Indicators: Metadata Repository." https://unstats.un.org/sdgs/metadata?Text=&Goal=1&Target=1.5. Accessed January 15, 2021.

UN-Water (United Nations Water). 2019. *Sustainable Development Goal 6: Synthesis Report 2018 on Water and Sanitation*. New York: United Nations. https://www.unwater.org/publication_categories/sdg-6-synthesis-report-2018-on-water-and-sanitation/.

UN-Water. n.d. "Transboundary Waters." https://www.unwater.org/water-facts/transboundary-waters/. Accessed January 15, 2021.

USGS (United States Geological Survey). n.d. "Watersheds and Drainage Basins." https://www.usgs.gov/special-topic/water-science-school/science/watersheds-and-drainage-basins?qt-science_center_objects=0#qt-science_center_objects. Accessed January 15, 2021.

Van Rooijen, D.J., T.W. Biggs, I. Smout, and P. Drechsel. 2010. "Urban Growth, Wastewater Production and Use in Irrigated Agriculture: A Comparative Study of Accra, Addis Ababa and Hyderabad." *Irrigation and Drainage Systems* 24 (June): 53–64. https://doi.org/10.1007/s10795-009-9089-3.

Vogel, C., A. Steynor, and A. Manyuchi. 2019. "Climate Services in Africa: Re-imagining an Inclusive, Robust and Sustainable Service." *Climate Services* 15 (August): 100107. https://doi.org/10.1016/j.cliser.2019.100107.

Wafula, C., and V. Raballa. 2020. "Lake Victoria Rises, Leaving Villagers Homeless." The Nation, April 26. https://nation.africa/kenya/counties/kisumu/lake-victoria-rises-leaving-villagers-homeless-492260.

Waldman-Brown, A., and G.C. Flatter. 2018. *Scaling Sanergy: Growing a Promising Sanitation Startup*. Cambridge, MA: Legatum Center for Development and Entrepreneurship, Massachusetts Institute of Technology. https://legatum.mit.edu/wp-content/uploads/2018/07/Sanergy-Case-Study_6.29.2018.docx.pdf.

Walter, D. 2020. "Court Declares Nairobi County Takeover Deal Unlawful." Citizen Digital, June 18. https://citizentv.co.ke/news/court-declares-nairobi-county-takeover-deal-unlawful-336078/.

Wambui, C. 2020. "Water Harvesting Has Added Benefit for Kenya: Less Flooding." Thomson Reuters Foundation, January 3. https://news.trust.org/item/20200103134727-yineo/.

WaterAid and Sheppard Robson International. 2015. *Sustainable and Resilient Infrastructure for African Cities.* Briefing Note. London: Sheppard Robson International.

Watson, V. 2002. "The Usefulness of Normative Planning Theories in the Context of Sub-Saharan Africa." *Planning Theory* 1 (1): 27–52. https://doi.org/10.1177/147309520200100103.

Watts, J. 2018. "'Day Zero' Water Crises: Spain, Morocco, India and Iraq at Risk as Reservoirs Shrink." *The Guardian*, April 11. https://www.theguardian.com/environment/2018/apr/11/day-zero-water-crises-spain-morocco-india-and-iraq-at-risk-as-dams-shrink.

WBG (World Bank Group). 2009. (Database.) *Africa Infrastructure Country Diagnostic (AICD)*. Private database. Washington, DC: WBG.

WBG. 2017. *Sierra Leone Rapid Damage and Loss Assessment of August 14th, 2017 Landslides and Floods in the Western Area*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/28836.

We Are Water Foundation. 2017. "Addis Ababa: Rain That Does Not Reach the Faucet." June 14. https://www.wearewater.org/en/addis-ababa-rain-that-does-not-reach-the-faucet_283991.

White, Z., and C. Morais. 2020. *Scaling Digital Solutions in the Water Sector: Lessons from CityTaps and Wonderkid*. London: GSMA. https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/12/Scaling-Digital-Solutions-in-the-Water-Sector-Lessons-from-CityTaps-and-Wonderkid.pdf.

