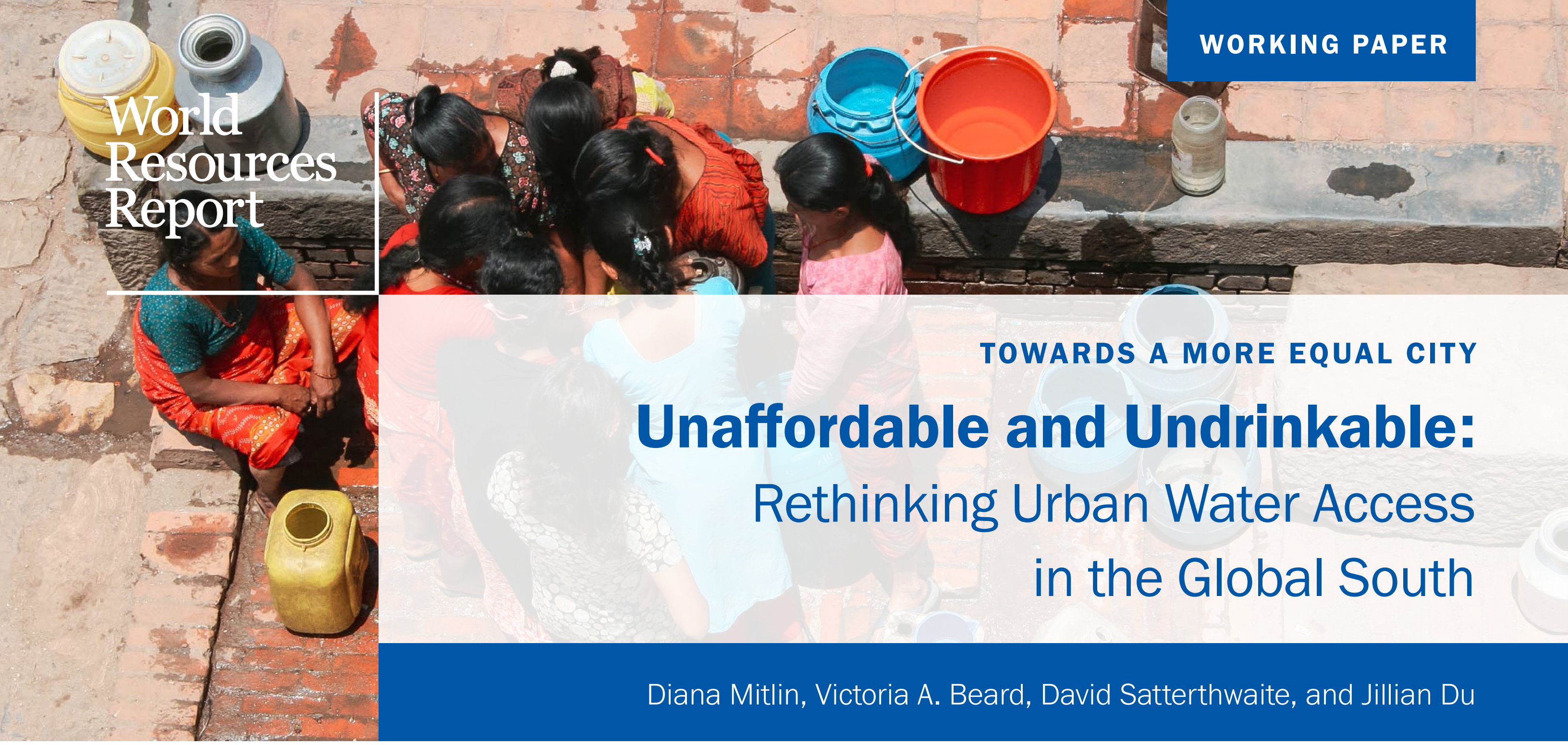


World Resources Report

WORKING PAPER

TOWARDS A MORE EQUAL CITY

Unaffordable and Undrinkable: Rethinking Urban Water Access in the Global South

Diana Mitlin, Victoria A. Beard, David Satterthwaite, and Jillian Du

CONTENTS

Working Papers contain preliminary research, analysis, findings, and recommendations. They are circulated to stimulate timely discussion and critical feedback and to influence ongoing debate on emerging issues. Most working papers are eventually published in another form, and their content may be revised.

Suggested Citation: 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. Available online at www.citiesforall.org.

EXECUTIVE SUMMARY

Highlights

- Equitable access to safe, reliable, and affordable water is a human right. Urban water provision is a social good, but one that will become increasingly difficult for cities and water utilities to provide due to climate change and population growth.
- Widely used global data underestimate the urban water crisis, which contributes to ineffective planning and management of urban water provision. New analysis of urban water access in 15 cities in the global South shows that piped utility water is the least expensive water service for most households, yet almost half of all households lack access.
- Households without access to municipal water self-provide or purchase water from private sources, such as tanker truck water which can cost up to 52 times as much as piped utility water. In 12 out of 15 cities analyzed, households connected to the municipal piped system received water intermittently, which compromises quality.
- Decades of attempts to increase the private sector's role in water provision and corporatize water utilities have not adequately improved access, especially for the urban under-served. Cities and urban change agents should commit to providing equitable access to safe, reliable, and affordable water.
- Cities and water utilities should work together to extend the formal piped network, address intermittent water service, and make water more affordable. City governments should support strategies to upgrade informal settlements, which include improved access to water and sanitation services.

WORLD RESOURCES INSTITUTE | ROSS CENTER

UKaid from the British people

Urban Water Provision and Access: What Is at Stake?

Equitable access to safe, reliable, and affordable water is fundamental to the quality of human life and the future of urban living. In the absence of a safely managed and reliable public piped water service, residents in struggling and emerging cities purchase water from private sources or obtain it directly from natural sources.[1] Nearly one-tenth of global disease can be prevented by improved water, sanitation, and hygiene.[2] These improvements are linked to reduced diarrheal disease, the second principal cause of child mortality and the leading cause of morbidity globally.[3] Approximately 1.4 million children die each year from preventable diarrheal disease, and the majority of these deaths are in sub-Saharan Africa and South Asia.[4]

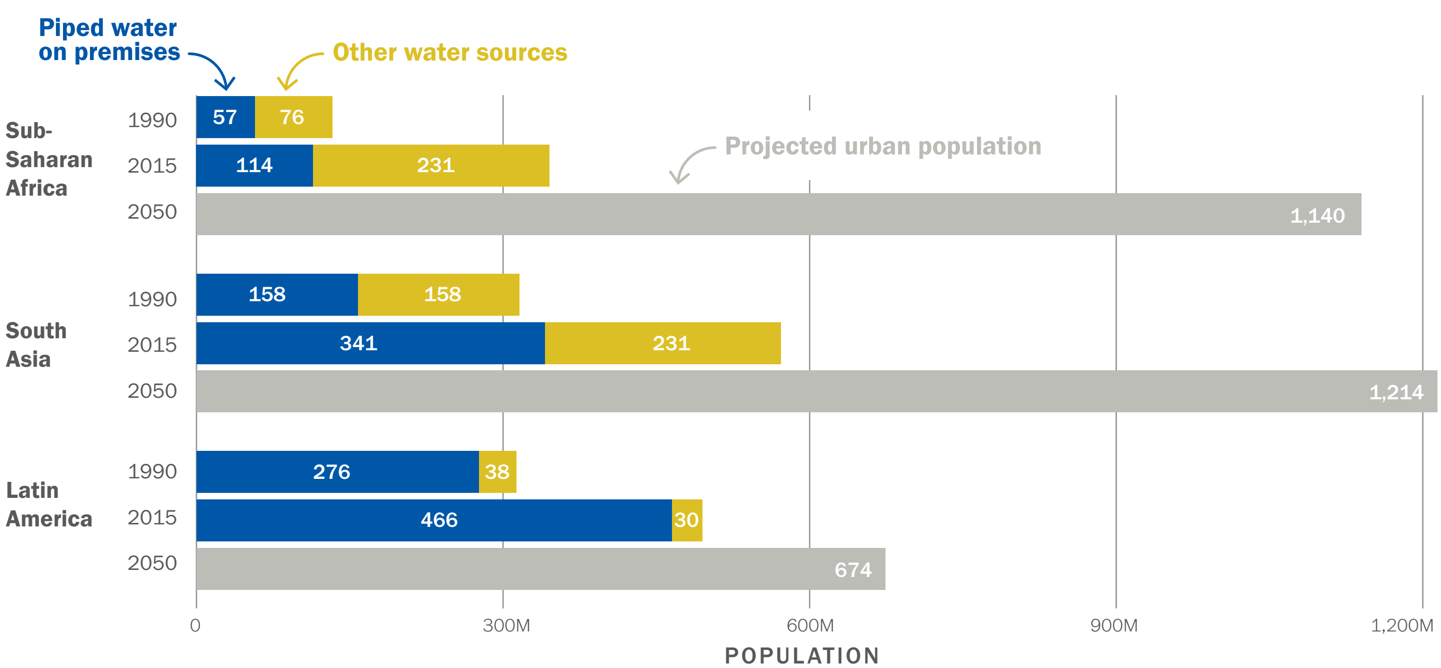
The World Health Organization (WHO) reports that the cost of investing in universal drinking water coverage in urban areas would be US$141 billion over five years.[5] However, total global economic losses from the negative economic and environmental consequences of inadequate water and sanitation amount to $260 billion per year.[6] Well-managed, public drinking water systems save households time and offer improved health, which, depending on regional variation, can account for as much as 80 percent of the total benefits.[7]

The environmental consequences are also significant. For example, when residents self-provide groundwater in dense urban settings, this can lead to overextraction, which is associated with saltwater intrusion and land subsidence.[8] In addition, urban construction causes water to flow over the landscape, picking up and carrying pollutants that contaminate local surface water sources.[9] Furthermore, inadequate wastewater infrastructure combined with intermittent water supply (when water is not continuously supplied to users) means that piped water is also at increased risk for contamination.[10] Climate change will further stress urban water supplies. By 2050 nearly 5.7 billion people will face water scarcity for at least one month every year.[11] It is imperative that cities act now to better manage their water supplies and invest in expanded and improved water infrastructure and services (see Figure ES-1).

About This Paper

The World Resources Report *Towards a More Equal City* views sustainable cities as composed of three related elements: equity, economic productivity, and environmental sustainability.[12] Through a series of research papers, it asks the question: Can providing equitable access to quality core services improve the economy and environment of the city as a whole?

Figure ES-1 | **The service gap is widening between the provision of piped water and growing urban populations**



Source: WHO and UNICEF, 2015; UN DESA, 2017.

This paper focuses on access to water in cities in the global South; a subsequent paper considers the issue of sanitation. The paper examines urban water access from the global perspective and looks more closely at 15 cities. It discusses how global definitions and measurements have led to a significant overestimation of urban water access, and documents that efforts to privatize water and to corporatize government water utilities have not improved water access, especially for the urban under-served.

The paper recommends four actions to ensure equitable water access. These include extending the piped water network, addressing the problem of intermittent water supply, and ensuring affordability. In addition, cities should work with residents of informal settlements to support upgrading efforts that include improved access to piped water and sanitation services for those who can least afford it.

The Urban Water Crisis Is Underestimated

Global urban water data contain significant limitations that lead policymakers, planners, and other urban change agents to overestimate access to water. The Joint Monitoring Programme (JMP) of the United Nations (UN) has created universal categories to measure, monitor, and compare progress on water access related to the Sustainable Development Goals (SDGs). However, these categories and measurements only superficially consider water quality, regularity, and affordability, and fail to identify the urban populations at risk. Although the JMP reports that the proportion of population with access to improved water sources increased globally, the proportion of urban populations receiving piped water has decreased since 1990. In 2015, many nations had less than half of their urban population receiving piped water on premises.[13]

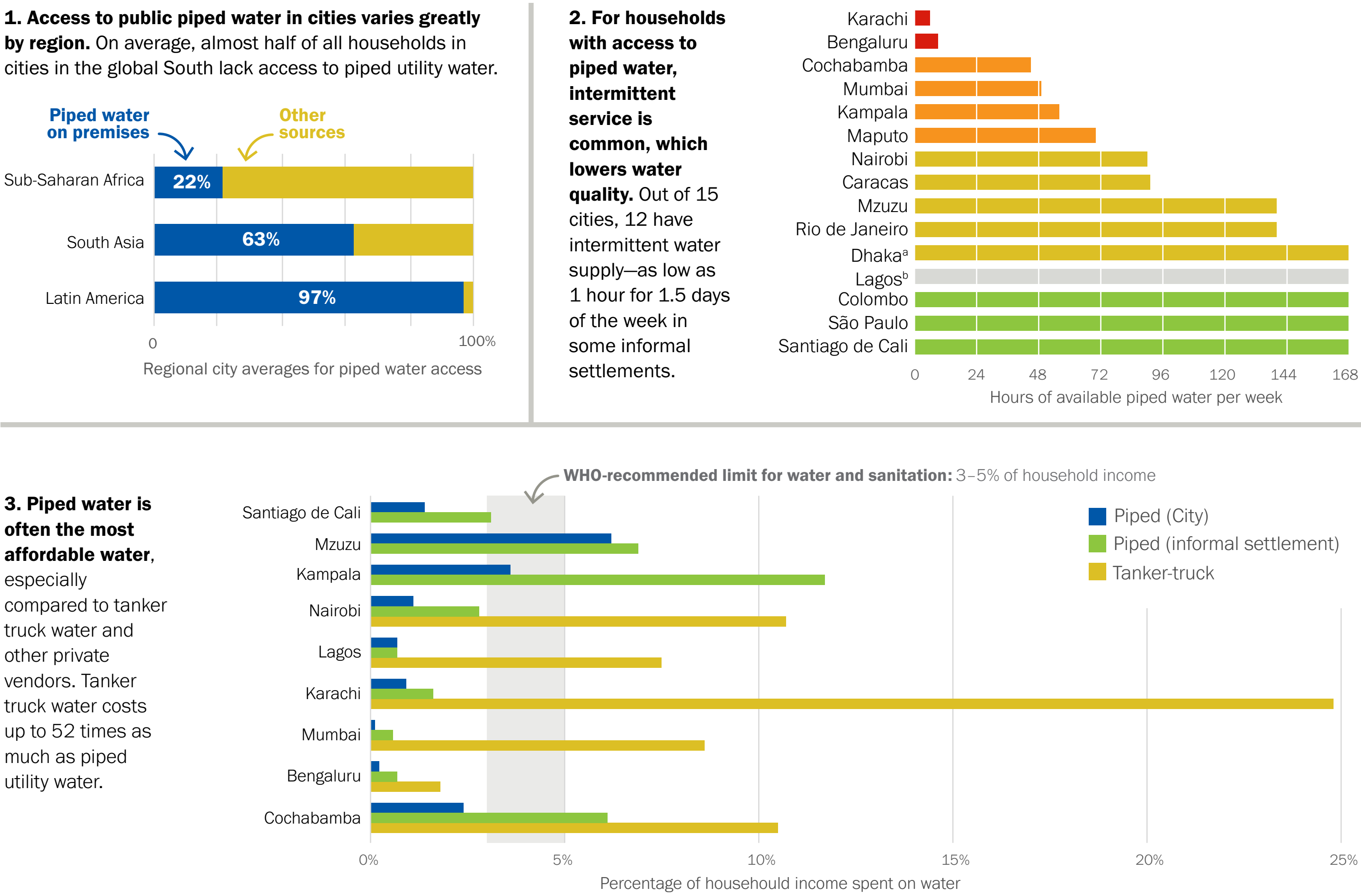
Water Access in 15 Cities in the Global South

To address the lack of comparable city-level data on water access, we compiled data in 15 cities in the global South (see Figure ES-2).[14] The data show that cities in sub-Saharan Africa had the lowest proportion of water piped to a dwelling or yard. South Asian cities had the second lowest, and cities in Latin America had the highest. Many households relied on alternative water providers where municipally piped water was unavailable. Water obtained from truck vendors costs as much as 52 times the cost of the city's piped water. Where natural sources of water (rain-, ground-, and surface water) are available, some households obtain some water less expensively or for free. Aside from free natural sources, the least expensive source was water piped to a dwelling or yard. However, both natural sources and piped water may be contaminated, particularly in densely populated urban areas. The risk of piped water being contaminated increases where service is intermittent.

Intermittent water supply is a common problem in cities in the global South. When the pressure in the piped network drops, sewage, groundwater, surface water, and other sources of contamination enter the system.[15] Factors that contribute to intermittent water supply include inadequate water and energy supplies, pipe breaks and leakages, a lack of financial investment, and local politics.[16] Significant costs are incurred as household members wait for water to become available. Intermittency also requires people to invest in storage facilities and/or spend time queuing for water. Only three cities in our sample—Colombo, Sri Lanka; São Paulo, Brazil; and Santiago de Cali, Colombia—reported having continuous piped water supplies. Two of the cities with the lowest water availability were Karachi, Pakistan, and Bengaluru, India, which experienced water access for an average of two hours per day over three days of the week across locations in the city. In cities with intermittent water supply, the informal settlements typically had fewer days per week and hours per day (compared to the city as a whole) when water was available.

It is widely recommended that households not spend more than 3–5 percent of their average household income on both water and sanitation services per month.[17] Based on an analysis of average household size and average income in both cities and informal settlements, and using the WHO-recommended amount of water consumption in non-emergency settings, we estimated the average monthly expenditure on water as a percentage of average income if households relied solely on piped water. In Kampala, Uganda, households would spend approximately 3.6 percent, and in Mzuzu, Malawi, households would spend 6.2 percent of their monthly income on piped water if they purchased the WHO-recommended minimum amounts. Residents of informal settlements would spend an even greater portion of their monthly income if connected to piped water, as their incomes are lower than the city average; in Kampala, they would spend 11.7 percent; in Mzuzu, 6.9 percent; in Cochabamba, Bolivia, 6 percent; and in Santiago de Cali, 3.1 percent. It should be noted that these costs do not include sanitation services, which, if included, would likely exceed the recommended percentage of monthly income spent on water and sanitation. These figures indicate the need for strategies to improve affordability.

Figure ES-2 | **New analysis of water access in cities in the global South**



Note: a. In Dhaka, water is available at all times, but pressure is intermittent; residents use hand or electric pumps to obtain water from the piped network.
b. In Lagos, water availability varies significantly depending on household location in the city.
Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.

Privatization and Corporatization Have Not Solved the Problem

In the 1980s private sector involvement and market principles were promoted in the water sector across the global South. These principles were introduced in a context where water was being subsidized so households could afford a piped water connection, but the lowest-income households were neglected as they lived in areas not covered by the piped network.[18] It was hoped that market-based approaches would make the sector more efficient. However, many governments were unwilling to supply water to informal settlements, and private sector involvement did not solve the problem of inadequate access. Prices rose as companies sought to make water provision more profitable. Citizens protested in response, thus deterring private companies from expanding their investments. Companies also realized that low-income households could not afford water without some form of government subsidy; hence, the profitable water market that they had anticipated did not exist.[19]

Since the early 2000s, international development agencies have promoted the corporatization of public water utilities in global South cities.[20] Corporatized utilities adopt commercial market principles with less risk of political interference than was the case when utilities were managed within the public sector. However, corporatization has not substantively improved low-income communities' access to water services. Some corporatized utilities have tried innovative ideas to expand the network, including making agreements with informal vendors and community organizations, but these have paid too little attention to affordability. Utilities have been unable to reconcile the gap between low incomes, minimum recommended amounts of water consumption, and commercial pricing. As a result, even "low-cost water" is still unaffordable to many urban residents.

Access to Water Is a Human Right

The United Nations has declared water to be both an economic and environmental good as well as a basic right of all human beings since 1991.[21] Although this idea has remained controversial, a global campaign for recognizing access to water as a human right gained momentum throughout the 2000s.[22] In 2010 the UN General Assembly (through Resolution 64/292) affirmed water and sanitation as a human right. A lack of adequate water compromises human health, undermines economic productivity, and threatens environmental sustainability. As such, cities must recognize that equitable access to reasonable amounts of safe, reliable, and affordable water is a social good. Cities should prioritize water access by investing in the capital costs needed to expand and maintain piped water networks, subsidizing water to ensure affordability, and regulating multiple actors in the water sector.

Recommendations

This paper recommends action areas for urban change agents interested in ensuring equitable access to safe, reliable, and affordable water (see Figure ES-3).

- ***Cities and water utilities should extend the formal piped water network to improve water access.*** An extended, networked water infrastructure system is the result of coordinated urban planning, good governance, and substantial financial investment. Although access for plots or dwellings is most desirable, affordable and regular supplies to kiosks and standpipes located close to homes constitutes an interim measure. Universal access to piped water requires governments to ensure adequate capital investment and make a long-term commitment to system maintenance.

- ***Cities and water utilities need to address intermittent water service.*** If consumers know when water will be available, this reduces stress, saves time, avoids costs associated with wasted time, and discourages hoarding. It also helps businesses that rely on water to operate more efficiently and effectively. It will not, however, address the increased risk of being exposed to contaminated water that results from intermittent water supply. Water utilities should address the gap between the volume of water they treat and distribute and the volume of water for which they receive payment (known as nonrevenue water). One strategy for doing so is to have water utilities use water meters, which improve billing systems. A second strategy is to regularly maintain infrastructure, which helps to prevent, detect, and resolve leakages.

- ***Cities and water utilities need to pursue diverse strategies to reduce the cost of water for the lowest-income consumers***. Strategies include providing subsidies for either free basic water or reducing the cost for small-scale purchases. Free basic water is the first few cubic meters of water that the water utility provides for free. This approach only works if the water utility supplies free basic water to all households entitled to receive it. Subsidies for free or low-cost water can be targeted to households and/or low-income neighborhoods, and they may be financed by cross-subsidies between customers and/or grants. Many strategies to reduce the cost of water do not benefit low-income households because they are not connected to the piped water system. Piped network connection fees can be made more affordable by offering low-income customers subsidies and/or allowing them to spread these payments over longer periods.

- ***Local and national governments need to support informal settlement upgrading to improve water access to the urban under-served in the short and medium terms.*** An estimated one in three urban dwellers in the global South live in informal settlements, which is where most low-income households are located.[23] The success of government- and community-led informal settlement upgrading schemes to improve access to water, sanitation, and drainage are well-documented.[24] Informal settlement upgrading requires local governments to work with communities, nongovernmental organizations (NGOs), and other actors to install water and sanitation infrastructure.

Conclusion

Water sources are depleted around the world due to the combination of climate change, pressure from urban population growth, and changes to the natural and built environments. Many households are not connected to the piped network, and many of those that are connected lack a continuous supply of water. Meanwhile, insufficient attention has been paid to issues of water affordability. Given this, extending the piped water network within cities and ensuring there are adequate supplies of piped water is the best way to provide residents with the safest water at the lowest price. Treating water as a commodity best managed by the market has not resulted in more equitable access in the global South. Water is a human right and a social good that is essential to human life, health, and well-being. As such, cities and water utilities need a sustained political commitment and sufficient financial investments to ensure equitable and continuous access to safe, reliable, and affordable water.

Figure ES-3 | **Priority actions for cities, water utilities, and other urban change agents to ensure equitable access to water in the global South**

ACTION AREA 1:
Extend the formal piped water network

- Universal access to piped water connections to the home or plot
- In the short- or medium-term, extend standpipes and kiosks located close to homes for those who do not have access to piped water

ACTION AREA 2:
Address context-specific causes of intermittent water service

- Universal use of water meters
- Improve billing systems
- Use technology to detect leaks
- Improve regular infrastructure maintenance to reduce leaks

ACTION AREA 3:
Pursue diverse strategies to make water affordable with special consideration for low-income consumers

- Affordable water connections
- Strategies to make monthly water service affordable (including subsidized water, cross-subsidies, "free basic water," incremental block tariffs, and spatially targeted subsidies)
- Promote flexible payment arrangements for water and water connections

ACTION AREA 4:
Support informal settlement upgrading to improve water access to the urban under-served

- City-wide participatory, in situ, informal settlement upgrading as a means to improve water access and quality of service

ENABLERS

DATA
Improved city-level and sub-city-level information on multiple dimensions of water access

FINANCE
Increased capital investment in water infrastructure and maintenance

GOVERNANCE
A sustained political commitment to ensure equitable access to safe, reliable, and affordable water for all and state regulation of the water service sector

EQUITABLE ACCESS TO SAFE, RELIABLE, AND AFFORDABLE WATER

BENEFITS

IMPROVED HEALTH AND WELL-BEING
Improved access to recommended quantities of water and improved water quality

ENVIRONMENTAL SUSTAINABILITY
Reduction of extraction of groundwater

ECONOMIC PRODUCTIVITY
Improved health and time saved

Source: Authors' analysis.

Glossary

Aquifer	Underground water-bearing rock that acts as a reservoir for groundwater.
Borehole	A hole drilled deep in the earth to obtain groundwater.
Corporatization	The process of transforming a public agency into a legal entity with a corporate structure and corresponding incentives.
Deep well	A hand-dug water well that is more than 7 meters deep and about 1.5 meters wide.
Groundwater	Water that is located beneath the earth's surface.
Groundwater recharge	A hydrologic process where water moves below from the earth's surface and replenishes an aquifer.
Improved water source	A classification used by JMP that includes water from pipes, boreholes, tube wells, protected dug wells, protected springs, rainwater, and packaged or delivered water.
Incremental block tariff (or progressive tariff)	A charge that increases with every successive block of water consumed.
Intermittent water supply	A piped water service that is not continuous.
Jerrican	A portable container of varying size that usually holds about 20 liters of water.
Joint Monitoring Programme (JMP)	The WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene, which maintains a global data set with comparable estimates of national, regional, and global progress towards the Sustainable Development Goals (SDG).
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.
Protected dug well or spring well	A groundwater well that has a protective seal.
Shallow well	A well that is typically less than 7 meters deep.
Standpipe	A freestanding pipe connected to a piped water system.
Surface water	Water that collects at ground level, including streams, rivers, lakes, reservoirs, and wetlands.
Tanker truck	Trucks equipped with a tank to deliver water.
Tube well	A well with a stainless steel tube or pipe bored into an underground aquifer.
Unprotected dug well	A well that provides access to groundwater but lacks a seal to protect against contamination from runoff, animal excreta, human waste, and other contaminants.
Urban recharge	When groundwater is replenished through recharge zones such as wetlands, wells, and pits as part of urban storm water management system.
Water ATM dispenser	Automated water dispensing units, which provide communities with access to pay-per-use water.
Water kiosk	An outlet operated by an attendant, which provides residents with pay-per-use water.
Water utility	An organization responsible for providing water services (and sometimes sanitation services) and maintaining water infrastructure.

Source: The glossary builds on definitions provided by the Sustainable Sanitation and Water Management (SSWM), JMP, and the authors' experience. For more information, see the SSWM Toolbox, https://www.sswm.info/glossary/, and the JMP website, https://washdata.org/monitoring/drinking-water.

Abbreviations

ACCA	Asian Coalition for Community Action
AdeM	Águas da Região de Maputo (Waters of the Maputo Region)
BWSSB	Bangalore Water Supply and Sewerage Board
CEDARE	Centre for Environment and Development for the Arab Region and Europe
CMC	Colombo Municipal Council
DHS	Demographic Health Survey
DWASA	Dhaka Water Supply and Sewerage Authority
EMCALI	Empresas Municipales de Cali (Municipal Utilities of Cali)
GDP	gross domestic product
HH	household
IBNET	International Benchmarking Network
IBT	incremental block tariff
IIED	International Institute for Environment and Development
JMP	Joint Monitoring Programme
KCCA	Kampala Capital City Authority
KWSB	Karachi Water and Sewerage Board
LDC	least developed country
LWC	Lagos Water Corporation
MCGM	Municipal Corporation of Greater Mumbai
MDG	Millennium Development Goal
NCWSC	Nairobi City Water and Sewerage Company
NGO	nongovernmental organization
NRWB	Northern Region Water Board
NWSC	National Water and Sewerage Corporation
NWSDB	National Water Supply and Drainage Board
PPP	public-private partnership
SDG	Sustainable Development Goal
SDI	Shack/Slum Dwellers International
SEMAPA	Servicio Municipal de Agua Potable
UNICEF	United Nations Children's Fund
USS	under-served settlements
WHO	World Health Organization
WRR	World Resources Report
WSTF	Water Services Trust Fund

1. THE CHALLENGE OF WATER ACCESS

Every city needs to provide its residents with access to safe, reliable, and affordable water to ensure public health, a productive economy, and environmental sustainability. However, two concomitant trends make this task increasingly difficult in cities in the global South. First, the urban population is growing and expected to reach 6.7 billion by 2050.[25] Second, climate change is threatening the sources and availability of urban water supplies. These two trends have increased the pressure on cities to plan and manage their entire water cycle—from source protection, to water access and use, to recycling and safe disposal.

Sustainable Development Goal (SDG) 6.1 aspires to achieve universal and equitable access to safe and affordable drinking water by 2030.[26] However, between 1990 and 2015, the proportion of urban households receiving piped water declined in many countries.[27] This is a result of the dual challenge of water scarcity as well as the inability of cities and/or water utilities to keep pace with growing urban populations. These challenges are already reaching crisis proportions in many cities. Major cities such as Cape Town, South Africa; Chennai, India; Jakarta, Indonesia; Mexico City, Mexico; and São Paulo, Brazil, face the threat of dry taps, depleted reservoirs, and exhausted groundwater supplies as well as rising conflicts related to urban water scarcity (see Box 1).[28] As urbanization and climate change continue to intensify, so will the challenge for cities and utilities to provide safe, reliable, and affordable water.

In regions with national-level estimates, the proportion of the population with access to safely managed water ranges from 24 percent in sub-Saharan Africa to 94 percent in North America and Europe.[29] Safely managed water is defined as "an improved drinking water source that is located on premises, available when needed and free from fecal and priority chemical contamination."[30] Approximately 34 percent of the population in the least developed countries (LDCs)[31] used safely managed services in 2015. From numerous studies, we know that water quality from "improved sources" does not meet the standards set by the World Health Organization (WHO) for a large number of people.[32] For example, in 2012, 74 percent of Nepalese and 45 percent of Ghanaians who used improved water tested positive for *E. coli*.[33] Although access to water has increased globally over the past two decades, these advances have the potential to obscure the persistent deficiencies and inequalities in water access across geographic regions, cities, and groups of people within cities.

Box 1 | Water Scarcity in São Paulo, Nairobi, and Bengaluru

Many cities in the global South live under threat of an imminent water crisis. According to one assessment, some 200 cities—including Beijing, China; Buenos Aires, Argentina; Kabul, Afghanistan; and Mexico City, Mexico—will find themselves in situations similar to "Day Zero" in Cape Town, South Africa, in which it was feared that the city's taps would run dry.[a] Of the 15 cities we analyzed, São Paulo, Brazil; Nairobi, Kenya; and Bengaluru, India, are experiencing severe water shortages.

In 2014 São Paulo experienced its worst drought in 80 years, resulting in major water shortages and dry reservoirs across southeastern Brazil.[b] The water crisis prompted supply rationing in over 19 Brazilian cities. Twelve million residents in São Paulo experienced reduced water pressure (and its associated problems).[c] Low-income neighborhoods were the first areas to experience intermittency and low pressure. While many residents went without water for several days, middle- and upper-class areas could afford to drill and access groundwater supplies.[d] Since 2014, the city has focused on augmenting its water supply with water from more distant watersheds. However, when water travels greater distances, more of it is lost. Studies suggest that deforestation and climate change will further endanger the stability of Brazil's urban water supply.[e]

As of late 2017 Nairobi's major reservoir was only half full compared to normal levels, and the water utility implemented a rationing program[f] that will continue through 2026 until more dams are built.[g] Given that half of the city does not have access to piped water, many households buy water from local vendors at high prices. High prices increase the incentive to illegally siphon water from the piped network. This further reduces the amount of water supplied through pipes, reducing pressure for the whole system and ultimately causing higher rates of contamination.[h] This is reflected in the fact that the city has experienced an increase in cholera outbreaks, which have become as frequent as two cases per month in some lower-income neighborhoods.[i]

Another reason for ongoing water shortages is the lack of groundwater recharge across the watershed area. Nairobi's main recharge areas are located in swamp regions, which, due to urban development, are now covered with impervious surfaces that inhibit the natural recharge process. During the rainy seasons of 2017 and 2018, poor storm water infrastructure contributed to severe flooding and limited groundwater recharge.[j] Informal settlements and low-lying neighborhoods suffered the most damage from the floods. Water continues to be rationed after the most recent rainy season.[k]

Bengaluru, previously known as Bangalore, in the Indian state of Karnataka, has experienced increased flooding, dry wells, and decreased water availability from the Cauvery basin over the past few years.[l] Karnataka's three-year drought is associated with 35 percent less rainfall and "unofficial rationing" in Bengaluru.[m] Some informal neighborhoods now receive water for less than two hours per day, with reduced pressure and poorer quality.[n] In response, households turn to tanker trucks that source their water from boreholes. Poorly monitored tankers have overextracted groundwater, causing both the utility and illegal vendors to drill deeper.[o] With urban expansion and more unplanned settlements, the number of under-served areas is increasing. The challenge for Bengaluru is to achieve integrated water management, which includes improving source protection, groundwater recharge, and drainage management, as well as reducing nonrevenue water.[p]

As climate change continues, it is expected that cities will experience more frequent periods of drought. When cities implement water restrictions and rationing schemes, low-income and informal populations are disproportionately impacted. Meanwhile, bringing water in from greater distances often has negative environmental consequences. Multiple levels of government need to work together to protect natural water sources and groundwater recharge areas as well as integrate water and sanitation services.

Notes: a. Venkatesh et al., 2018; b. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018; c. Watts, 2014; d, e. Romero, 2015; f. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018; g. Mbogo, 2018; h. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018; i. Njagi, 2018; j. Agutu, 2018; *Daily Nation*, 2018; k,l. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018; m, n. Maramkal, 2017; o. In two decades, the water table has decreased from 10–12 meters to 76–91 meters below the surface. See CSE, 2018; p. Bengaluru receives 530 million cubic meters/year from the Cauvery, but nearly half is lost as nonrevenue water in transmission and distribution. Due to this largely inefficient distribution, BWSSB's piped water supply would operate at a deficit even if every urban household were connected. See Chandra and Hegde, 2015.

In the absence of a safely managed and reliable public water network, residents in cities in the global South obtain water from a combination of private sources and/or find ways to provide their own water (see Box 2).[34] Perceptions of price, availability, and quality inform how different sources of water are used for various individual and household needs. Where groundwater is prevalent, some households still obtain water from wells and boreholes. In dense urban settlements where sanitation services are inadequate, shallow and unprotected wells are at risk of being contaminated.[35] Where there is unregulated, increased use of boreholes, groundwater may be overextracted and aquifers depleted.[36] Boreholes can be expensive and, if overused, have the potential to contribute to land subsidence—loss of surface elevation—which causes parts of cities to sink. Land subsidence due to overextracting groundwater has become a significant and highly publicized problem in Jakarta and Mexico City.[37]

A WHO study found that the total capital cost of achieving universal drinking water coverage would be US$203 billion over a five-year period (2010–15).[38] The investments are larger for urban areas ($141 billion) than rural ones ($62 billion) across all regions.[39] Such figures are high, but water access significantly affects urban economic growth and productivity. When water shortages occur, public officials close factories to divert water to households.[40] Industries relocate when water is contaminated and when ground supplies are depleted.[41] Affordable and reliable water supplies are also integral to informal economic activities, specifically those of home-based workers.[42] In all, the global economic losses resulting from inadequate water and sanitation are estimated to total approximately $260 billion per year.[43] Meanwhile, WHO estimates that every $1 invested in improved water supply and sanitation yields an estimated social benefit (return) of between $4 and $12.[44] More conservative economic studies demonstrate returns of at least twice the investment for improved water supply.[45] The main benefit of improved drinking water systems and services to households is saved time and better health, which can account for as much as 80 percent of the total benefits.[46]

The relationship between access to safe drinking water and human health is well established.[47] Nearly one-tenth of global disease can be prevented by improved water, sanitation, and hygiene.[48] These improvements are linked to reduced diarrheal disease, which is the second principal cause of child mortality and the foremost cause of morbidity globally.[49] It is estimated that 1.4 million children die each year from preventable diarrheal disease globally, and the majority of these deaths are in sub-Saharan Africa and South Asia.[50] Many cities in the global South experience intermittent water supply (when water is not continuously supplied to users), which is associated with higher risk of waterborne illness and exposure to microbial contamination.[51] Given the stress on water supplies from urban population growth and climate change, intermittent supply is expected to become an increasingly significant problem in the future.[52]

Urbanization and its related increased demand for urban water has environmental costs for river basins and watersheds. Urbanization replaces natural land cover with impervious surfaces that affect groundwater recharge and quality. Roads, sidewalks, and parking lots constructed from asphalt and concrete prevent water from percolating into the soil and aquifers from recharging. Urban construction contributes to the flow of water over an impervious landscape, which worsens flooding and spreads pollutants that degrade surface water sources.[53] This is reflected in the fact that heavy metals are often found in waterways near transportation routes.[54] Groundwater is presumed to require less treatment than surface water because of the natural filtration system provided by aquifers. However, given urban population growth and higher population densities, groundwater is extracted faster than it is replenished in many cities.[55] When groundwater is recharged through leakage from wastewater infrastructure, it has the potential to contaminate parts of an aquifer.[56] As a result, urban residents who rely on ground and surface water sources are increasingly vulnerable to consuming contaminated water.

To ensure water access today and in the future, cities need to consider how they will protect water sources and manage sanitation.[57] Urban water security requires undertaking activities to safeguard water sources, such as protecting forests, promoting reforestation, and improving agricultural practices.[58] These issues are often overlooked by urban political leaders and policymakers because part of the cause of water stress is often located outside the city's jurisdiction. Cities have political and economic interests in effective watershed management, even if part or all of the watershed lies outside their boundaries. As a result, cities need to consider water security from a regional perspective.

Equally important and also overlooked is the need to ensure that when water is delivered to an urban area, there is a system for safely removing and disposing of it after use. For example, if water is supplied to a densely populated urban area that lacks a proper sanitation system, disease from contaminated water can actually increase.[59] Furthermore, many sanitation systems

Box 2 | Where Water Utility Coverage Is Low, and the Cost of Privately Provided Water Is High

In the absence of reliable piped water provided by the city or a public utility, many households must meet their water needs using private and informal providers. The examples below illustrate the challenge of accessing water where piped supplies are limited and private providers charge high prices.

In Lagos, Nigeria, the utility provides water service to less than 10 percent of the city. The city's distribution network suffers from leakages, degraded physical infrastructure, an unreliable power supply, and a lack of financial resources. This means 20 million residents are reliant on alternative water sources. In high-income areas, households can afford frequent tanker truck deliveries provided by private vendors (despite the fact that these vendors often extract water from overused boreholes, so the water quality is compromised). However, many low-income households cannot afford water from tanker trucks, nor can they afford bottled or sachet water.[a] As a result, they rely on a combination of alternative sources, including unprotected and protected wells, rainwater collection, and small-cart water vendors. Water delivery from alternative sources is uneven and subject to highly discretionary arrangements and steep price differentials. More than 70 percent of households in Lagos have water vendors in their communities and report paying more than 10 times the public price for drinking water per cubic meter.

Karachi, Pakistan, faces similar challenges. The city's water utility serves approximately 30 percent of households, but water supplies are intermittent. The city's water utility has struggled with political corruption, water shortages, and a lack of planning and technical capacity. In many instances, pipes were laid inadequately and without technical supervision. This has led to the informal practice of households attaching their own water suction devices to pipes, which in turn inhibits the pressure needed for water to reach distant and/or high elevation areas. In addition, illegal water connections sometimes pass through open drains, increasing the possibility of becoming contaminated with human and household waste. As a result, many households turn to alternative water providers and pay much higher costs. Tanker trucks are on average 25 times more expensive than utility water. Residents from Ghaziabad, the informal settlement in Karachi, purchase water directly from a private reverse osmosis treatment plant at almost 50 times the cost of public water.

Cochabamba, Bolivia; Maputo, Mozambique; Mzuzu, Malawi; and other cities experienced challenges similar to the ones described above. When publicly supplied water is neither available nor reliable, households often obtain water through a complex mix of privately supplied sources. In urban areas this often results in households paying higher prices for water of questionable quality.

Note: a. Information Nigeria, 2013.

Source: WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.

(such as sewers, simple sewers, and septic tanks) will not work without adequate water supplies. Although the dual challenges of protecting water sources and managing urban sanitation are of the utmost importance,[60] this paper focuses on priority actions that cities and water utilities can take today, within their jurisdiction, to ensure equitable access to water.

There are three main facets to urban water access: availability, quality, and affordability. This paper examines all three at the city level, to varying degrees of depth. It analyzes availability and predictability from the perspective of the household. In terms of water quality, it analyzes water source, intermittent water supply, and how households treat their water. In the absence of testing water samples from households, these are the most commonly used proxies for assessing water quality.[61] Most countries use national water quality standards that are aligned with WHO guidelines for drinking water quality.[62] However, there is a dearth of comparable water quality data in cities in the global South.[63] Water quality data available in three of eight SDG regions suggest that "levels of compliance [with standards] are low in many developing countries."[64] Finally, the paper highlights the neglected issue of affordability, particularly its relationship to the amount of water individuals and households consume.

This paper starts from a normative position: because access to water is a human right, cities and urban change agents—which include political leaders, city planners, the private sector, civil society, activists, and others—need to commit to providing equitable access to safe, reliable, and affordable water. To this end, section 1 frames the need for equitable water access in cities. Section 2 describes how global definitions and data have led to an underestimation of the urban water crisis. Section 3 analyzes water access in 15 cities in sub-Saharan

Africa, South Asia, and Latin America. Section 4 examines why water affordability and regularity have been ignored. Section 5 focuses on four priority action areas: expanding the piped water network, addressing intermittency, ensuring water affordability, and supporting improved water access in efforts to upgrade informal settlements. This paper finds that improved water access will require cities and water utilities to be flexible and willing to work with communities, and to invest in subsidized water. Section 6 focuses on the long-term enabling conditions that require governments to make significant capital investments, sustain committed political leadership, reform water utilities, and work with diverse coalitions to achieve and protect positive reforms. Section 7 summarizes the most important findings from the research.

2. THE URBAN WATER CRISIS IS UNDERESTIMATED

Past declarations that the world met the Millennium Development Goal (MDG) that aimed to halve the proportion of people who lacked improved sources of water have led the current water crisis to be underestimated in cities in the global South.[65] After the MDG period ended, the United Nations (UN) introduced a new set of indicators to monitor progress towards water and hygiene-related goals as well as targets that are spelled out in the SDGs. These are the only statistics about global coverage currently available, so any global assessment of water access must engage with these categories (see Table 1). However, these global indicators have also contributed to an underestimation of the current urban water crisis.

While the Joint Monitoring Programme (JMP), a program managed by WHO and the UN Children's Fund (UNICEF), does not collect primary data, it has developed a set of "harmonized surveys" for households, schools, and healthcare facilities to help address the problem of data comparability.[66] The intention is for all national surveys and censuses to use these core questions. On the basis of data yielded from these questions, between 2000 and 2015, the MDGs focused on the category of improved water supplies, which includes water from a wide range of sources. The use of this broad category, along with the lack of attention to water quality, regularity, and affordability, led to an overestimation of water access and an underestimation of the water crisis in cities in the global South. The SDG responded to this shortcoming by introducing the category of "safely managed water."[67] However, this category still fails to address intermittency (and how it negatively affects water quality in piped systems) and affordability. Also as noted earlier, there are scant global data about water quality because reliable and systematic water quality data are difficult and costly to collect. Table 2 compares water access across different geographies on the basis of different categories and components of the JMP service ladder, which is used to compare service levels across countries.

Table 1 | **The JMP Service Ladder and Different Categories for Drinking Water**

SOURCE TYPE	JMP SERVICE LADDER	DEFINITION
Improved: ▶ Piped supplies (from tap water in the dwelling, yard, or plot, or public stand pipes) ▶ Nonpiped supplies (from boreholes/tube wells; protected wells and springs; rainwater; packaged water, including bottled and sachet water; and delivered water, including from tanker trucks and small carts)	**Safely managed**	**Drinking water from an improved water source that is located on the premises, available when needed, and free from fecal and priority chemical contamination**
	Basic	**Drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip, including queuing**
	Limited	**Drinking water from an improved source for which collection time exceeds 30 minutes for a round trip, including queuing**
Unimproved	**Unimproved**	**Drinking water from an unprotected dug well or unprotected spring**
Surface Water	**Surface water**	**Drinking water directly from a river, dam, lake, pond, stream, canal, or irrigation canal**

Source: Adapted from WHO and UNICEF, 2017: 8, 52.

Table 2 | **Analyzing Urban Water Access on the Basis of Different Components of the JMP Service Ladder**

REGION	BASIC	PIPED	SAFELY MANAGED	COMPONENTS OF SAFELY MANAGED		
				ACCESSIBLE ON PREMISES	AVAILABLE WHEN NEEDED	FREE FROM CONTAMINATION
Australia and New Zealand	100%	94%	97%	99%	97%	100%
Central Asia and Southern Asia	94%	67%	61%	78%	87%	61%
Eastern Asia and Southeastern Asia	96%	82%	89%	89%	—	93%
Latin America and the Caribbean	99%	96%	77%	97%	77%	93%
Northern America and Europe	99%	98%	96%	96%	99%	100%
Oceania, excluding Australia and New Zealand	92%	82%		73%	86%	—
Sub-Saharan Africa	82%	56%	46%	46%	66%	72%
Western Asia and Northern Africa	96%	91%		90%	84%	—
Least developed countries	83%	59%	53%	55%	63%	53%
WORLD	**95%**	**83%**	**85%**	**86%**	**85%**	**89%**

Note: Piped water here refers to tap water in the dwelling, yard, or plot, and public standpipes.

Source: WHO and UNICEF, 2017: 23, 105.

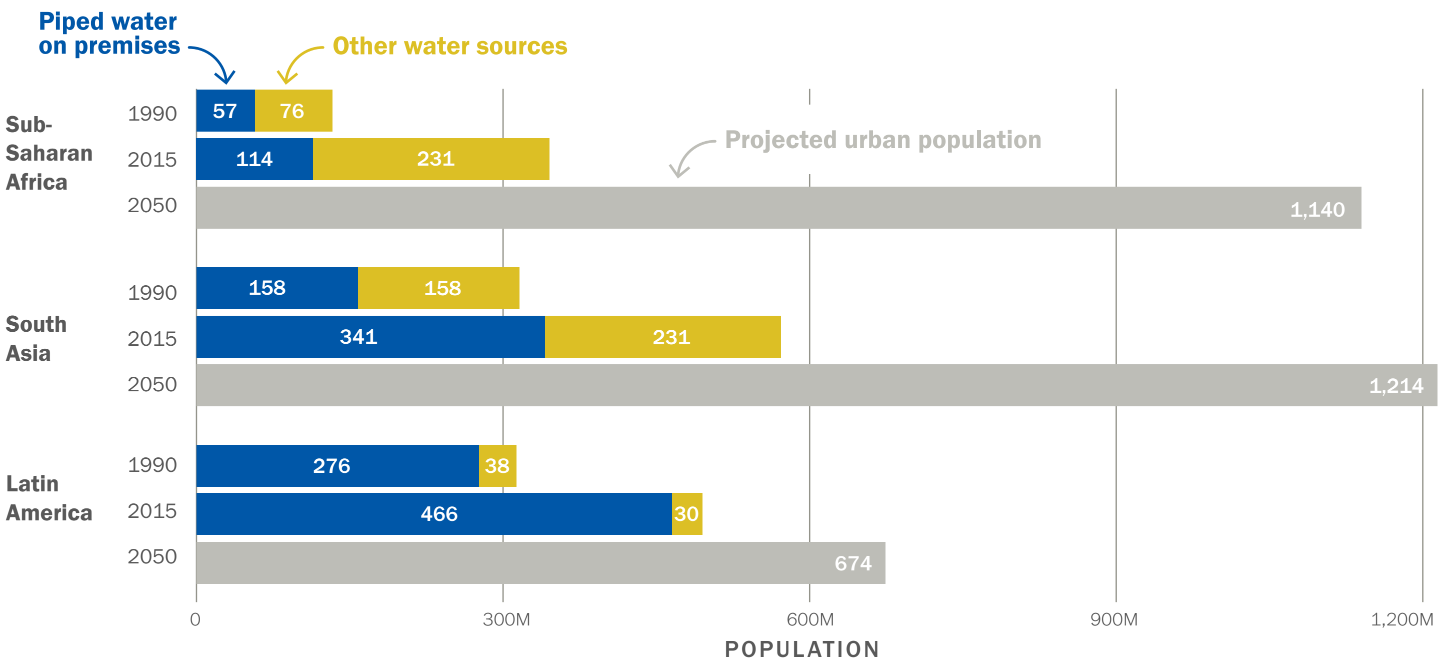
According to Table 2, 95 percent of the global urban population has basic water provision; 83 percent has piped provision; and 85 percent has safely managed provision.[68] Looking at global statistics rather than focusing on geographic regions makes the deficits appear smaller.[69] For example, in sub-Saharan Africa, the fact that 54 percent of the urban population lacks safely managed water means that 197 million people lack such provision.[70] Central and Southern Asia had the largest absolute numbers of urban residents who lacked safely managed water in 2015—258 million people. That same year, in Latin America and the Caribbean, 117 million people lacked safely managed water.[71]

If we take water piped to premises as a proxy for water access, then progress from 1990 to 2015 is much less impressive compared to the categories of urban residents who receive improved or basic water provision (see Figure 1).[72] This reflects the inability of cities and water utilities to keep pace with the water needs of their growing urban populations. In sub-Saharan Africa, for example, the urban population increased from 133 million in 1990 to around 350 million in 2015.[73] Moreover, in 2015, less than half the urban population in many sub-Saharan nations received piped water on premises, which was a lower proportion than in 1990.[74] If complete data on water provision for all countries existed, they would likely show many more countries in which half the urban population did not have access to piped water in 2015.[75]

In addition, water data provided by the Demographic Health Surveys (DHSs) reflect national urban and rural populations, not individual cities and towns. To provide a better picture of the deficient access to water in urban areas, in Nigeria the 2014 DHS reported that only 5.5 percent of urban households had water piped to premises.[76] For mainland Tanzania, the 2016 DHS reported that only a quarter of urban households had water piped to a dwelling, yard, or plot.[77] In 2015, the Central African Republic, the Democratic Republic of Congo, Equatorial Guinea, Guinea-Bissau, Haiti, Liberia, Madagascar, Myanmar, Nigeria, Sierra Leone, South Sudan, and Togo all had less than a fifth of their urban population receiving water piped to premises.[78]

An estimated 1.8 billion people globally drink water from contaminated sources.[79] Table 2 shows that nearly half the urban population in LDCs access water that is contaminated with chemicals and/or fecal matter. Water contamination is closely related to equitable access to safely managed sanitation services.[80] Indeed, the provision of water and sanitation services need to be considered jointly, as the two systems are interconnected—water quality depends in part on safely managed sanitation services, which in turn need sufficient water to function properly. If cities and water utilities deliver water, they also need to provide a safe way to dispose of wastewater.