WHO (World Health Organization) and UNICEF (United Nations Children's Fund). 2017. *Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines*. Geneva: WHO; New York: UNICEF. http://apps.who.int/iris/bitstream/handle/10665/258617/9789241512893-eng.pdf?sequence=1.

WHO and UNICEF. n.d. "Monitoring: Drinking Water." Joint Monitoring Programme for Water Supply, Sanitation and Hygiene. https://washdata.org/monitoring/drinking-water. Accessed January 15, 2021.

Wijnen, M.M.P., S. Barghouti, J.E. Cobbing, B.T. Hiller, and R. Torquebiau. 2018. *Assessment of Groundwater Challenges & Opportunities in Support of Sustainable Development in Sub-Saharan Africa*. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/420291533931251279/Assessment-of-groundwater-challenges-opportunities-in-support-of-sustainable-development-in-Sub-Saharan-Africa.

WIN (Water Integrity Network). 2016a. *Engaging with Partners for Change: WIN Strategy 2017–2022*. Berlin: WIN.

WIN. 2016b. *Water Integrity Global Outlook*. Berlin: WIN. https://www.waterintegritynetwork.net/wigo/.

WIN and Transparency International. 2010. *Integrity Pacts in the Water Sector: An Implementation Guide for Government Officials*. Berlin: WIN and Transparency International. https://images.transparencycdn.org/images/2010_IntegrityPactsWaterSector_EN.pdf.

WMO (World Meteorological Organization). *2020. State of the Climate in Africa in 2019*. Geneva: WMO. https://library.wmo.int/doc_num.php?explnum_id=10421.

World Bank. 2018. "Burkina Faso: World Bank Program to Boost Water and Sanitation Service Delivery." Press Release 2018/148/AFR, June 26. https://www.worldbank.org/en/news/press-release/2018/06/26/burkina-faso-world-bank-program-to-boost-water-and-sanitation-service-delivery.

World Bank. 2020. "World Bank Project: Ethiopia Urban Institutional and Infrastructure Development Program." Project P163452. https://projects.worldbank.org/en/projects-operations/project-detail/P163452.

World Water Council and OECD (Organisation for Economic Co-operation and Development). 2015. *Water: Fit to Finance? Catalyzing National Growth through Investment in Water Security*. Marseille, France: World Water Council. https://www.worldwatercouncil.org/sites/default/files/Thematics/WWC_OECD_Water_fit_to_finance_Report.pdf.

WRI (World Resources Institute). 2020a. "Building Urban Water Resilience in Africa." Webinar. https://www.wri.org/events/2020/12/building-urban-water-resilience-africa.

WRI. 2020b. "South Africa Joins WRI, Coalition for Urban Transitions in Supporting Green and Equitable Urban Recovery after COVID-19." Press Release, October 30. https://www.wri.org/news/2020/10/release-south-africa-joins-wri-cut-supporting-green-equitable-urban-recovery.

WRI. n.d. (Database.) *Aqueduct*. Version 2.1. https://www.wri.org/aqueduct. Accessed September 15, 2017.

WRI and GCA (Global Commission on Adaptation). 2021. "Principles for Locally Led Adaptation." https://www.wri.org/our-work/project/global-commission-adaptation/principles-locally-led-adaptation.

Yemeru, E. 2020. "Conversation 3: Sustainable Infrastructure as the Key to Success." Presented at the Reframe Conversation Series, African Centre for Cities, University of Cape Town, October 7.

Yeung, P. 2019. "Climate Change Is Already Battering This West African City." Bloomberg CityLab, April 8. https://www.bloomberg.com/news/articles/2019-04-08/coastal-senegal-braces-for-severe-climate-crisis.

Ying, Y., H. Skilling, S. Banerjee, Q. Wodon, and V. Foster. 2010. "Cost Recovery, Equity, and Efficiency in Water Tariffs: Evidence from African Utilities." Policy Research Working Paper. Washington, DC: World Bank. https://doi.org/10.1596/1813-9450-5384.

Zimmer, A. 2015. "Urban Political Ecology 'beyond the West': Engaging with South Asian Urban Studies." In *The International Handbook of Political Ecology*, edited by R.L. Bryant, 591–603. Cheltenham, UK: Edward Elgar.

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