Figure 1 | **The service gap is widening between the provision of piped water and growing urban populations**



Source: WHO and UNICEF, 2015; UN DESA, 2017.

Closely related to the issue of water contamination is intermittent service because water that is supplied on a discontinuous basis has an increased risk of contamination. That the definition of safely managed water includes the language "available when needed" (defined as available at least 12 hours a day) recognizes the lack of continuous supply. The JMP reports that an estimated 40 percent of those using piped municipal water supplies in South Africa suffered interruptions to supply, and 22 percent suffered interruptions of more than two days per week.[81] In addition, the JMP acknowledges that there are no reliable data on intermittent service for many nations.[82] We return to the challenge of intermittent water supply in more detail later in the paper.

The JMP began considering water affordability in its 2017 report.[83] There is growing evidence that municipal-supplied water is unaffordable for many low-income households.[84] For example, in Tanzania, 16 percent of urban households are spending more than 5 percent of their income on water, with households spending the most on tanker or vendor water.[85] The high cost of piped water often results in the use of ground and surface water. A further indication of water's unaffordability is that between 2000 and 2010, the use of packaged water—which households purchase in insufficient quantities because of the high cost—grew from 0 to 40 percent in urban areas of the Philippines and from 20 to 60 percent in urban areas of Ghana.[86] Less is known globally about how much households pay for water when they lack provision to their home and must purchase water from standpipes, kiosks, vendors, tankers, boreholes, bottled or sachet water, and other sources.[87]

It is worth highlighting four major limitations of the global water data, as together these contribute to a fundamental underestimation of urban water access.

1. The categories of improved, safely managed, and basic water encompass such a wide variety of sources that these definitions cease to be useful.

2. The data about drinking water piped to premises are incomplete and have limited value because of the lack of attention to quality, regularity, and user costs.

3. All UN water data categories pay inadequate attention to the price of water for households.

4. There are inadequate city and subcity data on water provision and access (this is especially true of informal settlements).[88]

Although the MDGs reported impressive progress on water access, the fact remains that today more urban residents lack water than was the case in the 1990s.[89] The lack of understanding of the scale and scope of the urban water crisis in the global South inhibits meaningful action on the part of urban change agents; as a result, cities are failing to take the steps necessary to ensure equitable water access.

3. ANALYSIS OF WATER ACCESS IN 15 CITIES IN THE GLOBAL SOUTH

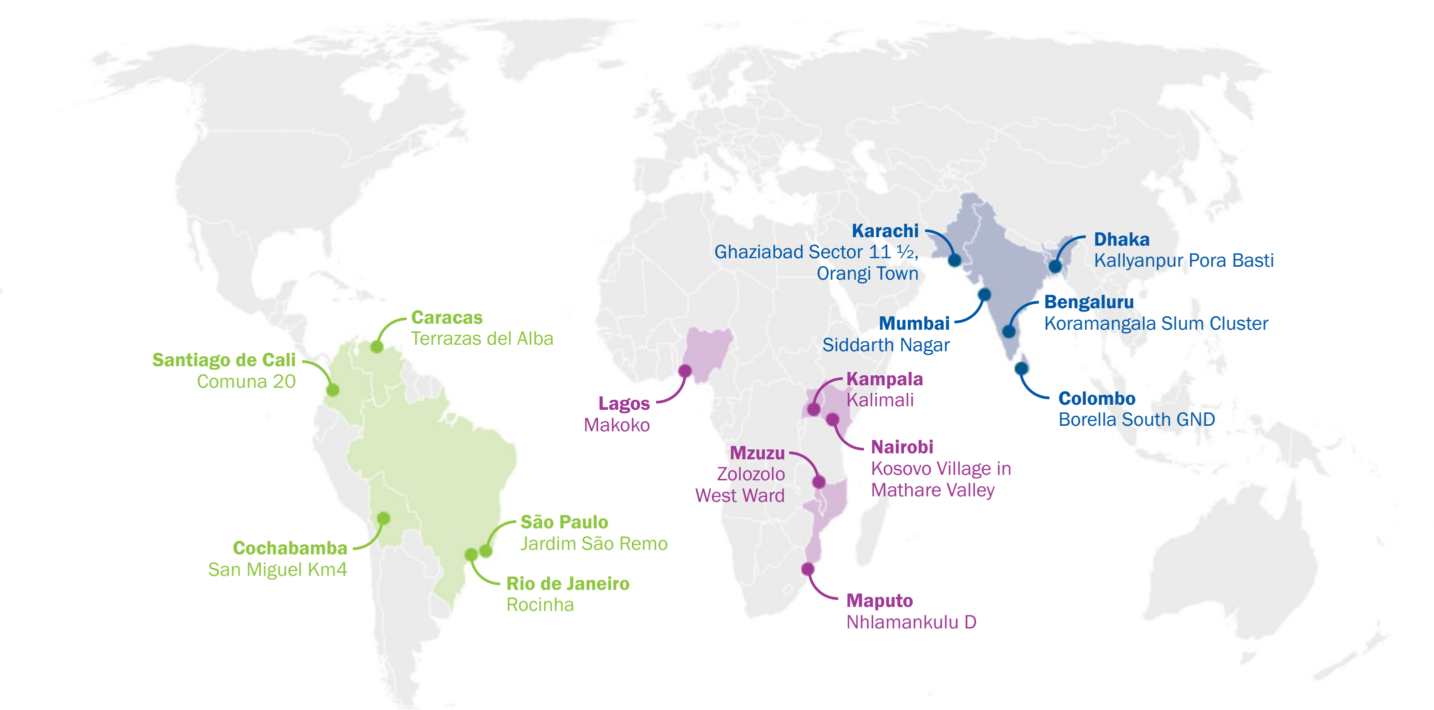
To address the absence of comparable city-level water data, we compiled data from 15 global South cities located in sub-Saharan Africa, South Asia, and Latin America and among the regions that are the focus of the World Resources Report (WRR) *Towards a More Equal City*. The 15 cities are Kampala, Uganda; Lagos, Nigeria; Maputo, Mozambique; Mzuzu, Malawi; Nairobi, Kenya; Bengaluru, India; Colombo, Sri Lanka; Dhaka, Bangladesh; Karachi, Pakistan; Mumbai, India; Caracas, Venezuela; Cochabamba, Bolivia; Rio de Janeiro, Brazil; São Paulo, Brazil; and Santiago de Cali, Colombia. Although not statistically representative, these cities illustrate the geographic, demographic, and economic development diversity regarding water access in each region (see Figure 2).

Research Strategy and Methods

To compile a data set on each city, we collaborated with local researchers who had a minimum of seven years of experience in the water sector. Data were obtained from a combination of interviews, fieldwork in an informal settlement, publicly available data sets, administrative records, websites, and project documents. Researchers in each city conducted an average of seven key informant interviews. Data were collected about household water access at the city level and fieldwork was conducted in one informal settlement in each city. At the city level, data were collected on the water utility, the city's sources of water, and the water utility's legal and administrative status.

We augmented the city-level data with fieldwork and data from one informal settlement in each city, for two reasons: (1) city-level data are usually presented in averages and thus tend to mask extremes at both ends of the socioeconomic distribution; and (2) in many cities, informal settlements are excluded from formal city-level statistics because their land occupation is considered illegal. To select the informal settlement in each city, the researchers identified a centrally located, well-established settlement that did not represent either the city's "best" or "worst" conditions but instead represented challenges to water access common in similar settlements in the city.

Figure 2 | **The geographic location of the 15 cities and informal settlements where water data were collected**



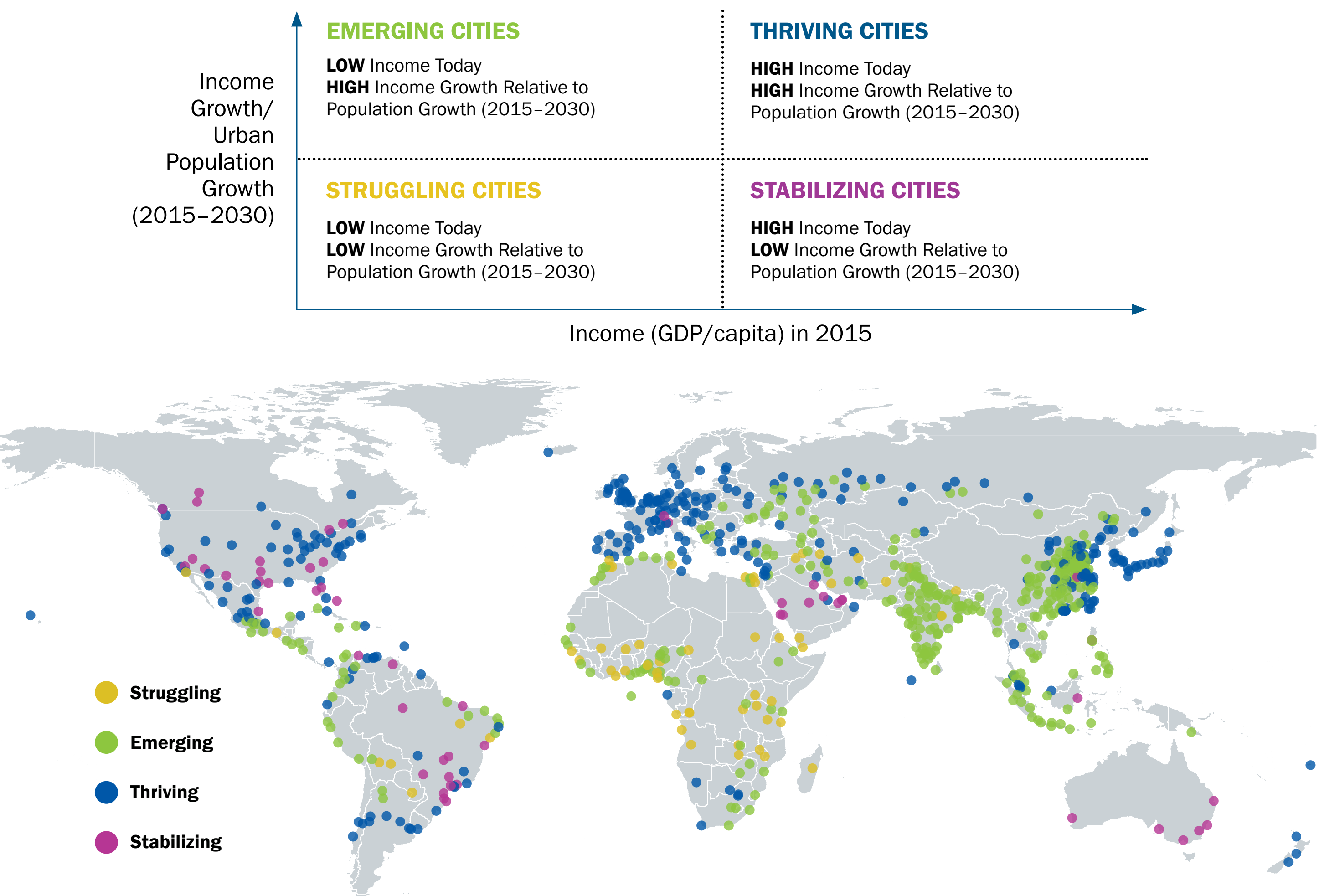
Source: WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.

In addition to the city-level and informal settlement data, each researcher wrote a narrative supplement. The narrative described the city's land-use patterns, residents' access to water, the rationale for selecting the informal settlement, a description of the institutional landscape of water provision, and an overview of unique contextual factors important for understanding water access. Examples of unique contextual factors include a water rationing policy in Nairobi, the presence of a large "floating population" in Santiago de Cali, the significant number of community-based water providers in Cochabamba, and the presence of powerful water mafias that control water valves in Bengaluru and Karachi. Each city had unique circumstances that were important for interpreting the data.

Using the city classifications introduced in the WRR *Towards a More Equal City*—struggling, emerging, thriving, and stabilizing—all the cities in Asia and Africa were either struggling or emerging (see Figure 3).[90] When the cities were classified in 2016, three cities in Latin America (Caracas, Rio de Janeiro, and São Paulo) were thriving; however, the economic situation in Venezuela has since declined significantly.

Respectively, struggling and emerging cities have lower incomes per capita, and this trend is projected to continue through 2030. In comparison, thriving cities currently have a relatively higher GDP (gross domestic product) per capita and are projected to have a higher ratio of growth in GDP per capita to population growth between 2015 and 2030.

Figure 3 | **World Resources Report city categories**



Source: Beard et al., 2016, based on data from Oxford Economics, 2016.

Table 3 provides an overview of the cities and informal settlements included in the study. Our findings from the informal settlements were consistent with the reality in many global South cities; the settlements were heterogeneous, with population size and number of households varying widely.[91]

How Do Households Obtain Water?

It is costly, time-consuming, and technically difficult to collect and analyze data about the quality of household drinking water.[93] As a result, the JMP uses information about the source of drinking water as a proxy for safety: "The assumption is that

Table 3 | A Snapshot of the 15 Cities and Selected Informal Settlements

					CITY				INFORMAL SETTLEMENT		
REGION	CITY NAME	COUNTRY	WRR CITY CATEGORY	TYPE OF JURISDICTION	POPULATION	AVERAGE HOUSEHOLD SIZE	% OF HOUSEHOLDS IN INFORMAL SETTLEMENT	% OF WORKFORCE IN INFORMAL ECONOMY	SETTLEMENT NAME	POPULATION	AVG. HOUSEHOLD SIZE
SUB-SAHARAN AFRICA	**Kampala**	Uganda	Struggling	City	1,507,080	4.0	60	70	Kalimali	1,540	5.0
	Lagos	Nigeria	Struggling	Metropolis	23,300,000	5.0	70	70	Makoko	204,720	5.0
	Maputo	Mozambique	Emerging	Municipality	1,288,721	4.9	9	55	Nhlamankulu D	12,175	5.1
	Mzuzu	Malawi	Struggling	City	254,891	5.0	60	80	Zolozolo West Ward	21,349	5.0
	Nairobi	Kenya	Struggling	City county	4,463,149	3.2	65	53	Kosovo Village in Mathare Valley	12,000	3.0
SOUTH ASIA	**Bengaluru**	India	Emerging	Municipal corporation	8,443,675	4.0	30	60	Koramangala Slum Cluster	38,500	4.5
	Colombo	Sri Lanka	Emerging	Municipality	555,031	6.1	44	38	Borella South GND	5,127	4.2
	Dhaka	Bangladesh	Emerging	City corporation	6,970,105	4.4	23	75	Kallyanpur Pora Basti	11,357	3.9
	Karachi	Pakistan	Emerging	Municipality	16,054,988	5.8	52	70	Ghaziabad Sector 11 ½, Orangi Town	51,000	8.0
	Mumbai	India	Emerging	Municipal corporation	12,442,373	4.5	40	80	Siddarth Nagar	2,160	4.2
LATIN AMERICA	**Caracas**	Venezuela	Thriving	Municipality	3,319,849	3.7	60	28	Terrazas del Alba	3,500	3.5
	Cochabamba	Bolivia	Struggling	Municipality	632,013	3.0	27	55	San Miguel Km4	1,705	6.0
	Rio de Janeiro	Brazil	Thriving	Municipality	6,320,446	3.0	23	35	Rocinha	77,178	3.0
	São Paulo	Brazil	Thriving	Municipality	12,040,000	3.2	12	20	Jardim São Remo	6,930	3.5
	Santiago de Cali	Colombia	Emerging	Municipality	2,278,022	4.0	23	60	Comuna 20	68,980	4.0

Notes: Figures for city population and average household size are based on national statistics. Figures for percentage of workforce in informal economy and households in informal settlements were locally determined. These figures came from a combination of key informants, project reports, and government records.

Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.[92]

certain types of drinking-water sources are likely to deliver drinking water of adequate quality for their basic health needs."[94] While not an ideal measure, the categories in our questionnaire were consistent with the questions suggested by the JMP. Figure 4 looks at the main source of drinking water for households in each city and in one informal settlement in each city.

Across all 15 cities, when weighted by population, approximately 58 percent of households had access to piped water. In Latin American cities, 97 percent of households received water piped to their dwelling or yard, but there was notable variation within each geographic region. For example, in Cochabamba, as many as 20 percent of households relied on tanker trucks. In Asia, Dhaka had the highest percentage of households with piped water (95 percent), but much of it is piped from underground reservoirs or storage tanks, and households must use hand or electric pumps to obtain it. This water is also a mix of utility water and groundwater. In Karachi, 25 percent of households received their water from tanker trucks, and 34 percent received it from small vendors or bottled water. In the two Indian cities, households that did not have water piped to their premises relied on surface water, groundwater, and rainwater. In Mumbai, for example, 8 percent of households relied on surface water, groundwater, and rainwater. Consistent with global figures, on average, cities in sub-Saharan Africa had the lowest rates of water access; less than half of all households received piped water. In Kampala, 70 percent of households relied on water from public taps, standpipes, and kiosks.[96] In Lagos, 69 percent of households relied on surface water, groundwater, or rainwater.

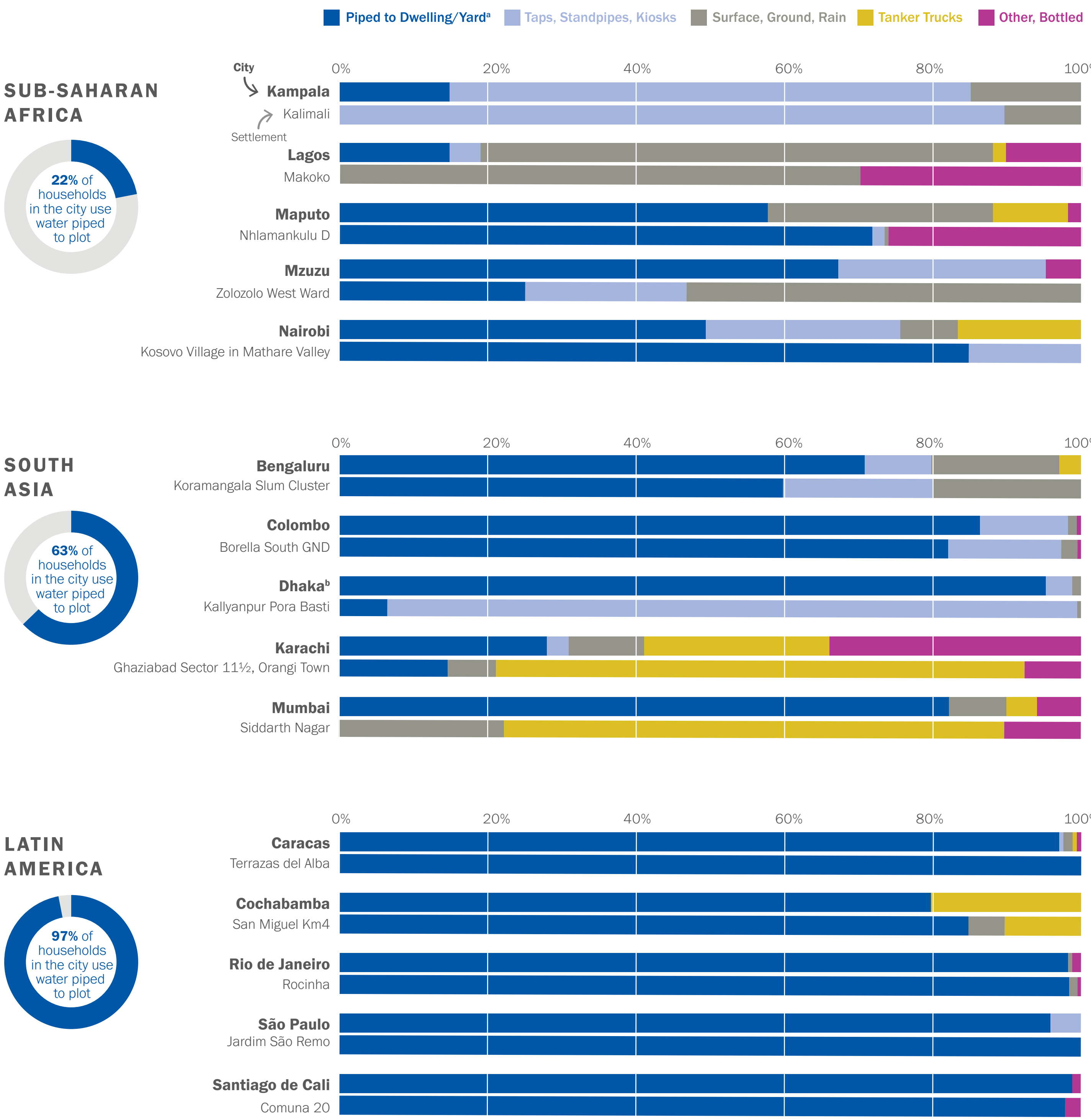
Many informal settlements reported lower rates of water piped to premises compared to the city, as it is common for houses in informal settlements to obtain their drinking water from a wide variety of sources. None of the three informal settlements in Mumbai, Kampala, and Lagos had water piped to premises. In all informal settlements that reported lower rates of water piped to premises compared to the city, households usually obtained their water from the same alternative sources as households at the city level, just in larger proportion. The informal settlement in Bengaluru, where 60 percent of households receive piped supplies (compared to 71 percent of households in the city as a whole), has higher piped water access than other slums because it is a formally "declared"[97] slum. Connection rates are lower in "undeclared" slums, where households are not eligible for water connections.[98] In many cities in the global South, access to piped water is closely tied with the politics of land use and informality.

In contrast, all five informal settlements from Latin American cities had high access to piped water (above 85 percent), similar to what was reported for the city as a whole, most likely because of their central location. Two other informal settlements in Maputo and Nairobi had higher access to piped water than the city average. In Maputo, where 72 percent of households in informal settlements had access to piped water compared to 58 percent as the average for the city, the informal settlement benefited from household connections installed by a water and sanitation NGO. In Nairobi, where 85 percent of households in an informal settlement received water piped to premises compared to the city average of 50 percent, households in the informal settlement received water connections as part of a pilot project. In some of the informal settlements, a high proportion of piped water to a dwelling or yard was obtained illegally.

Is There Water in the Pipes?

While 58 percent of households in the 15 cities have access to piped water, intermittent water supply remains a challenge. Intermittency is caused by a variety of factors, which include inadequate water and energy supplies, pipe breakages and leaks, and the desire to politically manipulate or control factions of the urban population (see section 4).[99] Intermittent supply also results from municipal rationing in response to water shortages, which is not uncommon in cities in the global South.[100] No matter the cause of intermittent water supply, when water pressure drops, contamination from sewage, groundwater, surface water, and other sources enters pipelines through holes and cracks.[101] When the system is repressurized and/or the water supply is restored, the contaminated water is delivered to taps.[102] In many cases, intermittent water supply leaves households unsure of when exactly water will be available. This causes them to use a variety of water storage systems, which further increases the risk of contaminating their water and adds to the cost. Figure 5 provides data on the average availability of water from the piped network and household-level water treatment methods.

Figure 4 | **In 15 cities in the global South, on average 58 percent of households have piped water to the dwelling**



Notes: Regional averages for percentage of "households in the city using water piped to plot" are weighted by city population.
a. Figures for "piped to dwelling/yard" draw from formal sources; b. For Dhaka's citywide data, about 78 percent of piped water is supplied by groundwater, and 22 percent comes from the water utility treatment plants.

Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.[95]

Figure 5 | Piped water availability and household water treatment in cities and informal settlements

Region	City Name	Average Availability per Week (hours per day/days per week)	% of Household Responses to Perceived Water Quality: No treatment	Boil/filter	Other[a]	Informal Settlement Name	Average Availability per Week (hours per day/days per week)	% of Household Responses to Perceived Water Quality: No treatment	Boil/filter	Other[a]
SUB-SAHARAN AFRICA	Kampala	8/7		80	20	Kalimali	0/0[b]		90	10
SUB-SAHARAN AFRICA	Lagos[c]		3	63	34	Makoko	0/0	95	5	
SUB-SAHARAN AFRICA	Maputo	10/7		80	20	Nhlamankulu D	6/7		15	85
SUB-SAHARAN AFRICA	Mzuzu	20/7	85	7	8	Zolozolo West Ward	20/7	92		8
SUB-SAHARAN AFRICA	Nairobi	18/5	41	35	24	Kosovo Village in Mathare Valley	24/7	85	5	10
SOUTH ASIA	Bengaluru[d]	3/3[e]	56	44		Koramangala Slum Cluster	2/2.5	35	65	
SOUTH ASIA	Colombo	24/7	29	68	3	Borella South GND	24/7	40	50	10
SOUTH ASIA	Dhaka[f]	24/7	18	81	1	Kallyanpur Pora Basti	24/7	87	13	
SOUTH ASIA	Karachi	2/3	38	60	2	Ghaziabad Sector 11 ½, Orangi Town	1/1.5	40	60	
SOUTH ASIA	Mumbai	7/7	75	22	3	Siddarth Nagar	0/0	75		25
LATIN AMERICA	Caracas	13/7	10	90		Terrazas del Alba	4/3	10	90	
LATIN AMERICA	Cochabamba	15/3		100		San Miguel Km4	4/4		100	
LATIN AMERICA	Rio de Janeiro	20/7	10	75	15	Rocinha	12/4	10	20	70
LATIN AMERICA	São Paulo	24/7	37	63		Jardim São Remo	24/7	20	80	
LATIN AMERICA	Santiago de Cali	24/7	98	2		Comuna 20	24/7	98	2	

AVAILABILITY HIGH 168 hours/week; MEDIUM 84–167 hours/week; LOW 10–83 hours/week; EXTREMELY LOW <10 hours/week

Notes:
a. "Other" household responses to perceived water quality includes water treated using bleach/chlorine, solar disinfection, the stand-and-settle method, disinfection tablets, as well as purchasing bottled water.
b. Though there are no piped connections into dwellings or plots in the informal settlement, privately owned standpipes are available on average for eight hours per day, seven days per week.
c. The data are unavailable for Lagos because water availability varies significantly depending on household location in the city.
d. Estimates for household water treatment are based on a 2017 study limited to one geographical location within the city.
e. Many households have underground sumps or storage tanks.
f. In Dhaka, although pressure is intermittent, water is available at all times, but residents use hand or electric pumps to obtain water from the piped network.

Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.[103]

São Paulo, Santiago de Cali, and Colombo reported having a constant water supply. Two of the cities with the lowest water availability were Bengaluru, where the utility has a rationing schedule that is relatively fixed and predictable, and Karachi, where water availability is more unpredictable. It should be noted that in cities where utilities have made water availability more predictable, this does not address the increased risk of water contamination. In a number of cities where water supply intermittency was an issue, a sizeable number of households do not treat their water; specifically, 38 percent of households and 56 percent of households citywide in Karachi and Bengaluru, respectively, do not treat their water. In Nairobi, there is intermittent water supply and an active water-rationing program in response to the utility's deficient water supply, yet 41 percent of households do not treat their water.

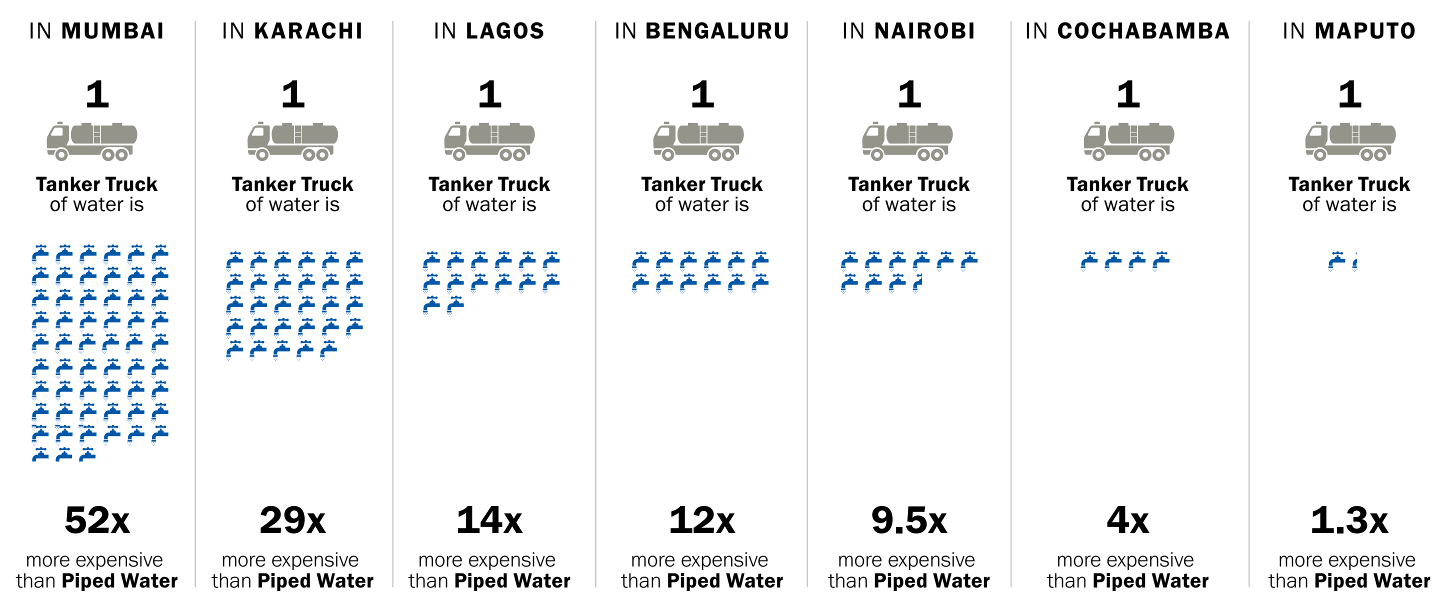
Out of the nine informal settlements with medium to high piped water access, five had intermittent water supply, and three reported that between 10 and 35 percent of households did not treat their water. In the cities with intermittent water supply, the informal settlements typically had fewer days per week and hours per day when water was available compared to the city as a whole; the two exceptions are the informal settlements in Nairobi and Mzuzu. However, this does not mean that households always have access to water; there are other barriers to access, including personal safety risks involved in leaving the home to obtain water and the high cost of water.

How Much Does Water Cost, and Is It Affordable?

Table 5 presents the cost of water by source. Market exchange rates were used to facilitate comparability among the 15 cities. In the table, the price of water is based on 1 cubic meter (m^3), which equals 1,000 liters (L). When there was a range in the price of water from a particular source, the price reported in the column represents the lowest cost for water in the range. When cities used differential block pricing, we calculated the cost for a monthly consumption of 10 m^3 per household.[104] When comparing water prices between cities we considered both market and purchase power parity exchange rates. However, Table 5 uses market exchange rates because, on balance, we found them more useful for facilitating comparisons.

In many cities where natural sources of water are available, some households obtained water at a very low cost or for free (represented in Table 5 by 0). In other cases, households incurred a cost when they obtained water from a neighbor or a vendor, for example. Besides natural sources of water, the least expensive source was water piped to a dwelling or yard, except in Mzuzu and Nairobi. After free water from natural sources and water delivered through a piped municipal system, water sourced from tanker trucks was the next most expensive, and notably so in seven out of eight cities where it is available (see Figure 6).

Figure 6 | **Tanker truck water is much more expensive than piped water**



Source: Based on authors' analysis of the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.

Table 5 | Cost of Water Services in 15 Cities and Selected Informal Settlements in the Global South

REGION	CITY NAME	COSTS PER CUBIC METER					INFORMAL SETTLEMENT NAME	COSTS PER CUBIC METER				
		PIPE	TAP, STAND-PIPE, KIOSK	SURFACE, GROUND, RAIN	TANKER TRUCK	OTHER, BOTTLE[a]		PIPE	TAP, STAND-PIPE, KIOSK	SURFACE, GROUND, RAIN	TANKER TRUCK	OTHER, BOTTLE[a]
SUB-SAHARAN AFRICA	**Kampala**	0.75	2.75	0	—	—	Kalimali	Not connected	2.75	2.75	—	—
	Lagos	0.16	0	0	2.17	210	Makoko	Not connected	—	1.11[b]	—	150
	Maputo	0.66	—	0.62	0.84[c]	310	Nhlamankulu D	0.66	0.17	6.00	—	8.35
	Mzuzu	0.75	0.55	—	—	—	Zolozolo West Ward	0.75	0.55	0.03	—	—
	Nairobi	0.50	0.19	4.73	4.73	—	Kosovo Village in Mathare Valley	0.19	0.22[d]	—	—	—
SOUTH ASIA	**Bengaluru**	0.17	0	0	2.02	—	Koramangala Slum Cluster	0[e]	0	0	—	—
	Colombo	0.97	0	0	—	390	Borella South GND	0.97	0	0	—	390
	Dhaka	0.13	0.13	0	—	—	Kallyanpur Pora Basti	0.13	0.13	0	—	—
	Karachi	0.32	0	0	9.42	14.13	Ghaziabad Sector 11½, Orangi Town	0.20	—	0	3.14	10
	Mumbai	0.06	—	0.12	3.11	23.33	Siddarth Nagar	Not connected	—	0	2.33	31
LATIN AMERICA	**Caracas[f]**	0.0004	0	0	0.81	11.63	Terrazas del Alba[e]	0	—	—	—	—
	Cochabamba	1.13	—	—	4.91	—	San Miguel Km4	0.56	—	—	4.91	—
	Rio de Janeiro	1.06	—	0	—	—	Rocinha	0	—	0	—	—
	São Paulo	1.09	0	—	—	—	Jardim São Remo	0.22	—	—	—	—
	Santiago de Cali	1.01	—	0	—	—	Comuna 20	1.01	—	-	—	—

Notes: Currency figures were converted to US$ using market exchange rates corresponding to the date of data collection.
a. This category includes bottled water, which is typically sold in smaller quantities (for example, 20-L bottles), and packaged water. All figures in this column are for bottled and packaged water except in Karachi, where the figure includes vendors (manual carriers), and in Nhlamankulu D, where the figure includes vendors who sell to their neighbors from a yard tap.
b. The costs reflect water sold from boreholes to neighboring households.
c. This is the price provided by water tankers in areas connected to the electrical grid. For areas without electricity, the price for tanker truck water is 20 percent higher.
d. This figure is an average of water from a kiosk and from a water ATM dispenser.
e. Most households do not have meters and do not pay.
f. Costs for water in Caracas were converted using the black market exchange rate from the date the data was collected: Bs 8,600 to $1.

Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.[105]

The most expensive type of water is bottled water, but this is not usually purchased in large quantities. Geographically, water was most expensive in the Latin American cities and least expensive in Mumbai, Dhaka, Lagos, and Bengaluru.[106]

Cities and water utilities have diverse schemes for determining the cost of water and how much it is subsidized (sometimes depending on national government programs). For example, Santiago de Cali classifies neighborhoods into six socioeconomic stratifications, each of which is charged a different price for water. Colombo and São Paulo use social tariffs to subsidize water for low-income neighborhoods. Lagos uses a higher tariff for gated estates, and Mzuzu uses different tariffs for water piped into a dwelling based on socioeconomic status and has lower tariffs for communal water points. Several cities, such as Bengaluru, Colombo, and Maputo, use a progressive block tariff in which the price per m^3 increases as a household consumes more water.

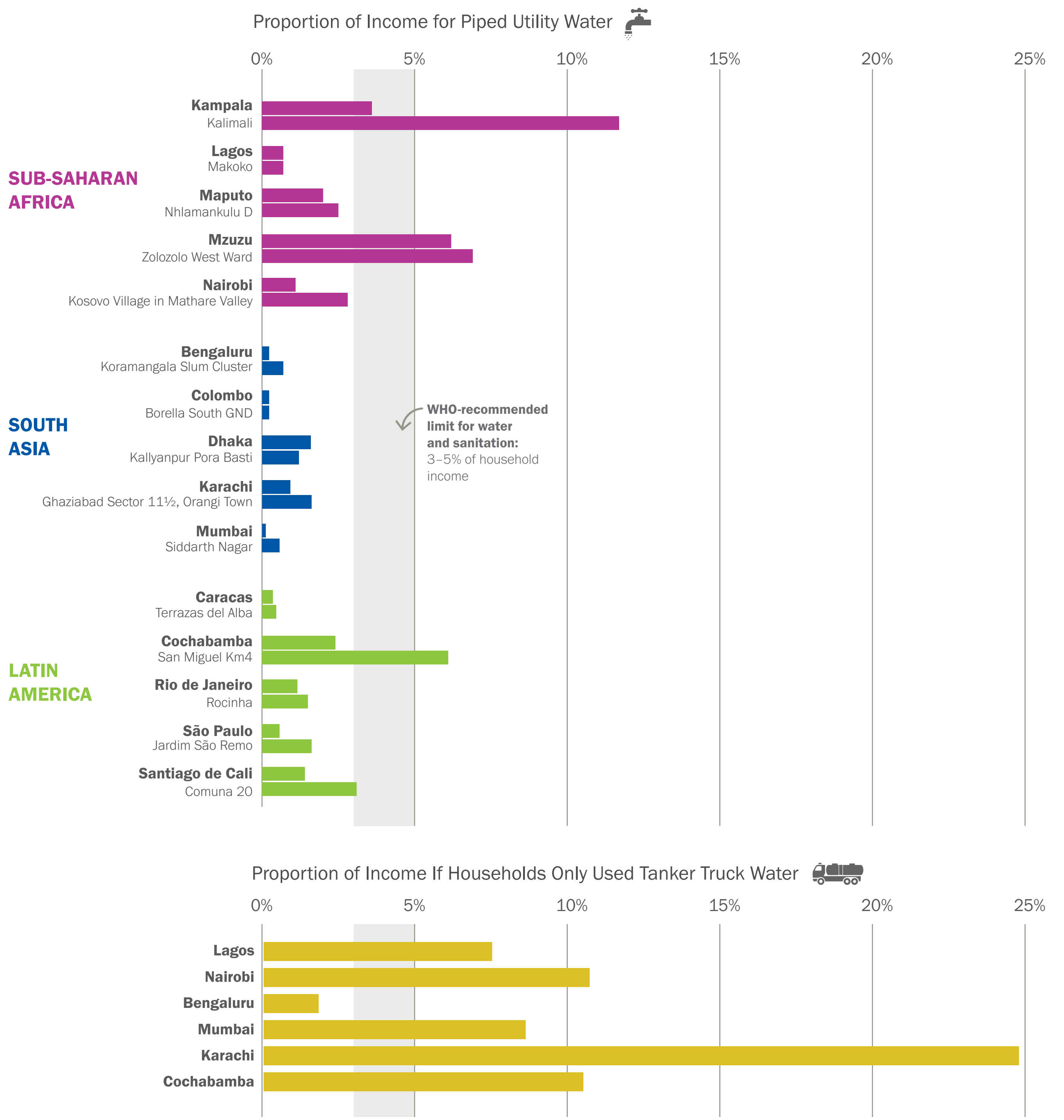
Informal settlements face unique challenges that are different from those that characterize water access in the city as a whole. For example, in three informal settlements—those in Mumbai, Lagos, and Kampala—there is no piped water service to the premises. Households in Kampala paid more than three times the price for water sourced from standpipes and natural sources distributed by private vendors compared to the cost of water piped to dwellings and yards. In another example, 26 percent of households in the informal settlement in Maputo purchased their water from neighbors and paid nearly 13 times the price of water piped directly to the dwelling or yard.

It is widely recommended in water policy literature that households not spend more than 3–5 percent of their income on water and sanitation combined, assuming that each household member has access to 50–100 L of water per day.[107] It should be noted that these amounts are based on what is needed to maintain a minimum level of human health and hygiene, and they rarely take into account the amount of water that households can afford to purchase (see section 4).[108] Figure 7 provides data on the percentage of a household's monthly income that is hypothetically spent on water, assuming the household relies completely on tanker truck water or is connected to piped water and uses that as its sole source.

In almost all cities where tanker truck water is available, if households relied solely on tanker truck water to meet all their needs, they would spend more than the recommended 3–5 percent of their monthly household income on water and sanitation. If a household is connected to piped water and uses it to meet all its needs, it would spend more than 3 percent of its monthly household income on water in just two cities: Kampala and Mzuzu. However, under the same conditions, households in the informal settlements would spend 11.7 percent of their monthly household income on water in Kampala, 6.9 percent in Mzuzu, 6.1 percent in Cochabamba, and 3.1 percent Santiago de Cali. It is important to note that these calculations use an estimate of average income in the city and informal settlement, and they do not consider the realities of the lowest-income households. This also assumes that the price of water does not change depending on, say, the household's physical location, the amount of water consumed, or other factors.

Informal settlements face unique challenges that are different from those that characterize water access in the city as a whole. For example, in three informal settlements—those in Mumbai, Lagos, and Kampala—there is no piped water service to the premises. Households in Kampala paid more than three times the price for water sourced from standpipes and natural sources distributed by private vendors compared to the cost of water piped to dwellings and yards.

Figure 7 | **Average household income spent on tanker truck water or piped utility water, if it were the sole source of water purchased**



Notes: Figures are based on an assumed monthly consumption of 50 L per day per person according to the average household size in the city and in the informal settlement. Average household incomes for the city and informal settlements were based on a combination of census data, government records, project documents, empirical studies, and interviews with key informants. Household income figures were converted to US$ using market exchange rates. See Table A.1 in the Appendix for the full data table.

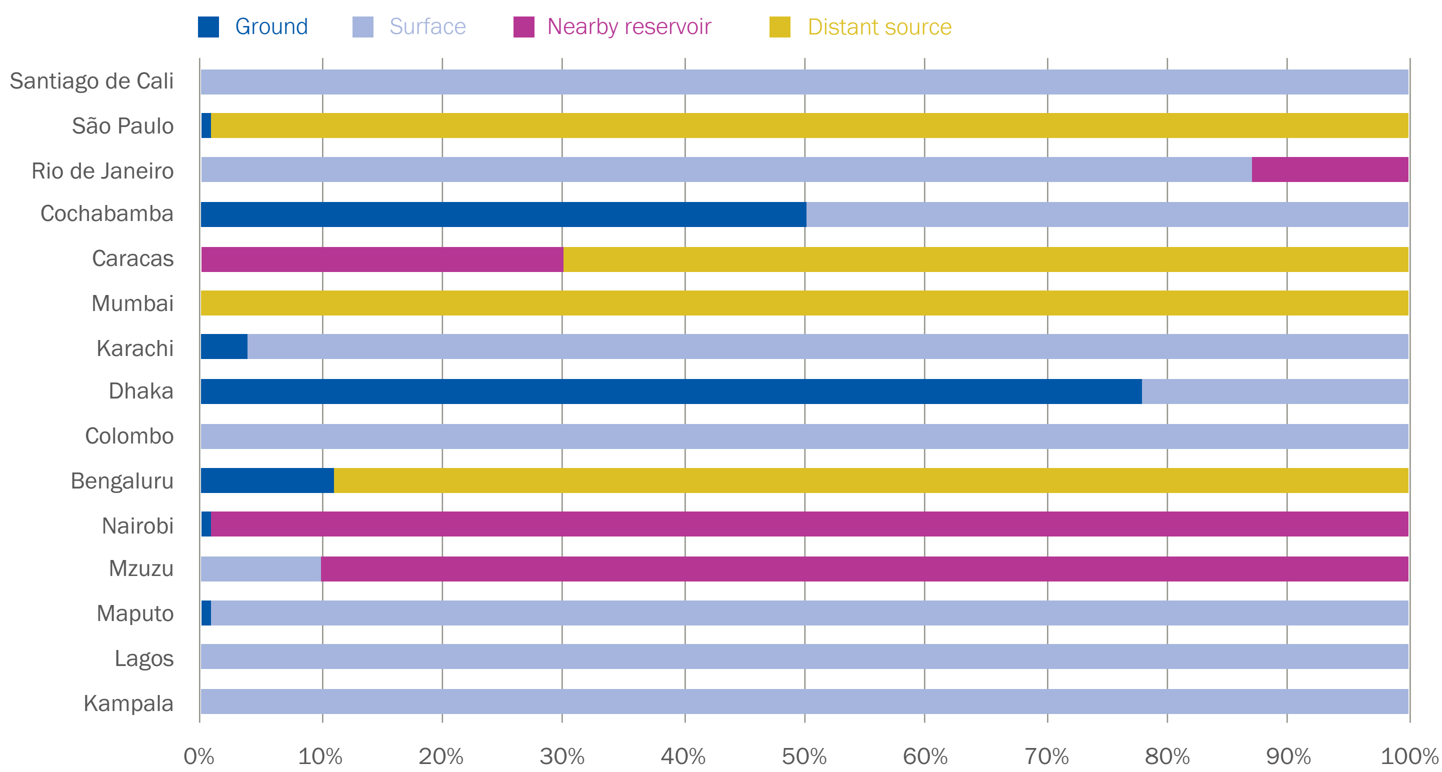
Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.[109]

Where Do Cities Obtain Water?

City water sources are vulnerable to different social, economic, and environmental risk factors. In dense urban settings, groundwater is at risk of being depleted when households obtain water from wells and boreholes. Indeed, as a result of groundwater depletion, Mexico City and Jakarta are seeing accelerated rates of land subsidence.[110] Surface water is also at risk of being contaminated with urban runoff and pollution from other anthropogenic activities. The building and use of dams and water reservoirs to ensure cities have water also has the potential to damage adjacent rivers and riparian environments. Finally, it is expensive for the city to transport water from distant sources, and there may be competition for this water from agriculture, industry, or other nearby urban centers. Figure 8 provides data about each city's water source.

Utilities in eight cities obtain most of their water from surface sources, which are particularly vulnerable to pollution from changes to the built environment and associated urban activities. Two cities, Cochabamba and Dhaka, obtain 50 percent or more of their municipal water from groundwater sources. Four cities—Caracas, Mzuzu, Nairobi, and Rio de Janeiro—obtain their water from nearby reservoirs. Four cities—Bengaluru, Caracas, Mumbai, and São Paulo—obtain most of their water from a reservoir located at least 100 kilometers away, some of which are located at a lower elevation. In both Bengaluru and Caracas, the process of bringing water across long distances and to higher elevations is very energy intensive.[112]

Figure 8 | **Urban water utilities rely on a variety of sources**



Notes: Distant source is defined as more than 100 kilometers away. For more information, see Table A.2.

Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.[111]

4. WHY HAS WATER AFFORDABILITY AND REGULARITY BEEN IGNORED?

To understand the present urban water crisis, it is helpful to understand the institutional context in which water services have developed. Beginning in the 1980s there was an international effort to privatize water services, particularly in the global South. This was encouraged both by issues specific to the water sector and a general concern regarding the ability of state agencies to effectively provide services. When privatization was not profitable and did not yield the expected improvements in water access, further efforts were made to corporatize water utilities. Corporatized utilities are owned by the public sector and managed within an incentive structure that encourages them to behave like private sector agencies. This context has had consequences for urban water access that are especially adverse for the urban under-served. Treating water as a commodity has led urban policymakers and other change agents to ignore water affordability issues, especially given the lack of precise data on household income and consumption. In the absence of such data, utility managers have tried to address affordability by lowering the cost of water rather than considering what households can actually afford to pay.

Efforts to Improve Water Management: The Promotion of Market Principles

Introducing private-sector and market principles into the water sector reflected the widespread concern that public utilities had been undermined by decades of poor management and limited investment in infrastructure.[113] Public piped water networks frequently were at an insufficient scale. For example, piped networks typically did not reach lower-income neighborhoods, especially those on the urban periphery and those with informal status.[114] Politically driven decision-making and a pressure to keep prices low—even for high-income households—resulted in financial losses. In the absence of financial transfers to cover the costs incurred by inexpensive water, utilities were unable to invest in and expand the piped network. As a result, subsidized water was provided to higher-income households and those connected to the network, while low-income households continued to be excluded.[115] An additional problem was that governments were reluctant to supply water to informal settlements, as they feared this would legitimize residents' claim to the land.[116] These were among the problems that private sector involvement in the water sector aimed to solve. It was expected that more efficient companies would expand the network, thereby expanding access and increasing their own financial viability.

In the absence of functional and affordable public piped water networks, water has been supplied to informal settlement residents through a set of informal and semiformal processes. Some areas were and remain neglected; in other areas, elites managed this informal sector and made money by providing services.[117] In other contexts, officials benefited; for example, recent reports from Dar es Salaam, Tanzania, suggest that well-positioned utility workers may garner illegal payments by providing (and denying) water.[118] In other areas, unorganized informal water vendors collect water from a range of public sources and sell it to residents.[119] Although some informal vendors charge exorbitant prices for their water, in other cases they are simply covering the high costs incurred from transporting water by hand or cart.[120] As confirmed by our data, informal vendors typically charge more than public suppliers (see Table A.3).[121]

Numerous studies have established a willingness to pay for water, and this has been, in part, used to challenge the lack of piped service to low-income residents.[122] Structural adjustment and the general reduction in state budgets further increased interest in attracting private sector investors.[123] It was thought that private sector involvement would reduce political influence over decision-making, enabling cost-recovery policies and enhancing network investments. As privatization took hold, the emphasis on cost recovery and improved financial management was combined with measures to encourage water provision to lower-income consumers.[124] Service obligations to extend provision were characteristic of water privatization strategies during the 1990s.[125] It was assumed that low-income households would buy water from the utility, reducing their own expenditure on water and providing additional revenue to the utility. In Bolivia, for example, it became illegal for city residents to collect rainwater for drinking under the rules introduced by the new private contractor.[126]

Privatization Slows with the Recognition That Subsidies Are Needed

Although many policymakers consider water access a commodity that is most appropriately allocated by the market, others consider it to be a human right that should be shared according to social justice principles. Although this paradox is understandable, it is not easily rectified or managed in the context of corporatized water utilities that prioritize cost recovery and operate at arm's length from the state. Such agencies are unequipped to deal with redistribution to lower-income and poor urban residents who cannot afford to purchase safe, reliable, and affordable water in sufficient quantities. The dominance of market principles in decision-making has created a context in which affordability concerns are unaddressed. The main way in which both utility managers and regulators have responded to the lack of adequate water supply is to reduce nonrevenue water rather than to facilitate access in adverse circumstances.[127]

The role of water regulators is tricky. Water has distinct characteristics—as both a public good and natural monopoly. Typically, public goods are regarded by economists as those that are nonexcludable and non-rivalrous. But water services are becoming increasingly rivalrous, and increased water scarcity will exacerbate this problem. Piped water from household connections and pay-per-use standpipes is clearly an excludable good, as households must pay the provider to gain access. Piped networks create monopolies because it does not make sense to have more than one piped network, and once one network is in place, it is unlikely that a second company will invest. Therefore, households may be exploited by the provider. Due to these characteristics, economists argue, unregulated markets are not an effective way to provide water services, and state intervention is required.[128]

Despite policymakers' expectations to the contrary, private sector involvement in water supplies has not significantly grown because of problems with access and affordability. Private companies struggled to achieve profitability on their investments in the global South, and by 2005 it was evident that most had little interest in increasing their involvement.[129] A major reason was the recognition that private companies cannot afford to supply water to low-income households without some form of subsidy.[130] Investments overseas became increasingly untenable for water companies once the associated risks were understood. In total, only 28 privately led water and sanitation projects took place in sub-Saharan Africa between 1990 and 2014, and 282 were undertaken in Latin America and the Caribbean during the same period.[131] Private international water companies have made it clear that they are primarily interested in management contracts that offer a more certain income.[132]

The perceived risks and limited profitability associated with private investment has meant that the water sector has moved away from privatization and toward corporatization. Continuing frustration with the outcomes of privatization have led to the remunicipalization—or when the city/utility takes over water management—of water supplies, in part because private providers have failed to address the needs of communities and provide water that is affordable.[133] Between 2000 and 2015, there were 235 cases of remunicipalization in 37 countries; however, only 51 of these were in low- and middle-income countries.[134] Remunicipalization has been posited as a way to improve water services, protect public interests, and develop more democratic water governance arrangements. However, in the global South, progress is limited due to municipal capacity and financial resources. Moreover, it is evident that remunicipalization may not solve water provision problems. This has been demonstrated in Cochabamba, where, as of 2015—15 years after the annulment of the private water concession to Aguas del Tunari—the remunicipalized public provider SEMAPA (Servicio Municipal de Agua Potable) was unable to address operational challenges and provided water to less than half the city.[135]

For the most part, in the absence of large-scale private sector investment, the corporatized model has been promoted in cities across the global South.[136] Since the early 2000s, international development agencies have been encouraging underperforming municipal providers in sub-Saharan Africa to corporatize.[137] Corporatized utilities adopt commercial market principles with autonomy from government and seek to secure cost recovery. These utilities behave more like private enterprises and are believed to be less vulnerable to political pressure. The approach has been supported in some contexts by awarding management contracts to private water supply companies.[138]

It is clear that conceptualizing water as a commodity now pervades the sector and explains why researchers, policy analysts, and urban change agents have failed to see water as a human right and a social good. With water regarded as a private good, discussions about affordability do not reference incomes or minimum quantities but instead focus on the need to reduce the price of water. Discussions about scarcity tend to focus on how to reduce nonrevenue water and how to address leaks and illegally obtained water. Little effort is spent figuring out how to make reasonable amounts of water affordable to urban residents at the lower end of the income distribution.

Corporatized Water Utilities and the Challenges of Supply

Advocates of corporatization contend it can make public services more efficient, highlighting the fact that corporatized public services are widely used in the global North. However, it is not clear that this approach can improve access for low-income communities in the global South, as the corporatized utility is focused on cost recovery. Such arrangements do not exclude the possibility of subsidies, which can include cross-subsidies for pricing and financial transfers to support the extension of services to those who cannot afford to pay.[139] However, the focus on market-based provision principles has prevented water from being conceptualized as a social good with appropriate management.

Utilities, public agencies, and regulators have recognized the need to extend the piped network, particularly into low-income areas.[140] This is not simply for social objectives. Informal settlements are increasingly recognized as potential markets; as such, numerous efforts have been made to find effective ways to deliver water to low-income customers. In Kenya and Tanzania, for example, Jaglin (2002) recognizes multiple processes of corporatization with scalar distinctions. In peri-urban neighborhoods, corporatized entities have sought to work closely with organized communities to extend services at reduced costs.[141] Agreements have also been made with informal vendors. Further innovations have included the growth of water kiosks as an alternative to plot access in low-income neighborhoods and standpipes that accept prepaid tokens.

Despite these efforts, there are numerous challenges involved with using corporatization to provide equitable water services. Although communities have been drawn into supply relationships with utilities to improve outcomes, such relationships are asymmetrical, as responsibilities and costs are passed on to the community.[142] Outcomes may be unequal, reflecting inequitable community-level institutions.[143] The fact that communities may still be willing to accept services on this basis reflects their powerlessness and the scale and extent of adversity. As Ranganathan (2014) elaborates from research in Bengaluru, access to water services—even on disadvantageous financial terms—is an opportunity for informal settlement residents to "bargain for legitimate tenure and recognition in the eyes of the state."[144]

Despite efforts to corporatize water, the supply costs remain high, particularly in sub-Saharan Africa.[145] Numerous studies highlight that affordability problems are associated with public supplies.[146] In Accra, utilities have been reconstructed into corporatized entities tasked with realizing profits. Water charges remain high, with family consumption of 6 m^3 a month costing more than seven dollars.[147] High prices and lack of affordability are also documented in Dar es Salaam, where shallow wells and groundwater serve as an alternative water supply.[148] The data in Table 5, based on 15 cities and selected informal settlements, do not indicate that the price of piped water in sub-Saharan Africa is particularly high, although other forms of water supply are expensive. These include tanker water in both Lagos and Nairobi and standpipes in Kampala. Tankers may or may not be part of the utility system. They are often unregulated, and their continued use reflects the limitations of the piped network.

Although measures like tariffs have been introduced to make water utilities more financially viable, they rarely cover the cost of maintaining and developing water infrastructure and services.[149] Despite the emphasis on cost recovery, the commodification of water services alone has been unable to fund improvements to water infrastructure and services. Moreover, it is not evident that improved cost recovery leads either to an extended network or to increased financial viability and more affordable services.[150]

The Challenge of Affordability

Too little attention is paid to the affordability challenges associated with corporatization and the consequences that pricing regimes have for household access.[151] This is not a new issue. The most commonly used proxy measure of affordability is the proportion of household budget spent on water, sanitation, and hygiene.[152] The UN Water Supply and Sanitation Collaborative Council suggests that in order to be considered affordable, the cost of water and sanitation services should not exceed 5 percent of a household's income.[153] The UN Human Rights Council (UNHRC) also uses the percentage of income spent as the primary means of assessing affordability.[154] However, underpinning the validity of this measure is the assumption that households are consuming adequate quantities of water. The Special Rapporteur of the UN Commission on Human Rights emphasizes the importance of affordability but avoids setting general global standards due to contextual differences.[155]

To secure health and well-being, WHO recommends minimum quantities of water consumption for both emergency (20 L per person per day) and nonemergency (50 L per person per day) situations.[156] However, higher-income countries (particularly those that use waterborne sanitation) have higher nonemergency standards; for example, Egypt and Portugal use 100 and 120 L per capita per day, respectively.[157] The WHO-recommended minimum quantities for nonemergency situations are broadly similar to the quantities supplied in the lowest-cost block within the progressive block tariff structure commonly used in water pricing.[158] The lowest-cost block generally ranges from 0 to 6 m^3, and in some cities up to 20 m^3 per household per month.[159]

Insufficient attention has been paid to the high cost of water relative to household income. Only in 2017 did the JMP finally recognize that affordability is a significant criterion when measuring access and that too little work has been done in this area.[160] The problem is exemplified by data showing that 16 percent of urban dwellers in Tanzania spent more than 5 percent of their income on water.[161] The World Bank also recognizes concerns about affordability: "In many African cities, incomes of poor families are not sufficient to pay for a basic needs quantity of water at average cost."[162] However, this report does not report on the quantities purchased; furthermore, when the authors discuss ways to raise investment capital, they suggest increasing the price of water.[163] This illustrates the difficulties of focusing on affordability in the context of market-based management frameworks.

The International Institute for Environment and Development (IIED) worked with four national federations of slum dwellers (affiliates of Shack/Slum Dwellers International, SDI)[164] to analyze the costs of achieving the WHO-recommended minimum quantities of water. Data were collected for: utility-provided piped connections from the city network to the house and both the low and high costs of other communal forms of public water provision (such as kiosks) in low-income settlements. In Windhoek, Namibia, there was only one price charged for communal provision; in both Blantyre, Malawi, and Dar es Salaam, Tanzania, multiple prices were charged, depending on neighborhood factors.[165] In Harare, Zimbabwe, only piped water was available.[166] Table 6 demonstrates that buying water can potentially take up a considerable proportion of income for low-income households, even if they only buy the WHO-recommended minimum amounts.

Across all four cities shown in Table 6, five-person households (that consume the higher amount of 50 L per person per day, and with piped supplies) spend between 7 percent and a theoretical 92 percent of their household income on water.[167] In Harare, water appears relatively affordable, but water cannot be purchased separately from other services. The cost of metered supplies are billed together with other council services such as sanitation and waste management, making the overall monthly bill (of approximately $28) less affordable.[168] In Dar es Salaam and Windhoek, households that can access piped supplies and manage with emergency levels of water pay an estimated 7 percent and 3 percent of their income, respectively.[169] Communal

Table 6 | **High Household Water Costs in Low-Income Settlements in Selected African Cities**

	LOCATION	PIPED WATER		LOW-COST COMMUNAL SUPPLY		HIGH-COST COMMUNAL SUPPLY	
		Consumption (liters per person per day)					
		20L	50L	20L	50L	20L	50L
Proportion of household income spent on water (five people per household)	Blantyre (2013)	38%	92%	13%	34%	22%	56%
	Dar es Salaam (2014)	7%	17%	15%	38%	61%	152%
	Harare[a] (2014)	6%	7%	—	—	—	—
	Windhoek (2013)	3%	9%	5%	12%	—	—

Notes:
a. Piped water in Harare incurs a standing charge as well as a unit charge.

Source: Adapted from Mitlin and Walnycki, 2016: 3.

provision in both Dar es Salaam and Blantyre is particularly expensive, and five-person households without piped supplies spend upwards of 13 percent of their income if they are to meet their minimal water needs.[170] It is important to note that these calculated expenditures are hypothetical—households cannot actually afford to spend these amounts on water, and so they instead use less, go into debt, or use groundwater to meet their needs. Over the last five years, repeated discussions with community groups have confirmed that service charges are a major issue.

There are exceptions, however. One example comes from South Africa, where a "free basic water" policy emerged in Durban (eThekwini metro), under which households receive a free water allowance based on the WHO-recommended minimum.[171] The amount of free basic water was increased from 6 to 9 m^3 following pressure from organized communities.[172] Tensions between free basic water and alternative water supply models continue in South Africa, where the government has introduced the right to water as part of the new Constitution while simultaneously trying to maintain a cost-recovery management model.[173] Over time, other South African cities have followed this model to comply with South Africa's free basic water policy.[174] One weakness of the approach is that informal tenants are not allocated free water, which is only provided to formal homeowners.

Most analysis of water's high cost has focused on sub-Saharan Africa. However, this issue is also a concern in other regions, especially where considerable numbers of urban residents can only access water from informal providers.[175] This is exemplified in Table 5 and also Figure 6, which illustrate the prices charged for water and the average household income spent on water in the 15 cities. Given that percentages are for average incomes in the city and in one informal settlement, and that the 5 percent limit on the percentage of household incomes is for both water and sanitation expenditures, water is likely unaffordable for many of the lowest-income households.

To ensure equitable access to safe, reliable, and affordable water, cities and water utilities in the global South need to extend the formal piped water network.

5. HOW CAN CITIES AND WATER UTILITIES IMPROVE WATER ACCESS?

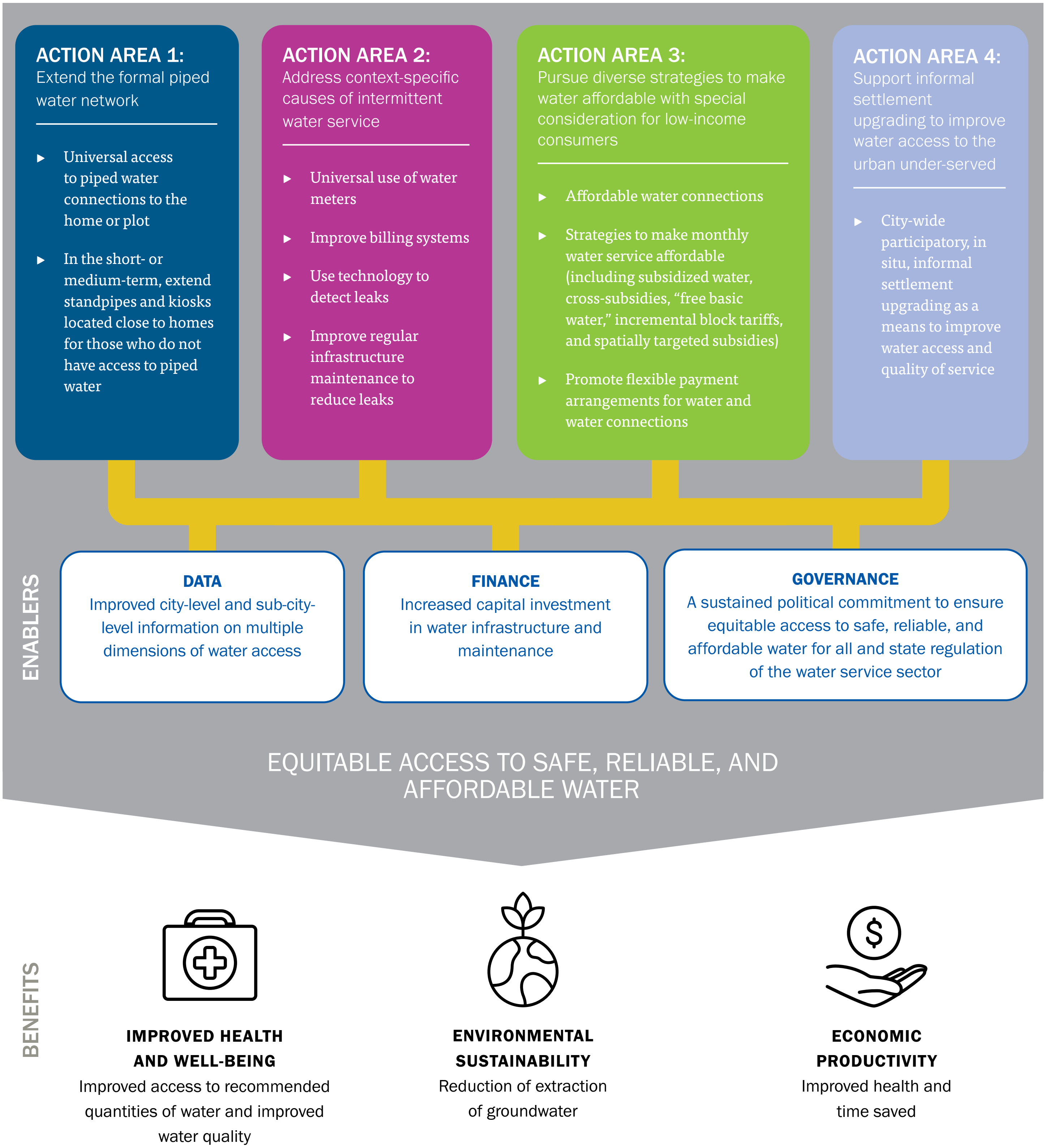
Different cities have different administrative arrangements for providing water services. In some cases, such as in Harare and elsewhere in Zimbabwe, water provision is the responsibility of the city authorities. In other cases, water is provided by a separate utility. The water utility is a public agency in 13 of the 15 cities we examined. In other cases, the water utility is a private company, or a hybrid public-private partnership (PPP), as is the case in São Paulo and Maputo. In terms of jurisdiction, a water utility's service area typically corresponds with the city's political-administrative jurisdiction, but not always. Of the 15 cities, the city's jurisdiction and the water utility's service area did not align in Bengaluru, Cochabamba, and Lagos, where the latter has four water utilities.[176] The actions discussed in this section are targeted towards urban change agents responsible for providing equitable access to safe, reliable, and affordable water (see Figure 9). These urban change agents include the city or municipal government, the water utility, and other state and nonstate actors.

Extend the Piped Water Network

To ensure equitable access to safe, reliable, and affordable water, cities and water utilities in the global South need to extend the formal piped water network. This recommendation is more controversial than it might initially seem.[177] There is heated debate over whether universal networked infrastructure can be effectively implemented in cities in the global South.[178] It is notable that this debate is taking place against a backdrop of declining investment in and deferred maintenance of public services in cities in the global North.

There are many explanations for why universal piped water infrastructure has not yet been extended in cities in the global South. Some analysts attribute the water infrastructure's current condition to building practices and systems initiated during the colonial period as well as to attitudes towards modern ideals; others, however, argue that this confluence of factors "closed" the process of technological innovation and the search for alternative designs.[179] Nilsson (2016) concludes that the pursuit of an idealized Northern water infrastructure system has prevented innovation that is more relevant to Africa's physical and social urban environments.[180] Still other urbanists associate the multiplicity of water networks and actors with a unique pattern of urbanization characterized by informality and fragmented services that is pervasive in cities in the global South.[181]

Figure 9 | **Priority actions for cities, water utilities, and other urban change agents to ensure equitable access to water in the global South**



Source: Authors' analysis.

The reality is that in the absence of universal access to networked public water infrastructure, cities of the global South have diverse, numerous, and overlapping water networks to meet the basic human needs of their urban populations. As mentioned, piped utility water exists alongside the use of shallow wells, boreholes, and private water vendors. Households use these systems alternatively and simultaneously to meet their different needs. This is particularly true in contexts where water supplies are intermittent and in informal settlements that lack access to a piped water network.

Water utilities have recently demonstrated more willingness to work with private water providers. In some places kiosk operators now sell piped water as part of the utility's provisioning system. Utilities have also been more willing to experiment with new supply forms, such as having utility- and/or community-managed kiosks alongside private kiosks. In Mombasa, Kenya, water kiosks are the primary medium for water delivery, although some households also secure supplies from private water vendors.[182] This reflects an acknowledgment that although informal water vendors may be expensive, they provide a useful service.[183] However, as discussed earlier, there are serious concerns about whether any of these solutions are affordable. Moreover, the provision of water via hybrid systems increases the risk of contamination. Therefore, even though such systems are to be supported because they improve access, these are short-term solutions: in the long term, each household needs to be able to access water from its plot or dwelling.

There is an urgent need for safe, reliable, and affordable water in struggling and emerging cities. On the basis of our research in 15 cities, other than "free" water obtained from natural sources such as shallow wells and rainwater, piped utility water was the most affordable source.[184] Observers agree that in cities with equitable access to water and where the poor are well served, piped water is provided by the water utility.[185] After an extensive examination of public, private, and community-driven systems of water provision, Bakker (2010) concludes, "The most equitable long-term solution is universal provision, overseen by the state."[186] So, the question then becomes: How can public water utilities extend piped service to more households? And how can utilities ensure that this water is affordable, safe, and reliable? And finally, how can cities pay for the capital and other investments needed to deliver this water to all?

As with many core urban infrastructures and services (for example, energy, public transportation, and sanitation), a universal piped water network requires urban planning, good governance, and substantial financial investment. Maintaining the system requires urban management and technical capacity. Arguments in favor of having the government own and manage the water supply system are predicated on the ability of municipal governments and water utilities "to achieve economies of scale through integrated monopolistic provision, to cross-subsidize water bills to poorer customers, [and] to cross-subsidize network expansion through municipal taxes."[187] Universal access to piped water requires governments to make substantial capital investments that the private sector has been unwilling to make due to its lack of confidence that adequate profits can be secured. It must also be acknowledged that financial viability depends on how investment costs are spread out over time, and this is extremely difficult to estimate in the context of expensive, long-lasting infrastructure.

Strategies for Addressing Context-specific Intermittent Water

Continuous piped water service is the internationally accepted standard for water utilities around the world. However, at present, an estimated 1 billion people receive piped water that is available fewer than 24 hours each day.[188] This problem is referred to as intermittent water supply. In 12 out of the 15 cities we examined, water service was intermittent. Intermittent water supply has many negative implications for users, including poorer water quality and higher costs.[189] Intermittent water supply increases the risk of contamination and ultimately the disease burden for water consumers.[190] In cities in the global South, it is expected that the number of people receiving intermittent water will likely increase due to rapid urbanization, increased water scarcity as a result of climate change, and general underinvestment in water infrastructure.

When confronting the challenge of delivering high-quality water in environments with intermittent services, the city can take two approaches. The first is to keep water pressure high, which prevents contaminated materials from entering the piped system in the first place.[191] The second approach is to educate households about the importance of treating water before they consume it and the risks involved with various water storage practices. However, both safe water treatment and storage are difficult for low-income households to practice because of the inherent costs.

From the household perspective, there are unique challenges associated with intermittent water. In addition to the disease burden, households incur economic costs when water is intermittent or runs very slowly. First, a household member must spend time monitoring water availability and managing the collection process. Second, when water is needed but unavailable in the pipes, it must be purchased from more costly sources. Third, some households will mitigate problems associated with intermittent water by purchasing storage containers, investing in alternative water sources (such as drilling boreholes), and purchasing systems and materials to purify water. Finally, for those who lack direct water service to their dwelling or yard, intermittency may require them to acquire water from distant locations, which comes with the associated burdens of queuing for and transporting water.

A systematic review of the literature emphasizes the financial consequences of coping with an unpredictable water supply.[192] This points to the importance of taking into account the additional costs imposed by intermittent water supply when analyzing affordability.[193] The costs of coping with poor-quality water supplies were found to be significantly high for low-income households in both Kenya and India.[194] For example, in India, there was "an increase in the income/cost ratio for low income households, and coping costs comprised 15 percent of income for lower income households, compared to 1 percent for wealthy households."[195] Although long-term financial costs are not reported, the short-term consequences appear significant.[196]

When water intermittency is the norm, storage and hoarding become the dominant practices.[197] One strategy that utilities can use to address hoarding is to better inform users about when water will be available. For example, in Quibdó, Colombia, the water utility makes its service schedule known.[198] In 2011, it initiated a system where each day, different sections of the city receive two hours of water service.[199] Such "planned disruptions" are assumed to reduce costs to users because households can plan around when water will be available. Service schedules also reduce the need for households to hoard large quantities of water because they can feel more confident about when it will next be available.[200] In India, some consumers are using applications like NextDrop, which provides information about when to expect water.[201] However, a recent study of this program found it did not significantly reduce household wait times because of the complexities of collecting and disseminating information related to asymmetrical gender relationships in households (in this specific case, men held the household's cell phone and women were responsible for water collection; thus, the women were not receiving information about when water would be available).[202] However, the study did find that the program resulted in a "modest reduction in stress levels associated with managing household water among low-income households."[203]

In cities in the global South, it is expected that the number of people receiving intermittent water will likely increase due to rapid urbanization, increased water scarcity as a result of climate change, and general underinvestment in water infrastructure.

One way that utilities can address the lack of available water is to reduce the gap between the volume of water they treat and distribute and the volume of water for which they receive payment.[204] This gap, or lost water, is referred to as nonrevenue water. In many cities, this accounts for 25–60 percent of the total water collected, treated, and distributed.[205] Because of the factors driving nonrevenue water (for example, leaky infrastructure), systems with intermittent provision would actually experience much higher losses (in both absolute and relative terms) if water were provided continuously.[206] Inaccurate metering and illegal connections account for approximately 25 percent of nonrevenue water and undermine the water utility's financial viability by reducing its ability to collect revenue.[207] Many cities are just beginning to use reliable water meters, but the practice is not universal, particularly in informal settlements. In an analysis of more than 2,000 water utilities from the International Benchmarking Network (IBNET), water meters were found to be a significant factor in a utility's ability to successfully account for and regulate water use, information that can facilitate a transition towards continuous service.[208]

The other main cause of nonrevenue water is when water is lost as a result of inadequate physical infrastructure or deferred maintenance.[209] In a recent analysis of IBNET, it was found that utilities with lower revenues expressed as a percentage of gross national income are more likely to have intermittent water service.[210] Utilities with more financial resources to spend on repair, maintenance, and energy were better able to provide continuous water. Better-financed utilities can replace old pipes, follow a regular maintenance schedule, detect and repair underground leakages early, and develop a system that responds to above ground leakages 24 hours a day, seven days a week.[211] Sensors can be placed between the meter and the submain pipe to help identify a leak's location.[212] The relationship between adequate financial resources, maintenance, and repairs is a complicated one. The same study found that the total operational costs were not a significant predictor of intermittency; the authors concluded that "resources must be both available and spent on the right things in order to produce continuous water supply."[213] Sufficient financial resources must be coupled with institutional capacity (on both the part of the water utility and the city) to adequately plan and manage an urban water system.

According to the data we collected in Colombo, São Paulo, and Santiago de Cali, and given other experiences in Karnataka, India, it *is* possible to provide continuous water supply in cities in the global South.[214] There is no single solution to the challenges posed by intermittent water because the causes of it vary according to local conditions.[215] However, the availability of water supplies, accurate and reliable metering, improved infrastructure maintenance, access to sufficient financial resources, and more sophisticated water planning and management all appear key. Although increased transparency and predictability help households manage water-related stress, these solutions do not address the problem of water being contaminated from lost pressure in the piped system (and, in at least one study in India, they did not address the associated user costs).[216]

Cities that seek to achieve continuous water service will need to consider their own local, economic, and environmental conditions. More specifically, they should examine the extent to which water supplies are currently limited and how they might become even more so in the future. Who benefits from water service improvements? What is the impact on water affordability, particularly for low-income households, households in informal settlements, and households without piped water connections to their home or yard? Above all, how can cities prevent such improvements from exacerbating existing inequalities?[217]

Strategies to Make Water More Affordable for Households

There are three main strategies for reducing the absolute cost of piped water for households and a fourth that reduces the expenditure burden for households by spreading costs over time. First, cities can reduce connection charges or create opportunities to spread this capital cost over multiple payments. This is only relevant for those households that can install such a connection, and it is unlikely to apply to renters or households where tenure is insecure. Providing a connection without adjusting piped water prices also assumes that water service is already affordable once the connection is established, and this is not always the case. Second, cities can make efforts to reduce the price of piped water for low-income households, either through direct subsidies or incremental block tariffs. A third strategy is to enable those households that lack a piped connection to access piped supplies through kiosks with more favorable differential pricing. A fourth strategy is to allow those with piped supplies more flexible payment options. Each of these strategies is discussed in more depth below.

Cities or water utilities can make household connections to piped water more affordable by offering capital subsidies and low-cost or free credit. There have been multiple efforts to improve access by subsidizing the cost of water connections. In South Africa, the capital subsidy for housing, which has provided financing for more than 2 million dwellings, typically includes metered water connections.[218] In Nyeri, Kenya; Kampala, Uganda; and Dakar, Senegal, connection fees are $35, $35, and $31, respectively.[219] This is considerably lower than the actual cost of a connection; for example, in Dakar it is estimated that this amount represents only about 20 percent of the connection charge. Water utilities seek to expand their customer base for both financial viability and to meet service delivery goals. As a result, connection numbers increased by a factor of 2.4 (Nyeri), 2.3 (Kampala), and 1.4 (Dakar) between 2006 and 2015.[220] A similar approach has been used in Maputo, where a connection fee of $73 has been cut in half, and customers have the option to spread payments over 12 months.[221] Water coverage increased from 36 percent to 73 percent in the selected barrios.[222] Similar efforts have been made in other contexts, including Latin America.[223]

Efforts to improve access for low-income households include adjusting prices for those with access to piped supplies (see Box 3). This includes means-tested subsidies and changing relative prices within the block tariff structure, which delivers the subsidies through price adjustments. As noted earlier, the water utility in Durban (eThekwini metro) pioneered a policy of providing free basic water that was subsequently expanded across South Africa.[224] One challenge has been that the free basic water allowance may be insufficient. Households have a history of exceeding the allowance and running up water bills that they cannot afford to pay, so utilities introduced prepaid meters. This approach was challenged in South Africa's Constitutional Court; however, the court ruled that prepaid meters were legal, and their integration with free water continues to be used in Johannesburg and elsewhere.[225] South African cities have introduced trickle meters to help low-income households manage consumption; these distribute the month's supply of free water in daily allocations.[226] This is intended to prevent low-income households from consuming more than the free amount, thus helping them avoid incurring bills they will struggle to pay. Cape Town has responded to these challenges by increasing the allocation from the original 6 m^3 per household per month to 10.5 m^3.[227]

To keep the initial allocation of water affordable, cities in the global South—including the 15 we examined—make widespread use of incremental block tariffs (IBTs). For example, Bengaluru charges $0.10 per kiloliter (kL) for the first 8 m^3 of water per month consumed, and $0.17 per kL for the next 8–25 m^3 of water consumed per month.[228] If the household consumes more than 25 m^3 of water, the tariff doubles to $0.39.[229] In Nairobi, the first 10 m^3 of water consumed by households each month is highly subsidized, and this is referred to as a "lifeline" or social tariff.[230] Colombo, Maputo, and Santiago de Cali use a two-part tariff where households have a fixed-charge component plus a variable charge, depending on their monthly consumption. In Santiago de Cali, the second block acts as a penalty fee; it costs three times as much as the first block to incentivize households to consume less than 18 m^3 per month.[231] Note that, as explained earlier, Santiago de Cali also subsidizes water across income levels. The fixed charge for the first block of water for high-income households ranges from $3.63 to $3.96 per month, whereas middle-income households pay $1.71–$2.47 per month and the lowest-income households pay $0.79 per month.[232] Caracas varies pricing across different parts of the city; formal parts use an IBT whereas low-income neighborhoods are subsidized and pay a fixed charge at a lower cost.[233]

Box 3 | Comparing Household and Neighborhood Approaches to Targeting Water Subsidies in Chile and Colombia

A comparison of the Chilean and Colombian approaches to targeting water subsidies highlights the challenges of identifying low-income households.

In Chile, direct water subsidies were introduced in 1989 in response to concerns that privatizing water would make it unaffordable.[a] The subsidy program has since been redesigned to secure better outcomes and is now targeted towards households. Up to 15 cubic meters (m^3) per month per household are subsidized.[b] The lowest-income households receive a 100 percent subsidy, but slightly better-off households are expected to cover at least 15 percent of their water bill.[c]

Colombia's present subsidy system was introduced in 1991.[d] It is targeted towards neighborhoods and is based on a six-tier classification system, representing socioeconomic status, which avoids the costs of collecting detailed household-level economic data. Reflecting the understanding that access to water is a human right, Medellín established a "lifeline water tariff" of 2.5 m^3 per person per month at a subsidized cost, and Bogotá allows qualifying households to receive 6 m^3 per person per month of subsidized water.[e]

In the Chilean system, some higher-income households secured the subsidy while significant numbers of low-income households remain unreached.[f] The Colombian system also included higher-income households—which is not surprising, given the neighborhood focus—but delivers the subsidy to large numbers of low-income households without the administrative costs. Both countries' approaches to water subsides increased access for the lowest-income households but could be improved with additional research and subsequent policy adjustment.

Notes:
a–c. Valdés Fernandez, 2007.
d. Guerrero et al., 2015.
e. Guerrero et al., 2015: 182.
f. Gómez-Lobo and Contreras, 2003.

Despite their widespread use, IBTs have limitations.[234] They are obviously of no help to households that are not connected to the piped network, and this has implications for equity if these are the households that have the lowest incomes. In this context, lowering the price of water purchased from kiosks and standpipes may be a more equitable way to reach the urban under-served. IBTs are also irrelevant without effective household metering, the capacity for which is low in many cities in the global South. A further problem is that low-income households that are renting may find themselves in dwellings with plot connections that go into the higher tariff bands due to the number of households using that water connection. Across sub-Saharan Africa it is common for the lowest-income households to rent a room in a compound (or plot) together with other households. Joint consumption will push these water bills into higher tariff blocks, which is inconsistent with policy objectives. Given these challenges, there is a need for more innovation to ensure that water subsidies reach the lowest-income households.

Although water may have historically been available through public standpipes at no charge, this is increasingly rare in cities in the global South. It is more common now for residents to access public standpipes with prepaid meters and cards, or to purchase water from kiosks. Differential pricing can reduce the costs of water for those without piped connections, as these prices are lower than what is charged for piped connections. In Kampala, the utility relies on standpipes to serve low-income households. In Blantyre, the tariff for standpipe water is less than that of piped residential supplies;[235] the same is reported for Mzuzu (see Table 6). In Dar es Salaam, the water utility contracts small-scale entrepreneurs to resell water at controlled prices to the residents of informal settlements, but this is not at a reduced price.[236] As with any other public pipes, public standpoints are at risk of being captured or controlled by powerful individuals who seek to resell water at higher prices.

The previous three strategies all focus on reducing the absolute costs incurred by low-income households. Even though lowering costs helps with affordability, more needs to be done (see Box 4). With this in mind, water utilities are using innovations such as mobile phone technology to introduce more flexible payment schemes. This is intended to address the difficulties of paying monthly bills when one's income is irregular. In Kenya, for example, customers can read their own meters, pay their bill using mobile money, and make smaller, more frequent payments if they choose.[237] The ability to pay when money is available is important to avoid having water service shut off. Selling water through kiosks (and standpipes) in low-income neighborhoods also gives residents more flexibility with how and when they make payments.[238]

Upgrading Informal Settlements to Improve Water Access

Upgrading informal settlements is a mechanism to improve access to housing and other related basic services, including water, for the urban under-served. Informal settlement upgrading is an approach to improving housing conditions for low-income groups that live outside of formal planning and regulatory frameworks.[239] If the location of an informal settlement does not pose a safety risk to its residents or others in the city, then urban upgrading strategies are typically underpinned by several general principles, which include

Across sub-Saharan Africa it is common for the lowest income households to rent a room in a compound (or plot) together with other households. Joint consumption will push these water bills into higher tariff blocks, which is inconsistent with policy objectives. Given these challenges, there is a need for more innovation to ensure that water subsidies reach the lowest-income households.

Box 4 | Pro-poor Policies and Programs in Colombo, Kampala, and Nairobi

Some cities in the global South use pro-poor policies and programs to make water services more affordable. In some cases, these policies are mandated by the national government, but others are issued by separate departments within the city's water utility.

In Colombo, policy commitments to the urban poor began as early as the 1970s.[a] In 1995, the national government officially initiated the Samurdhi Program to address poverty,[b] which was embraced by the City of Colombo as an opportunity to respond to the growing slum population. The Colombo Municipal Council (CMC) denoted slum areas as "under-served settlements" (USSs) and initiated policies specifically targeting their improvement.[c] Today, almost half of the city is made up of informal settlements (1,600 USSs, according to the CMC), yet 98 percent of the city has piped coverage to dwellings or shared yards.[d] Most notably, over the last two decades the improvements have led to a shift away from public standpipes to household piped connections in many USSs. Only a few shared public taps remain. Although it should be noted that the city still experiences service gaps for water and sanitation, civil society and community-based organizations played a key role in shaping USS policies that increased the number of household connections.[e]

In Kampala, the National Water and Sewerage Corporation (NWSC) created a pro-poor unit in 2006. For the first three years, the office connected approximately 50 new customers per month, increasing revenue collection by twentyfold.[f] With the support of other bilateral and multilateral funding schemes, the pro-poor unit extended piped water service, usually in the form of shared standpipes, and constructed new toilet blocks in areas without access to sanitation services. Support mechanisms have also been put in place at the city and national level. For example, the Kampala Capital City Authority (KCCA) and the NWSC offer a toll-free hotline whereby households can report problems, pay bills, or apply for a new connection. However, the program has been criticized for not adequately addressing the affordability of water from public standpipes and prepaid kiosks. Kiosk dealers charge households almost five times the cost of the NWSC domestic tariff.[g] Households cannot afford to buy adequate quantities and thus resort to supplementing with water from unprotected wells.[h]

Created in 2008, Nairobi's pro-poor unit uses a participatory approach that focuses on informal settlements and community partnerships. Over 60 percent of Nairobi's population lives in informal settlements— this is approximately 2 million residents.[i] The pro-poor unit frequently holds community meetings in informal settlements to clarify water reforms, promote conservation and payment, and consult on community priorities. Financial support from the Water Services Trust Fund (WSTF) has been a key part of its success. Under Kenya's 2002 Water Act, the national government established the WSTF to mobilize funds for water and sanitation investments for under-served populations.[j] The WTSF and Nairobi's pro-poor unit have successfully partnered to improve water services for informal settlements, including the one selected for our study. Since 2008, nearly 1.8 million people have gained access to the piped network through kiosks and yard taps.[k]

As demonstrated in the World Resources Report, *Towards a More Equal City* series, providing core infrastructure and services to the urban poor and informal settlements has numerous challenges as well as benefits. Pro-poor policies, programs, and units are among some of the more effective mechanisms that can help cities and utilities reach the poor and under-served.

Notes: a. Mcloughlin and Harris, 2013; b, c, d. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018; e. Mcloughlin and Harris, 2013; f. World Bank, 2009; g, h, i, j. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018; k. Werchota and Nordmann, 2015.

Source: WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.

the goals of minimizing relocation, improving access to basic infrastructure and services, and making the upgrading process participatory.[240] Upgrading efforts are led by different urban change agents or coalitions of urban change agents comprising government representatives, civil society organizations, and community-based organizations.

Government-led upgrading ranges from rudimentary improvements that cost less than $100 per household (for example, investing in drains or providing public taps) to more comprehensive improvements that can cost several thousands of dollars per household, such as providing piped water, sewers, or septic tanks to all houses; installing storm drains; paving roads; improving electricity; securing tenure for occupants; building community facilities; and sometimes promoting income generation or support for housing improvements or extensions.[241]

Another form of upgrading is that which is community led. This type of upgrading is more piecemeal than government-led upgrading, especially in the early stages when the community is securing improvements and negotiating for political support. However, community-led upgrading is critical for creating a more equal city because it simultaneously provides material improvements and strengthens the community's voice. Community action is a particularly effective catalyst when government has failed to act.

A novel example of community-led upgrading is the work done by the Asian Coalition for Community Action (ACCA) across Asia.[242] The ACCA provides grants to organized communities working with members of the Asian Coalition for Housing Rights. Communities identified water improvements as one of the priorities that required immediate action. By the end of 2014, ACCA had supported 2,139 community-upgrading projects in 207 cities across 18 countries.[243] Improvements to the water supply were the third-highest priority among the funded projects.[244]

In Albay, Philippines, for example, the scale of need was such that the Philippines Homeless People's Federation used the full city budget (of $3,000) to construct a large water supply system in a resettlement colony.[245] In the city of Navotas (also in the Philippines), the savings group in Chungkang, a large informal settlement near the sea, used its modest project funds to provide loans so members could pay for legal water connections.[246] Residents of Bapa Dayalu Nagar, Bhuj, in India, live in an informal settlement built around a pond that provides water to both humans and animals. The pond became polluted with garbage and weeds. The community used a small project grant of $1,150 to rejuvenate the pond, adding $70 of their own funds.[247] Meanwhile, in the Afghan city of Mazar-e-Sharif, which is home to many war-displaced refugees, the savings groups in two very poor communities—Ali Chopan and Choghdek—used $3,000 in ACCA grant money to develop water supply systems that included wells, pumps, and a piped network connected to shared taps.[248]

In each city, the community organizations present their work to the city government. In most cities, a joint working group was established at the city level to provide a platform for community networks, city governments, civic groups, NGOs, and academics to plan and manage the upgrading and the city-development fund, and to identify responses to land issues. In addition, $10,000 per country per year was available through ACCA for national coordination, meetings, and exchanges to scale up initiatives and support learning.[249] By the end of 2014, 136 city development funds had been established,[250] and by 2017, that number had increased to 476.[251]

SDI offers another excellent example of what organized informal settlement residents can contribute to water-improvement projects. SDI is an international network of federations of women-led savings schemes based in informal settlements and other low-income neighborhoods and their support NGOs. The network seeks to amplify the voices of disadvantaged citizens, particularly women, and make cities more inclusive. The federations are active in more than 500 cities in 17 countries. SDI federations use their savings to develop innovative solutions to common problems in informal settlements. SDI estimates that its affiliates have supported improved access to water for 185,000 households.[252] In some cases these improvements were part of a comprehensive upgrading program. For example, in South Africa, the SDI federation groups have helped about 13,500 households secure financing to develop new community-managed housing projects.[253] South Africa's capital housing subsidy also includes provision for access to full infrastructure, which includes the free water subsidy.

SDI affiliates are increasingly emphasizing the need to upgrade informal settlements and provide them with communal access to basic services rather than build new infrastructure. In Windhoek, the government has provided opportunities for low-income households to access communal water services when they migrate from rural areas. SDI women's groups (members of the Shack Dwellers Federation of Namibia) have used their own savings to extend communal pipes and provide plot-level access to water (and sometimes sanitation).[254] In most of these settlements, households have also paid to have individual meters installed.

In addition to programs that are led by either governments or community organizations, there are also initiatives that are founded on the principles of coproduction. Coproduction in urban areas involves the delivery of basic services, with shared roles for both government and organized citizens in one or more of the following areas: planning, financing, implementation, and management.[255]

Community leaders recognize that upgrading at scale requires the support of local governments. Some of the most successful upgrading programs have been driven by local NGOs working with residents and their organizations to build partnerships with local governments. This is because community-driven upgrading inevitably comes up against the need to integrate with citywide systems; for example, community-designed and installed water pipes need water mains from which to draw water. As such, attempting such initiatives without government support is exceedingly difficult.

An example of upgrading based on coproduction principles is the SDI federations' combining their own funds drawn from savings of their member groups with funds from external agencies, such as local and national governments, NGOs, and international organizations, to improve water supplies. For example, the Kenyan federation Muungano wa Wanavijiji (Swahili for "United Slum Dwellers") has the support of the Akiba Mashinani Trust to raise and manage both community savings and loans and bridging finance that enables communities to take on development initiatives. The Trust has improved access to water in Mathare through an innovative program with the utility. Resident groups may also take loans to improve access to piped water.[256] In another example, SDI manages the Urban Poor Fund International, which draws support from international donors and in turn supports many community-driven upgrading programs. In 2017 this fund had improved access to water for 185,163 households.[257]

Coproduced informal settlement upgrading involves a myriad of local organizational arrangements to implement jointly acceptable solutions to common problems. Whether led by government, communities, or both, upgrading informal settlements is a proven effective strategy to ensure equitable access to water.

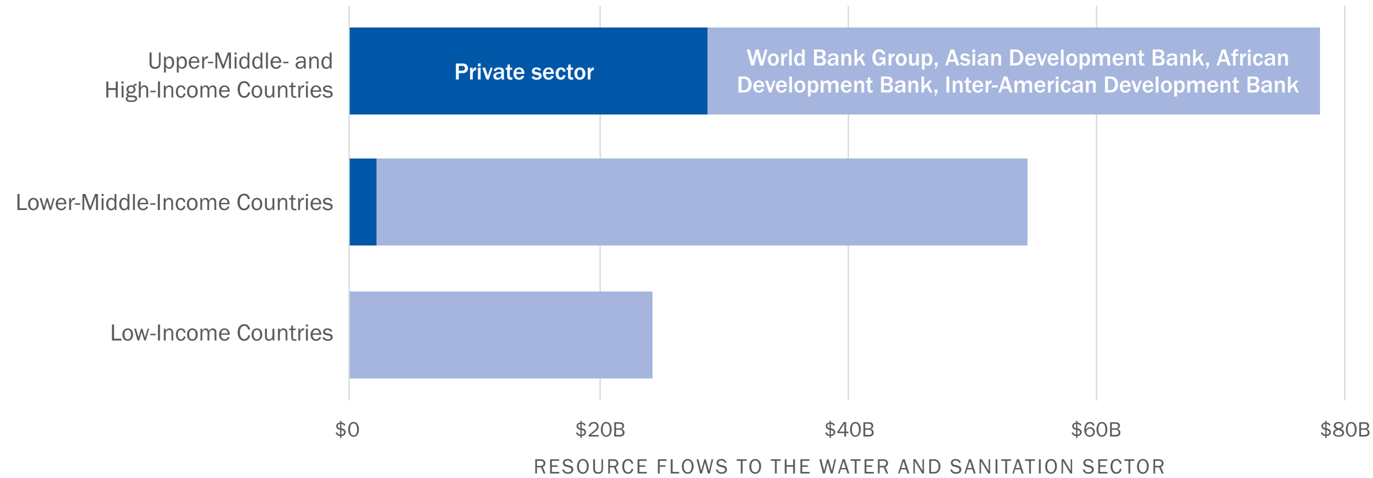
6. THE ROLE OF FINANCE AND REGULATION

Expanding the water network, improving the quality of provision, and ensuring all households can afford the WHO-recommended minimum water supplies will require considerable investment in the piped water network and in the supporting regulatory systems and agencies. Financing and regulation needs are particularly acute in the context of rapid urbanization, where growing populations are straining local service providers.[258] A 2017 study estimated that an additional $24.1 billion financial investment is required over what was spent on water and sanitation in the last decade to meet global targets for safely managed water and sanitation in urban areas by 2030.[259]

Multiple sources of financing are thus required, especially in low-income countries. Because private sector equity finance has been unsuccessful in contexts where returns are uncertain (particularly when extending services to low-income groups) and financial risks are high, such funding has needed to come from the World Bank and regional development banks, but, to date, these amounts have been limited.

Financing from markets to the water and sanitation sectors is observable only in the higher- and middle-income countries. For example, countries like Brazil, Chile, China, Colombia, and Morocco are seeing inflows of financing, but even in these countries the funding contributes to a small fraction of the investment needs. In China, for example, *Global Water Intelligence* estimates annual inflows of $3–4 billion of private financing in contrast to the multibillion-dollar municipal and water utility borrowings.[260] As a result, interest in PPPs is much greater in middle-income countries that have internally generated enough public funding to guarantee returns to

Figure 10 | **Limited capital flows from the private sector and multilateral development banks to the water and sanitation sector, 2007–2015**



Source: World Bank, 2017c, based on the Public-Private Infrastructure Advisory Facility (PPIAF) database: http://www.ppiaf.org.

investors and have more sophisticated legal and regulatory frameworks capable of enabling and supporting PPPs (such as the Kingdom of Saudi Arabia and the United Arab Emirates).

National governments have a substantial role to play in financing water infrastructure. Yet their ability to do so is likely constrained in low-income countries, even when proposed investments have good financial and social returns. In the absence of private equity, however, government finance, either through domestic sources or overseas development assistance, is essential. Despite recognizing the economic and social returns to investing in water and sanitation services, the financial resources available to the sector from domestic government monies and donor financing are grossly insufficient in countries in the global South. This has been exacerbated by rhetoric that has emphasized the need for cost recovery as the basis for service provision, with little recognition about what is required for this to be achieved alongside social goals such as inclusion, universal access, continuous provision, and affordability.

In the absence of adequate financing, the piped water network in many cities in the global South has been inadequately expanded and improved. To achieve SDG 6.1[261]—which would require augmenting trunk infrastructure and retrofitting feeder infrastructure—an estimated $112 billion would be required annually, or three times the amount that has historically been invested in the sector.[262] Figure 10 shows that investments from the World Bank and regional development banks have been insufficient to address these needs. Although the need for financing is fairly ubiquitous, exactly what is required and how best to provide it must be determined at the city level. There needs to be greater recognition that affordable access to sufficient water supplies is an issue of social protection and poverty reduction as much as it is of service provision.

At the neighborhood level, the utility alone might decide to extend a piped network (assuming there is a standalone agency), but it may also require financial contributions from the municipality or another state agency, and/or residents themselves. Development funding agencies may make contributions to advance provision directly at the city or neighborhood level. For example, the Bill and Melinda Gates Foundation has given money to the City of Harare to upgrade low-income neighborhoods. In some cases, such investments are financed by official development assistance monies, routed through NGOs, or provided by NGOs using their own funds.[263]

Financing is likely to be contributed in part by consumers when they are charged for a household connection. However, the systemic requirements for finance are substantial and households have limited resources to contribute, especially low-income households. Municipal governments and utilities that have the resources may help facilitate such contributions. The City of Windhoek, for example, is responsible for providing serviced sites to low-income households.[264] Rather than requiring households to pay for the serviced plot immediately, they can spread this cost over several years.

In addition to financing, governments need regulators to ensure that "arm's length" water providers comply with public policy frameworks and directives.[265] Such regulators have an especially significant role to play in overseeing services that involve "natural monopolies."[266] These are cases in which the market structure favors a single supplier, with risks that the supplier takes advantage by charging high prices and/or delivering a poor-quality service. Piped water is one such natural monopoly. Although it might be argued that households without piped supplies have a range of alternative suppliers, the difficulties (and hence costs) of transporting water over distances mean that the market is not competitive and consumers risk being badly treated. Therefore, governments need capable regulators to ensure that utility management results in the best outcomes from the perspective of the public sector and citizens.[267]

Regulating public and private agencies is a complex undertaking. To guard against excessive profits, regulators need independent information about the service and its charges.[268] The difficulties of such work are exacerbated in the global South, where service provision management is highly fragmented.[269] When multiple agencies manage different aspects of water services, the regulatory challenge is increased. The policy framework determines the standards for which regulators are responsible; for example, the acceptable distance to a kiosk or water distribution point, and what this should cost.

Regulators that are not dependent on utilities to supply them with information are in a more powerful position to support efforts that extend supplies to households, improve the quality of the service, and reduce prices. Hence, there is a strong case to be made for regulators engaging with civil society organizations to better understand the realities of service provision, particularly for low-income households.[270] However, despite the primacy of water and sanitation services in daily life, service providers are surprisingly unaccountable to their consumer base. Similarly, there is a dearth of citizen outcry and active engagement, except in cases of health epidemics (like cholera in Haiti and plague in Surat, India), the "water wars" in Cochabamba, and natural disasters such as extreme drought and floods.

In addition to independent sources of reliable evidence, regulators need sophisticated skills and considerable experience to engage with utility managers and negotiate improved outcomes.[271] They need to understand the market at least as well as the water providers and work with them to achieve public objectives.

7. EQUITABLE ACCESS TO URBAN WATER SERVICES

Water is a human right and a social good. Households need access to adequate supplies of safe, reliable, and affordable water. Although groundwater is still available in some urban contexts, it is becoming increasingly scarce in many urban neighborhoods and quality is declining. It is ever more rare to be able to collect free water from standpipes, as policies—encouraged by a range of technologies—have been introduced to ensure pay-per-use modalities of supply. Smarter meters and new supply systems are making illegal tapping increasingly difficult. Piped water, as opposed to wells and boreholes, requires long-term capital, and network investments establish natural monopolies that require state regulation.

The issue of how network infrastructure is costed out—and therefore priced—remains difficult. Piped networks require public investment, but that does not answer the question of how to determine a fair and accurate price for water service. The time period over which the investment is spread and the interest rate (or public sector discount rate) is a political decision, guided by technical expertise. The financial viability of water depends, at least in part, on decisions about how long the repayment period is, how investments are depreciated, and the discount rate used to equate financial flow in one period with that in another.

As shown in this study, since the early 1980s water has predominantly been managed according to market principles across much of the global South. In some contexts, subsidies are provided alongside other measures to improve access for the lowest-income households. With the current emphasis on corporatized utilities providing water services, there is inequitable access to water regardless of who is involved in the supply chain. And without equitable access to water, it is not possible to create equitable cities. Water services need to be managed in a way that provides access to disadvantaged and low-income households—only this will secure the achievement of SDG 6.1.

The inability of some governments to ensure that water services expand at a rate commensurate with urban population growth and to safely manage the water supply have been recognized as problematic for some time. This analysis suggests that two additional problems have been given insufficient attention. The first is that intermittent water service causes considerable problems that are exacerbated by a lack of predictability, but, most importantly, degrade water quality and threaten consumer health. The second is that the price charged for water means it is unaffordable in adequate quantities for the lowest-income households. Securing equitable access to water requires recognizing that it must be managed at multiple scales and according to multiple criteria.

We suggest priority actions for cities, water utilities, and other urban change agents that are concerned about the well-being of the urban under-served. First, extending the water utility's piped network will most likely provide the cheapest and safest access for residents. Groundwater sources are becoming riskier and scarcer, and overexploitation has deleterious environmental consequences as residential densities increase. Intermittent supply reduces the quality of the water, and households will struggle to deal with the lack of availability. It remains a priority to extend the network and ensure adequate supplies of water, particularly into low-income areas. Enabling access through kiosks and standpipes is a necessary first step in many neighborhoods because of the many tenants who depend on their landlords to secure a piped connection.

Cities and water utilities need to pay greater attention to the affordability of water, especially at the quantities required for health and well-being. Insufficient attention has been paid to the high price of water when considering the cost of securing minimum quantities and comparing these costs to wages. There is a need for increased support, both for research into the best way to measure affordability and for coalitions that strengthen the consumer voice, especially citizen groups in informal and low-income neighborhoods. Greater awareness on the part of professionals and pressure for reform on the part of organized citizens may achieve the necessary change.

Utilities, together with municipalities, need to identify groups in need (for example, the households in the bottom four income quintiles in low-income neighborhoods) and report on what it would take for them to purchase the WHO-recommended quantities as a percentage of their income. Publicly recognizing and discussing the need for affordable water will help change the perspective of both residents and utility staff. With knowledge, pro-poor pricing becomes more likely.

Upgrading informal settlements will require continued community and government effort to extend the piped network and achieve the other critical improvements noted above. Upgrading has multiple benefits, from economies of scale realized by providing integrated service provision, to providing residents with the conditions required for security, health, and well-being. In the short term, informal settlements need to be mapped, and plans for their upgrading made. Cities need to move the focus away from individual settlements and replace this with a substantive commitment to upgrading informal settlements citywide and connecting them to core public service systems. Short-term reliance on kiosks and standpipes needs to be rapidly followed by comprehensive access to piped services. Public reporting of needs and progress on upgrading urban settlements will help establish the accountabilities required and increase the likelihood of subsequent action.

It is important to remember that in cities in the global South, urban access to quality water service has been significantly overestimated. The overarching objective is to have safe, reliable, and affordable water that continuously flows to a plot dwelling. As the world progressed from the MDGs to the SDGs, there was a clear commitment to achieving such a universal level of service. Too often, in the case of urban water, the scope, magnitude, and complexity of the true situation remains hidden. Universal access to water is a human right, a social good, and essential for ensuring that all cities are places where everyone can live and thrive.

APPENDIX

Table A1 | **Average Household Income and Proportion Spent on Water in Selected Cities and Informal Settlements in the Global South**

CITY NAME	CITY: AVERAGE HOUSEHOLD INCOME/MONTH[a]		% INCOME FOR PIPED UTILITY WATER[b]	INFORMAL SETTLEMENT NAME	SELECTED INFORMAL SETTLEMENT: AVERAGE HOUSEHOLD INCOME/MONTH[a]		% INCOME FOR PIPED WATER[c]	% INCOME FOR PIPED UTILITY WATER[d]
	LOCAL CURRENCY	US$/ MARKET EXCHANGE			LOCAL CURRENCY	US$/ MARKET EXCHANGE		
SUB-SAHARAN AFRICA								
Kampala	USh 450,000	124	3.63	Kalimali	USh 175,000	48	11.72[e]	11.72
Lagos	₦73,200	218	0.55	Makoko	₦65,300	195	0.62[e]	0.62
Maputo	MT 10,000	162	1.95	Nhlamankulu D	MT 8,000	130	2.53	2.53
Mzuzu	MK 66,480	91	6.18	Zolozolo West Ward	MK 59,000	81	6.94	6.94
Nairobi	Ksh 22,500	213	1.13	Kosovo Village in Mathare Valley	Ksh 8500	81	1.06	2.78
SOUTH ASIA								
Bengaluru	₹43,000	668	0.15	Koramangala Slum Cluster	₹15,000	233	0	0.64
Colombo	රු85,000	549	1.62	Borella South GND	රු78,000	503	1.21	1.21
Dhaka	৳55,086	653	0.13	Kallyanpur Pora Basti	৳14,421	171	0.44	0.44
Karachi	Rs 35,000	330	0.84	Ghaziabad Sector 11 ½, Orangi Town	Rs 29,000	273	0.88	1.41
Mumbai	₹15,728	244	0.17	Siddarth Nagar	₹13,000	202	0.19[e]	0.19
LATIN AMERICA								
Caracas[f]	Bs 7,754	1803	0.27	Terrazas del Alba[f]	Bs 4,624	1075	0	0.43
Cochabamba	Bs 1,500	210	2.42	San Miguel Km4	Bs 1,200	168	3.00	6.05
Rio de Janeiro	R$1,519	475	1.00	Rocinha	R$1,209	378	0	1.26
São Paulo	R$3,467	1083	0.48	Jardim São Remo	R$1,350	410	0.28	1.40
Santiago de Cali	COP$1,327,890	437	1.39	Comuna 20	COP$590,173	195	3.11	3.11

Notes: Currency figures were converted to US$ using market exchange rates based on the time of data collection for monthly salaries.
a. Average household incomes for the city and informal settlements were based on a combination of census data, government records, project documents, empirical studies, and interviews with key informants.
b. This column represents percentage of income spent on water if all household water came from the city's piped water system. Figures are based on a monthly consumption of 50 L per day per person according to the average household (avg HH) size in the city and in the informal settlement. The calculation is as follows: (citywide piped price) x (avg HH size for city) x (50 L/day) x (30 days) / 1000 x 100.
c. This column represents the percentage of income spent on water if all household water came from the informal settlement's current piped costs. The calculation is as follows: (piped price for informal) x (avg HH size for informal) x (50 L/day) x (30 days) / 1000 x 100.
d. This column represents the percentage of income spent on water if all household water was charged at citywide costs for piped water. The calculation is as follows: (citywide piped price) x (avg HH size for informal) x (50 L/day) x (30 days) / 1000 x 100.
e. These informal settlements are not connected to a piped network. Figures are based on the citywide cost for piped water.
f. Caracas has variable inflation rates. Costs were converted using the black market exchange rate using the year of data collection: 2012 (Bs 4.30 to $1).

Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.[272]

Table A2 | **Water Sources, Ownership, and Regulators in 15 Cities in the Global South**

	CITY NAME	NO. OF UTILITIES	PERCENTAGE OF UTILITY'S WATER THAT COMES FROM LISTED SOURCE				OWNERSHIP	REGULATOR[b]	UTILITY NAME
			GROUND	SURFACE	NEARBY RESERVOIR	DISTANT SOURCE[a]			
SUB-SAHARAN AFRICA	**Kampala**	1	0	100	0	0	Public	Federal	NWSC
	Lagos[c]	3	0	100	0	0	Public	State/province	LWC
	Maputo	1	1	99	0	0	PPP	Other	AdeM
	Mzuzu	1	0	10	90	0	Public	State/province	NRWB
	Nairobi	2	1	0	99	0	Public, private[d]	Other	NCWSC
SOUTH ASIA	**Bengaluru**	1	11	0	0	89	Public	State/province	BWSSB
	Colombo	1	0	100	0	0	Public	National	NWSDB
	Dhaka	1	78	22	0	0	Public	State/province	DWASA
	Karachi	1	4	96	0	0	Public	State/province	KWSB
	Mumbai	1	0	0	0	100	Public	City	MCGM
LATIN AMERICA	**Caracas**	1	0	0	30	70	Public	Federal	Hidrocapital
	Cochabamba	1	50	50	0	0	Public	Federal	SEMAPA
	Rio de Janeiro	1	0	87	13	0	Public	State/province	CEDAE
	São Paulo	1	1	0	0	99	PPP	State/province	Sabesp
	Santiago de Cali	1	0	100	0	0	Public	Federal	EMCALI

Notes:
a. Distant source is defined as more than 100 kilometers away.
b. For regulators, *other* denotes some form of an autonomous regulatory authority.
c. In Lagos, there are 3 major utilities and 48 miniwaterworks. They are all owned by LWC.
d. Nairobi's second water utility is very small and private; it serves a specific neighborhood that purchases water from NCWSC.

Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.[273]

Table A3 | Cost of the Main Alternative Water Providers in Selected Informal Settlements in 15 Cities in the Global South

	CITY NAME	INFORMAL SETTLEMENT NAME	TYPE OF PROVIDER	COSTS PER CUBIC METER US$/MARKET EXCHANGE
SUB-SAHARAN AFRICA	**Kampala**	Kalimali	jerricans from private standpipes, springs	2.75
	Lagos	Makoko	tube well/borehole	1.11
	Maputo	Nhlamankulu D	neighbor's yard tap	8.35
	Mzuzu	Zolozolo West Ward	dug well, boreholes; standpipes	0.03; 0.55
	Nairobi	Kosovo Village in Mathare Valley	kiosk	0.24
SOUTH ASIA	**Bengaluru**	Koramangala Slum Cluster	borehole	0
	Colombo	Borella South GND	public tap	0
	Dhaka	Kallyanpur Pora Basti	dug well	0
	Karachi	Ghaziabad Sector 11 ½, Orangi Town	tanker truck	3.14
	Mumbai	Siddarth Nagar	from work; tanker truck	0; 2.33
LATIN AMERICA	**Caracas**	Terrazas del Alba	no alternative	
	Cochabamba	San Miguel Km4	tanker truck	4.91
	Rio de Janeiro	Rocinha	no alternative	
	São Paulo	Jardim São Remo	no alternative	
	Santiago de Cali	Comuna 20	no alternative	

Source: Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.[274]

ENDNOTES

1. WWAP, 2019; The World Resources Report (WRR) *Towards a More Equal City* categorized 769 cities as struggling, emerging, thriving, and stabilizing. Struggling and emerging cities currently have lower incomes per capita, and this trend is projected to continue through 2030. For a detailed explanation of the city categories, see Beard et al., 2016.
2. Bhalotra et al., 2017: 88; WWAP, 2016.
3. WWAP, 2016; Bhalotra et al., 2017: 2, 88.
4. WWAP, 2016: 89; Bhalotra et al., 2017.
5. WHO, 2012: 7.
6. WHO, 2012.
7. WHO, 2012: 5.
8. Kimmelman, 2017a, 2017b.
9. Brears, 2017: 19.
10. Wakode et al., 2018.
11. WWAP/UN-Water, 2018.
12. Beard et al., 2016.
13. Satterthwaite, 2016b.
14. The 15 cities include Caracas, Venezuela; Cochabamba, Bolivia; Rio de Janeiro, Brazil; São Paulo, Brazil; Santiago de Cali, Colombia; Bengaluru, India; Colombo, Sri Lanka; Dhaka, Bangladesh; Karachi, Pakistan; Mumbai, India; Kampala, Uganda; Lagos, Nigeria; Maputo, Mozambique; Mzuzu, Malawi; and Nairobi, Kenya.
15. Bivins et al., 2017: 7544.
16. Bivins et al., 2017; Anand, 2017; Björkman, 2015.
17. OHCHR et al., 2010; Mack and Wrase, 2017.
18. Spiller and Savedoff, 1999.
19. BiWater (a UK company) withdrew from one water privatization project in Zimbabwe arguing that, given consumers' capacity to pay, the returns were not sufficient to generate a commercial return (Bayliss 2001, 6).
20. McDonald, 2014; Dagdeviren, 2008.
21. UN, 1991.
22. Angel and Loftus, 2019; Bakker, 2007; Karunananthan, 2019; Langford and Russell, 2017; Pestova, 2016.
23. King et al., 2017.
24. CODI, 2011; Archer, 2012; Papeleras et al., 2012.
25. UN, 2014.
26. UN DESA, 2017.
27. Satterthwaite, 2016a: 99.
28. Hanif, 2018; Nagaraj, 2018; BBC News, 2018.
29. WHO and UNICEF, 2017: 22.
30. WHO and UNICEF, 2017: 24.
31. The LDC category includes Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Vanuatu, Yemen, and Zambia (WHO and UNICEF, 2017: 57).
32. WHO, 2017: 39; Bain et al., 2014.
33. WHO, 2017: 39.
34. WHO, 2017: 32.
35. For an in-depth analysis on sanitation access in the global South, see the 2019 forthcoming WRR working paper on sanitation services. Also see Berendes et al., 2018; and Cairncross, 2018.
36. Heymans et al., 2016: 51.
37. Kimmelman, 2017a, 2017b.
38. WHO, 2012: 6.
39. WHO, 2012: 7.
40. WWAP, 2016: 33.
41. WWAP, 2016: 33.
42. Chen and Beard, 2018.
43. WHO, 2012: 5.
44. WWAP, 2016: 88; Hutton and Haller, 2004.
45. WHO, 2012: 8–9.
46. WHO, 2012: 5.
47. Bhalotra et al., 2017; Cain and Rotella, 2001; Cutler and Miller, 2005; Ferrie and Troesken, 2008; Koppaka, 2011; Ketzenbaum and Rosenthal, 2014; Ogasawara and Inoue, 2015; Knutsson, 2016.
48. Bhalotra et al., 2017: 88; WWAP, 2016.
49. WWAP, 2016; Bhalotra et al., 2017: 2, 88.
50. WWAP, 2016: 89; Bhalotra et al., 2017.
51. Bivins et al., 2017: 2542; WHO and UNICEF, 2000: 19.
52. WHO and UNICEF, 2015; Kaminsky and Kumpel, 2018; Kumpel and Nelson, 2016.
53. Brears, 2017: 19.
54. Brears, 2017: 18.
55. Kimmelman, 2017a, 2017b.
56. Wakode et al., 2018.
57. Abell et al., 2017.
58. Woodhouse and Muller, 2017; Abell et al., 2017.
59. Cairncross, 2018; Lilford et al., 2016.
60. The challenge of urban sanitation is discussed in another WRR paper (forthcoming, 2019); for a comprehensive discussion of water source protection, see Abell et al., 2017.

61. WHO, 2017.
62. WHO and UNICEF, 2017: 26.
63. WHO and UNICEF, 2017: 26.
64. WHO and UNICEF, 2017: 26.
65. For example, the UN's website on the MDGs reports, "The world has met [the goal of] halving the proportion of people without access to improved sources of water, five years ahead of schedule." For more information, see the UN Millennium Development Goals and Beyond 2015 website, http://www.un.org/millenniumgoals/environ.shtml.
66. WHO and UNICEF, 2006.
67. Walton, 2017.
68. WHO and UNICEF, 2017. Since safely managed is better quality than piped (its definition includes using an improved source that should be accessible on premises, available when needed, and free from contamination), it is a puzzle why some areas have a higher proportion of safely managed than piped water, yet other areas have a higher proportion of piped than safely managed water.
69. WHO and UNICEF, 2017: 105.
70. WHO and UNICEF, 2017: 105.
71. WHO and UNICEF, 2017: 105.
72. Satterthwaite, 2016a.
73. Satterthwaite, 2016a: 104.
74. Satterthwaite, 2016b.
75. Satterthwaite, 2016a.
76. NPC and ICF International, 2014.
77. MoHCDGEC et al., 2016.
78. WHO and UNICEF, 2015: 18.
79. Bain et al., 2014.
80. Urban access to sanitation services will be discussed in a future WRR working paper on sanitation in the global South, coming in 2019.
81. WHO, 2017: 34–35.
82. WHO and UNICEF, 2017.
83. WHO, 2017.
84. Mitlin and Walnycki, 2016; Subbaraman et al., 2015.
85. WHO, 2017: 23.
86. WHO, 2017: 37.
87. WHO, 2017: 20.
88. For example, in Mzuzu, city-level data obscure the complete absence of water services in some parts of the city and the reliance of those inhabitants on natural water sources.
89. Satterthwaite, 2016a: 99.
90. Beard et al., 2016.
91. Each researcher selected the categorization that best characterized the settlement that was the basis for the "case within the case"; however, for the remainder of the paper these settlements are referred to as informal settlements.
92. **Caracas:** INE Venezuela, 2011a; Interview: Community leader, Terrazas del Alba, July 2017. **Cochabamba:** Interview: Administrator, Drinking Water Association of San Miguel Km4, March 2017. **Rio de Janeiro:** IBGE, 2009; Interviews: Community leaders, Rocinha, July 2017. **São Paulo:** Prefeitura Municipal de São Paulo, 2017a; Prefeitura Municipal de São Paulo, 2017b; IBGE, 2010a. **Santiago de Cali:** Municipality of Santiago de Cali, 2017. **Bengaluru:** Interview: Community leader, Koramangala, July 2017. **Mumbai:** ICDS, 2016. **Colombo:** DCS, 2010. **Karachi:** Interviews: Representative, Technical Training Resource Centre; Community leaders, Ghaziabad Sector, July 2017. **Dhaka:** WSUP, 2016a. **Kampala:** ACTogether Uganda et al., n.d. **Lagos:** MoPPUD, 2013; LBS, 2013. **Maputo:** WSUP, 2016b; CMM, 2010; INE Mozambique, 2015. **Mzuzu:** MCC, 2017. **Nairobi:** Interview: Community leader, Kosovo Village, July 2017.
93. Rocha-Melogno et al., 2018.
94. WHO and UNICEF, 2006: 8.
95. **Caracas:** INE Venezuela, 2011b; Interviews: Community leaders, Terrazas del Alba, July 2017. **Cochabamba:** AAPS, 2016; Interviews: Water Regulator Engineer, National Water Authority; Administrator, Drinking Water Association of San Miguel Km4, March 2017. **Rio de Janeiro:** SNIS, 2017; IBGE, 2009; Interviews: Community leaders, Rocinha. **São Paulo:** Prefeitura Municipal de São Paulo, 2017b; IBGE, 2010b; Sabesp, 2018. **Santiago de Cali:** EMCALI, 2017; Interviews: Community leader, Comuna 20, July 2017. **Bengaluru:** BWSSB, 2011; Interviews: Community leader, Koramangala; Representative, BWSSB, July 2017. **Mumbai:** DCO, 2011; Interviews: Campaign leaders, Pani Haq Samiti (Committee for Water Right); Community leaders, Siddarth Nagar, July 2017. **Colombo:** DCS, 2010; Interviews: Statistician, Department of Census and Statistics; Administrator, Grama Niladhari, Borella South, July 2017. **Karachi:** Interviews: Representative, Technical Training Resource Centre; Senior Engineers at Karachi Water and Sewerage Board; Community leaders, Ghaziabad. **Dhaka:** ITN-BUET, 2015; Interviews: Consultant, World Bank; Director, Coalition for Urban Poor Dhaka; Representative, Nagar Daridrabasi Unnayan Samaj, local NGO; Project officer, WSUP, September 2017. **Kampala:** Interviews: Supervisor, KCCA; Community leaders, Kalimali, July 2017. **Lagos:** LBS, 2013. **Maputo:** Interviews: Planning Technical Officer, Águas da Região de Maputo, July 2017; Zuin et al., 2013. **Mzuzu:** Interviews: Community leaders, Zolozolo West Ward; Representative, Zolozolo Health Center; Representative, City Council, July 2017; Government of Malawi, 2012; Stockman et al., 2007; MCC, 2017. **Nairobi:** MajiData, 2017; Interviews: Community leaders, Kosovo Village, May 2017.
96. Although we do not have data on the specific breakdown of what source of water these households used, we know that most of these households used public taps and standpipes, and many fewer relied on kiosks.
97. In India, informal settlements are either declared or nondeclared. Declared informal settlements are those that have been formally declared as slums by the respective governing bodies, whereas a nondeclared informal settlement lacks the tenure security associated with the state's formal recognition.
98. Anand, 2017: 87.
99. Kumpel and Nelson, 2016; Kaminsky and Kumpel, 2018; Taylor et al., 2018; Bivins et al., 2017; Anand, 2017; Björkman, 2015; Van den Berg and Danilenko, 2010.
100. Van den Berg and Danilenko, 2010.
101. Bivins et al., 2017: 7544.
102. Bivins et al., 2017: 7544.

103. **Caracas:** Interviews: Former adviser, Hidrocapital; Community leaders, Terrazas del Alba, July 2017. **Cochabamba:** Interviews: Water Engineer, National Water Authority; Administrator, Drinking Water Association, San Miguel Km4, March 2017. **Rio de Janeiro:** Interviews: Director, Rocinha Health Office; Sanitation Director, Rio Aguas Foundation; Director, CEDAE, July 2017; IBGE, 2017. **São Paulo:** Sabesp, 2018; Interviews: Community representatives, São Paulo. **Santiago de Cali:** Interviews: Chair, ACODAL (La Asociación Colombiana de Ingeniería Sanitaria y Ambiental; Colombian Association of Sanitary and Environmental Engineering); Community leader, Communa 20, July 2017; Municipality of Santiago de Cali, 2018. **Bengaluru:** Mohd and Malik, 2017; Interview: Community leader, Koramangala, July 2017. **Mumbai:** Interviews: Professor, Center of Water Policy, Regulation and Governance, Tata Institute of Social Sciences; Community leaders, Siddarth Nagar; Associate, Pani Haq Samiti (Committee for Water Rights), July 2017. **Colombo:** Interviews: Health Officer, City Food Hygiene and Safety Unit of the Colombo Municipal Council; Administrator, Grama Niladhari, Borella South, July 2017. **Karachi:** Interviews: Coordinator, Technical Training Resource Centre, Orangi Town; Community leaders, Ghaziabad, July 2017. **Dhaka:** Interviews: Manager, DWASA; Sanitation Lead, WSUP; Uttam Kumar, Commercial Manager, DWASA; Professor, Bangladesh University of Engineering and Technology; Community leader and organizer, RUPA Project, Kallyanpur; Representative, Nagar Daridrabasi Unnayan Samaj, local NGO, September 2017; Badhan et al., 2017. **Kampala:** Interviews: Supervisor, KCCA; Community leaders, Kalimali. **Lagos:** LBS, 2013. **Maputo:** Interviews: Planning Technical Officer, Águas da Região de Maputo, July 2017; AdeM, 2017a; Zuin et al., 2013. **Mzuzu:** Interviews: Community leaders, Zolozolo West Ward, Representative, Zolozolo Health Center; Representative, City Council, July 2017; MCC, 2017; Government of Malawi, 2012; Stockman et al., 2007. **Nairobi:** Interviews: Community leaders, Kosovo Village, May 2017; MajiData, 2017.

104. Monthly household consumption of 10 m^3 of water assumes an average household size of five persons consuming 50–100 L of water per person per day.

105. **Caracas:** INE Venezuela, 2011b; Interviews: Community leaders, Terrazas del Alba, July 2017. **Cochabamba:** AAPS, 2016; Interviews: Water Regulator Engineer, National Water Authority; Administrator, Drinking Water Association of San Miguel Km4, July 2017. **Rio de Janeiro:** SNIS, 2017; IBGE, 2009; Interviews: Community leaders, Rocinha. **São Paulo:** Prefeitura Municipal de São Paulo, 2017b; IBGE, 2010b; Sabesp, 2018. **Santiago de Cali:** EMCALI, 2017; Interview: Community leader, Comuna 20, July 2017. **Bengaluru:** BWSSB, 2011; Interviews: Community leader, Koramangala; Representative, BWSSB, July 2017. **Mumbai:** DCO, 2011; Interviews: Campaign leaders, Pani Haq Samiti (Committee for Water Rights); Community leaders, Siddarth Nagar, July 2017. **Colombo:** DCS, 2010; Interviews: Statistician, Department of Census and Statistics; Administrator, Grama Niladhari, Borella South, July 2017. **Karachi:** Interviews: Representative, Technical Training Resource Centre; Senior Engineers at Karachi Water and Sewerage Board; Community leaders, Ghaziabad. **Dhaka:** ITN-BUET, 2015; Interviews: Consultant, World Bank; Director, Coalition for Urban Poor Dhaka; Representative, Nagar Daridrabasi Unnayan Samaj, local NGO; Project officer, WSUP, September 2017. **Kampala:** Interviews: Supervisor, KCCA; Community leaders, Kalimali, July 2017. **Lagos:** LBS, 2013. **Maputo:** Interview: Planning Technical Officer, Águas da Região de Maputo, July 2017; Zuin et al., 2013. **Mzuzu:** Interviews: Community leaders, Zolozolo West Ward, Representative, Zolozolo Health Center, July 2017; Representative, City Council; Government of Malawi, 2012; Stockman et al., 2007; MCC, 2017. **Nairobi:** MajiData, 2017; Interviews: Community leaders, Kosovo Village, May 2017.

106. If local prices were converted using 2016/17 purchasing power parity factors, piped water from most expensive to least would be Mzuzu, Colombo, Cochabamba, Kampala, Santiago de Cali, São Paulo, Rio de Janeiro, Maputo, Nairobi, Karachi, Bangalore, Lagos, Dhaka, and Mumbai.

107. OHCHR et al., 2010; Mack and Wrase, 2017.

108. OHCHR et al., 2010; Mack and Wrase, 2017.

109. **Caracas:** INE Venezuela, 2011b; based on city enumerator's analysis, November 2017. **Cochabamba:** INE Bolivia, 2017; Interview: Administrator, Drinking Water Association San Miguel Km4, November 2017. **Rio de Janeiro:** IBGE, 2010a. **São Paulo:** IBGE, 2010b. **Santiago de Cali:** Municipality of Santiago de Cali, 2015; Interview: Statistician, Municipality of Santiago de Cali. **Bengaluru:** NCAER, 2008; Interview: Community leader, Koramangala, November 2017. **Mumbai:** Government of Maharashtra, 2015; Interview: Community leader, Siddarth Nagar, November 2017. **Colombo:** DCS, 2016. **Karachi:** Interviews: Engineer, KWSB, July 2017; Community representatives, Ghaziabad. **Dhaka:** PPRC and UNDP, 2015; PPRC, 2016; ICDDR,B, 2015. **Kampala:** MoH Uganda, 2016; Interviews: Community representatives, Kalimali. **Lagos:** LBS, 2016. **Maputo:** Based on city enumerator's analysis, November 2017. **Mzuzu:** URAC, 2017; CfSC, 2012; MCC, 2010. **Nairobi:** World Bank, 2016; Interview: Community leader, Kosovo Village.

110. Kimmelman, 2017b, 2017a.

111. **Caracas:** Interviews: Former adviser, Hidrocapital; Technical representative, National Laboratory of Hydraulics, July 2017. **Cochabamba:** Interview: Operations Director, SEMAPA, April 2017. **Rio de Janeiro:** Interviews: Planning Officer, Metropolitan Chamber; Manager, CEDAE-STS Algeria; Manager, CEDAE-Guandu. **São Paulo:** SNIS, 2006. **Santiago de Cali:** Interview: Director, EMCALI, July 2017. **Bengaluru:** BWSSB, 2011. **Mumbai:** Interview: Professor, Center of Water Policy, Regulation and Governance, Tata Institute of Social Sciences. **Colombo:** Interview: Manager, Research & Development, NWSDB; NWSDB, 2011. **Karachi:** Interviews: Superintending Engineers, KWSB, July 2017. **Dhaka:** Interviews: Manager and Analyst, DWASA; Consultant, World Bank–Dhaka; DWASA, 2016. **Kampala:** Interviews: Representatives, NWSC; NWSC, 2015. **Lagos:** Interview: Representative, Lagos Water Corporation; LWC, 2014. **Maputo:** Interview: Technical Officer, AdeM; AdeM, 2017a, 2017b. **Mzuzu:** Interviews: Manager, NRWB; Engineer, NRWB; NRWB, 2017. **Nairobi:** Interviews: Managers, NCWSC; Afriwater, 2017; NCWSC, 2017b; World Bank, 2016; WASREB, 2016; NCWSC, 2017b.

112. In addition, the watershed that feeds the reservoir is disputed between the state of Karnataka, where Bengaluru is located, and the state of Tamil Nadu.

113. Herrera and Post, 2014: 623.

114. Spiller and Savedoff, 1999.

115. Spiller and Savedoff, 1999.

116. UN-Habitat, 2003.

117. For details of Guayaquil, Ecuador, see Swyngedouw, 2004. For details of Karachi, Pakistan, see Rahman, 2008.

118. Nganyanyuka et al., 2014.

119. McGranahan et al., 2006.

120. McGranahan et al., 2006.

121. Dagdeviren and Robertson, 2011.

122. Marson and Savin, 2015.

123. Dagdeviren and Robertson, 2011.

124. Mitlin and Walnycki, 2016.

125 Chisari et al., 2001: 1.

126. Cohen, 2012; Finnegan, 2002.

127. The problem of inadequate water supply is multifaceted and needs to be engaged with reductions in nonrevenue water and through efforts to increase the overall supply of water.

128. Musgrave, 1969; Makwara, 2011.

129. Weizsäcker et al., 2005.

130. BiWater (a UK company) withdrew from one water privatization project in Zimbabwe arguing that, given consumers' capacity to pay, the returns were not sufficient to generate a commercial return (Bayliss, 2001: 6).

131. World Bank, 2017a.

132. There are exceptions to the lack of private sector growth in the provision of water services, particularly where public utilities are weak with relatively small networks. For example, in Maputo, Mozambique, private providers supply 191,000 households compared to 185,000 from the water utility (Heymans et al., 2016: 51).

133. Kishimoto et al., 2015.

134. Kishimoto et al., 2015: 10.

135. Walnycki, 2015.

136. McDonald, 2014; Dagdeviren, 2008.

137. McDonald, 2014; Dagdeviren, 2008.

138. Dagdeviren and Robertson, 2011.

139. Mitlin and Walnycki, 2016.

140. Dagdeviren and Robertson, 2011; Jaglin, 2002.

141. Jaglin, 2002: 235.

142. Jaglin, 2002; Cheng, 2013.

143. Jaglin, 2002: 241.

144. Ranganathan, 2014: 591.

145. Foster and Briceño-Garmendia, 2010.

146. Heymans et al., 2016; Rugemalila and Gibbs, 2015.

147. Based on GWCL, 2018. In 2016, the charges per kL were GH₵2.98 ($0.74 between 0 and 5 m^3 and GH₵5.07, or $1.27, over 5 m^3). Public standpoint charges were GH₵0.335 per L ($0.84).

148. Farolfia and Gallego-Ayalab, 2014; Rugemalila and Gibbs, 2015: 317, 422.

149. Foster and Briceño-Garmendia, 2010. Also, see Dagdeviren, 2007, for the example of Zambia.

150. Marson and Savin, 2015.

151. Marson and Savin, 2015.

152. WHO and UNICEF, 2017.

153. UN and WSSCC, n.d.

154. Hutton, 2012.

155. UNHRC, 2015.

156. WHO and WEDC, 2013.

157. Hutton, 2012: 54–55.

158. Donoso, 2017.

159. Heymans et al., 2016.

160 WHO, 2017: 11.

161. WHO, 2017: 23.

162. Heymans et al., 2016: 43; Hutton and Varughese, 2016.

163. Heymans et al., 2016: 39.

164. SDI is a network of community-based organizations of the urban poor in 32 countries and hundreds of cities and towns across Africa, Asia, and Latin America. In each country where SDI has a presence, affiliate organizations come together at the community, city, and national level to form federations. Since 1996, this network has helped create a global voice of the urban poor, engaging international agencies and operating on the international stage to support and advance local struggles. The primary scale of practice for SDI's constituent organizations is the local level: the informal settlements where the urban poor of the developing world struggle to build more inclusive cities, economies, and politics. Membership in the SDI federation is over 80 percent women. They share organizational practices, such as savings, data collection, horizontal learning, and coproduction of urban development solutions with other stakeholders.

165. Mitlin and Walnycki, 2016: 3.

166. Mitlin and Walnycki, 2016: 3.

167. Mitlin and Walnycki, 2016: 3. The percentage of income required is estimated using a consumption of 50 L per person per day with average or typical incomes of the bottom 40 percent of residents and a household size of five. No allowance is made for the different water needs of the old and young.

168. Mitlin and Walnycki, 2016: 3.

169. Mitlin and Walnycki, 2016: 3.

170. Mitlin and Walnycki, 2016: 3.

171. Nleya, 2008: 277.

172. Nleya, 2008: 277.

173. Nleya, 2008: 277.

174. Heymans et al., 2016: 44.

175. Subbaraman et al., 2015.

176. For a more in-depth discussion on the relationship between city jurisdictions and service areas, see the 2019 WRR working paper "Upward and Outward Growth: Managing Urban Expansion for More Equitable Cities in the Global South."

177. Furlong, 2014.

178. Bakker, 2010; Silver, 2015; Nilsson, 2016; Lawhon et al., 2018; Graham and Marvin, 2002.

179. Nilsson, 2016: 504; Gandy, 2014.

180. Nilsson, 2016.

181. Roy and AlSayyad, 2004; Roy, 2005.

182. Dagdeviren and Robertson, 2011: 40.

183. McGranahan et al., 2006.

184. The cost of obtaining water from "natural sources" may surface negative environmental or health costs.

185. Heymans et al., 2016: 12; Bakker, 2010: 226.

186. Bakker, 2010: 226.

187. Bakker, 2010: 85.

188. Kaminsky and Kumpel, 2018.

189. Taylor et al., 2018; Kumpel et al., 2017; Kumpel and Nelson, 2013; Ercumen et al., 2015; Zerah, 1998; Pattanayak et al., 2005.
190. Kaminsky and Kumpel, 2018; Kumpel and Nelson, 2016; Burt et al., 2018.
191. Kumpel and Nelson, 2016: 547.
192. Majuru et al., 2016.
193. Majuru et al., 2016.
194. Majuru et al., 2016.
195. Majuru et al., 2016: 13.
196. Majuru et al., 2016.
197. Furlong, 2014: 143.
198. Furlong, 2014: 144.
199. Furlong, 2014: 144.
200. Furlong, 2014: 145.
201. Chhabra, 2014.
202. Kumar et al., 2018: 159.
203. Kumar et al., 2018: 157.
204. Brears, 2017: 69.
205. Brears, 2017: 69; Kaminsky and Kumpel, 2018; Kingdom et al., 2006; Ismail and Puad, 2007; Frauendorfer and Liemberger, 2010.
206. Kamisky and Kumpel, 2018: 12.
207. Brears, 2017: 70.
208. Kaminsky and Kumpel, 2018.
209. Brears, 2017: 70.
210. Kamisky and Kumpel, 2018: 11.
211. Brears, 2017: 70.
212. Sarni et al., 2019; Brears, 2017: 70.
213. Kamisky and Kumpel, 2018: 11.
214. Galaitsi et al., 2016: 18; World Bank, 2014: 10.
215. Kaminsky and Kumpel, 2018; Kumpel and Nelson, 2016; Kumpel and Nelson, 2013; Klingel, 2012.
216. Kumar et al., 2018: 157.
217. Burt et al., 2018.
218. PDG, 2007.
219. Heymans et al., 2016: 43.
220. Heymans et al., 2016: 32.
221. WSUP, 2017.
222. WSUP, 2017.
223. Sparkman and Sturzenegger, 2016.
224. Nleya, 2008: 277.
225. *Mail & Guardian*, 2009; CoJ, 2017.
226. Petersen, 2017.
227. Naidoo, 2009.
228. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.
229. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.
230. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.
231. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.
232. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.
233. Based on the WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study, 2018.
234. Fuente et al., 2016: 4852; Nauges and Whittington, 2017.
235. Mitlin and Walnycki, 2016.
236. Nganyanyuka et al., 2014.
237. Heymans et al., 2016: xvii.
238. Thompson et al., 2000. Thompson et al. (2000) discuss the expansion of kiosks in Dar es Salaam and Nairobi during the 1990s.
239. Beard et al., 2016; For a more detailed description of the benefits of in situ upgrading to the urban under-served, see King et al., 2017.
240. King et al., 2017.
241. Alamansi, 2009.
242. Archer, 2012; Papeleras et al., 2012.
243. ACHR, 2015: 7.
244. ACHR, 2015.
245. ACHR, 2015.
246. ACHR, 2015.
247. ACHR, 2015.
248. ACHR, 2015: 75.
249. ACHR, 2015.
250. ACHR, 2015.
251. ACHR, 2018.
252. SDI, 2016.
253. SDI, 2016.
254. Satterthwaite, 2011.
255. Mitlin and Bartlett, 2018.
256. Weru et al., 2017.
257. SDI, 2016.
258. WWAP, 2019.
259. WWAP, 2019; World Bank, 2017b.
260. GWI, 2016.
261. Target 6.1: "By 2030, achieve universal and equitable access to safe and affordable drinking water for all."
262. Hutton and Varughese, 2016.
263. Shand, 2018; WaterAid, n.d.

264. Muller and Mitlin, 2004.

265. OECD, 2013.

266. Berg and Tschirhart, 1988.

267. Rouse, 2013; Furlong, 2012.

268. Rouse, 2013; OECD, 2013.

269. Furlong, 2012.

270. WWAP, 2019.

271. Furlong, 2012.

272. **Caracas:** INE Venezuela, 2011a; Based on city enumerator's analysis, November 2017. **Cochabamba:** INE Bolivia, 2017; Interview: Administrator, Drinking Water Association San Miguel Km4, November 2017. **Rio de Janeiro:** IBGE, 2010a. **São Paulo:** IBGE, 2010b. **Santiago de Cali:** Municipality of Santiago de Cali, 2015; Interview: Statistician, Municipality of Santiago de Cali. **Bengaluru:** NCAER, 2008; Interview: Community leader, Koramangala, November 2017. **Mumbai:** Government of Maharashtra, 2015; Interview: Community leader, Siddarth Nagar, November 2017. **Colombo:** DCS, 2016. **Karachi:** Interviews: Engineer, KWSB, July 2017; Community representatives, Ghaziabad. **Dhaka:** PPRC and UNDP, 2015; PPRC, 2016; ICDDR,B, 2015. **Kampala:** MoH Uganda, 2016; Interviews: Community representatives, Kalimali. **Lagos:** LBS, 2016. **Maputo:** Based on city enumerator's analysis, November 2017. **Mzuzu:** URAC, 2017; CfSC, 2012; MCC, 2010. **Nairobi:** World Bank, 2016; Interview: Community leader, Kosovo Village.

273. **Caracas:** Interviews: Former adviser, Hidrocapital; Technical representative, National Laboratory of Hydraulics, July 2017. **Cochabamba:** Interview: Operations Director, SEMAPA, April 2017. **Rio de Janeiro:** Interviews: Planning Officer, Metropolitan Chamber; Manager, CEDAE-STS Algeria; Manager, CEDAE-Guandu. **São Paulo:** SNIS, 2006. **Santiago de Cali:** Interview: Director, EMCALI, July 2017. **Bengaluru:** BWSSB, 2011. **Mumbai:** Interview: Professor, Center of Water Policy, Regulation and Governance, Tata Institute of Social Sciences. **Colombo:** Interview: Manager, Research & Development, NWSDB; NWSDB, 2011. **Karachi:** Interviews: Superintending Engineers, KWSB, July 2017. **Dhaka:** Interviews: Manager and Analyst, DWASA; Consultant, World Bank–Dhaka; DWASA, 2016. **Kampala:** Interviews: Representatives, NWSC; NWSC, 2015. **Lagos:** Interview: Representative, Lagos Water Corporation; LWC, 2014. **Maputo:** Interview: Technical Officer, AdeM; AdeM, 2017a, 2017b. **Mzuzu:** Interview: Manager, NRWB; Engineer, NRWB; NRWB, 2017. **Nairobi:** Interviews: Managers, NCWSC; Afriwater, 2017; NCWSC, 2017b; World Bank, 2016; WASREB, 2016; NCWSC, 2017b.

274. **Caracas:** INE Venezuela, 2011b; Interviews: Community leaders, Terrazas del Alba, July 2017. **Cochabamba:** AAPS, 2016; Interviews: Water Regulator Engineer, National Water Authority; Administrator, Drinking Water Association of San Miguel Km4, July 2017. **Rio de Janeiro:** SNIS, 2017; IBGE, 2009; Interviews: Community leaders, Rocinha. **São Paulo:** Prefeitura Municipal de São Paulo, 2017b; IBGE, 2010b; Sabesp, 2018. **Santiago de Cali:** EMCALI, 2017; Interview: Community leader, Comuna 20, July 2017. **Bengaluru:** BWSSB , 2011; Interviews: Community leader, Koramangala; Representative, BWSSB, July 2017. **Mumbai:** DCO, 2011; Interviews: Campaign leaders, Pani Haq Samiti (Committee for Water Right); Community leaders, Siddarth Nagar, July 2017. **Colombo:** DCS, 2010; Interviews: Statistician, Department of Census and Statistics; Administrator, Grama Niladhari, Borella South, July 2017. **Karachi:** Interviews: Representative, Technical Training Resource Centre; Senior Engineers at Karachi Water and Sewerage Board; Community leaders, Ghaziabad. **Dhaka:** ITN-BUET, 2015. Interviews: Consultant, World Bank; Director, Coalition for Urban Poor Dhaka; Representative, Nagar Daridrabasi Unnayan Samaj, local NGO; Project officer, WSUP, September 2017. **Kampala:** Interviews: Supervisor, KCCA; Community leaders, Kalimali, July 2017. **Lagos:** LBS, 2013. **Maputo:** Interview: Planning Technical Officer, Águas da Região de Maputo, July 2017; Zuin et al., 2013. **Mzuzu:** Interviews: Community leaders, Zolozolo West Ward, Representative, Zolozolo Health Center, July 2017; Representative, City Council; Government of Malawi, 2012; Stockman et al., 2007; MCC, 2017. **Nairobi:** MajiData, 2017; Interviews: Community leaders, Kosovo Village, May 2017.

REFERENCES

AAPS (Autoridad de Fiscalización y Control Social de Agua Potable y Saneamiento Básico). 2016. "Indicadores de Desempeño 2015." La Paz: AAPS.

Abell, R., N. Asquith, G. Boccaletti, L. Bremer, E. Chapin, A. Erickson-Quiroz, J. Higgins, et al. 2017. *Beyond the Source: The Environmental, Economic and Community Benefits of Source Water Protection*. Arlington, VA: The Nature Conservancy.

ACHR (Asian Coalition for Housing Rights). 2015. *215 Cities in Asia: Fifth Yearly Report of the Asian Coalition for Community Action*. Bangkok: ACHR.

ACHR. 2018. *City Development Funds*. Bangkok: ACHR.

ACTogether Uganda, NSDFU (National Slum Dwellers Federation of Uganda), and SDI (Slum Dwellers International). n.d. "Kampala Profiles, Kawempe Division." http://www.actogetherug.org/. Accessed June 30, 2017.

AdeM (Águas da Região de Maputo). 2017a. "AdeM Performance Report to the CRA." Maputo, Mozambique: AdeM.

AdeM. 2017b. "Monthly Report (April)." Maputo, Mozambique: AdeM.

Afriwater. 2017. "Welcome to Africa Water, Sanitation & Hygiene." https://afriwater.org. Accessed June 30, 2017.

Agutu, N. 2018. "Stuck Nairobians Ask for 'Noah's Ark' after Morning Rains Flood Roads." *Star* (Nairobi). https://www.the-star.co.ke/news/2018/03/15/video-stuck-nairobians-ask-for-noahs-ark-after-morning-rains-flood_c1730370. Accessed June 15, 2018.

Alamansi, F. 2009. "Regularizing Land Tenure within Upgrading Programmes in Argentina; the Cases of Promeba and Rosario Hábitat." *Environment and Urbanization* 21 (2): 389–413.

Anand, N. 2017. *Hydraulic City: Water and the Infrastructures of Citizenship in Mumbai*. Durham, NC: Duke University Press.

Angel, J., and A. Loftus. 2019. "With-against-and-beyond the Human Right to Water." *Geoforum* 98: 206–13.

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

Badhan, M.A., B. Roy, and S.A. Sifat. 2017. "Water Supply and Sanitation Situation of Kalyanpur Slum Area in Dhaka." *International Journal of Natural and Social Sciences* 4 (2): 54–59.

Bain, R., R. Cronk, R. Hossain, S. Bonjour, K. Onda, J. Wright, H. Yang, T. Slaymaker, P. Hunter, A. Prüss-Ustün, and J. Bartram. 2014. "Global Assessment of Exposure to Faecal Contamination through Drinking Water Based on a Systematic Review." *Tropical Medicine and International Health* 19 (8): 917–27.

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.

Bakker, K. 2010. *Privatizing Water: Governance Failure and the World's Urban Water Crisis*. Ithaca, NY: Cornell University Press.

Bayliss, K. 2001. *Water Privatisation in Africa: Lessons from Three Case Studies*. Greenwich, UK: Public Services International Research Unit, University of Greenwich.

BBC News. 2018. "The 11 Cities Most Likely to Run Out of Drinking Water—Like Cape Town," February 11. https://www.bbc.com/news/world-42982959. Accessed December 15, 2018.

Beard, V.A., A. Mahendra, and M.I. Westphal. 2016. *Towards a More Equal City: Framing the Challenges and Opportunities*. World Resources Report. Washington, DC: World Resources Institute.

Berendes, D.M., A.E. Kirby, J.A. Clennon, C. Agbemabiese, J.A. Ampofo, G.E. Armah, and K.K. Baker. 2018. "Urban Sanitation Coverage and Environmental Fecal Contamination: Links between the Household and Public Environments of Accra, Ghana." *PLOS ONE* 13 (7).

Berg, S.V., and J. Tschirhart. 1988. *Natural Monopoly Regulation: Principles and Practice*. New York: Cambridge University Press.

Bhalotra, S.R., A. Diaz-Cayeros, G. Miller, A. Miranda, and A.S. Venkataramani. 2017. "Urban Water Disinfection and Mortality Decline in Developing Countries." Working Paper 593. Stanford, CA: Stanford Center for International Development.

Bivins, A.W., T. Sumner, E. Kumpel, G. Howard, O. Cumming, I. Ross, K. Nelson, and A. Brown. 2017. "Estimating Infection Risks and the Global Burden of Diarrheal Disease Attributable to Intermittent Water Supply Using QMRA." *Environmental Science & Technology* 51 (13): 7542–51.

Björkman, L. 2015. *Pipe Politics, Contested Waters: Embedded Infrastructures of Millennial Mumbai*. Durham, NC: Duke University Press.

Brears, R.C. 2017. *Urban Water Security*. Chichester, UK: John Wiley & Sons.

Burt, Z., A. Ercümen, N. Billava, and I. Ray. 2018. "From Intermittent to Continuous Service: Costs, Benefits, Equity and Sustainability of Water System Reforms in Hubli-Dharwad, India." *World Development* 109 (September): 121–33.

BWSSB (Bangalore Water Supply and Sewerage Board). 2011. "National Census 2011—Household Amenities Table 14." Bengaluru: BWSSB.

Cain, L.P., and E.J. Rotella. 2001. "Death and Spending: Urban Mortality and Municipal Expenditure on Sanitation." *Annales de Demographie Historique* 1 (101): 139–54.

Cairncross, S. 2018. "The Public Health Benefits of Urban Sanitation in Low and Middle Income Countries." *Utilities Policy* 51 (April): 82–88.

CfSC (Centre for Social Concern). 2012. "Growing Income and Nutritional Poverty: An Issue of Social Concern." Lilongwe, Malawi: CfSC.

Chandra, K.S., and G. Hegde. 2015. *Bangalore Water Resources Management—Challenges and Remedies.* Bengaluru: Institute for Natural Resources Conservation, Education, Research, and Training.

Chen, M.A., and V.A. Beard. 2018. "Including the Excluded: Supporting Informal Workers for More Equal and Productive Cities in the Global South." Working Paper. Washington, DC: World Resources Institute.

Cheng, D. 2013. "(In)Visible Urban Water Networks: The Politics of Non-payment in Manila's Low-Income Communities." *Environment and Urbanization* 25 (1): 249–60.

Chhabra, E. 2014. "Tech Startup Partners with Bangalore to Help Residents Get Water from the Tap." Next City, November 17. https://nextcity.org/daily/entry/nextdrop-water-sms-india-bangalore-partnership. Accessed October 15, 2018.

Chisari, O., A. Estache, and C. Waddams Price. 2001. "Access by the Poor in Latin America's Utility Reform." WIDER Discussion Paper 2001/75. Helsinki: World Institute for Development Economics Research, United Nations University.

CMM (Conselho Municipal de Maputo). 2010. "Perfil Estatístico do Município de Maputo." Maputo, Mozambique: CMM.

CODI (Community Organizations Development Institute). 2011. "Results: Statistics January 2011." http://www.codi.or.th/housing/results.html. Accessed June 10, 2018.

Cohen, D.A. 2012. "Bolivia's Water Fight." *Walrus*, July 25. https://thewalrus.ca/2008-10-online-exclusive-4/. Accessed April 16, 2019.

CoJ (City of Johannesburg). 2017. “CoJ Water Policy and Registering for the Expanded Social Package for Customers with Prepaid Water Meters.” https://www.johannesburgwater.co.za/coj-water-policy-and-registering-for-the-expanded-social-package-for-customers-with-prepaid-water-meters/. Accessed June 10, 2018.

CSE (Centre for Science and Environment). 2018. “Bengaluru Might Head the Cape Town Way, Says Assessment by *Down to Earth* Magazine,” March 28. https://www.cseindia.org/bengaluru-might-head-the-cape-town-way-says-assessment-by-down-to-earth-magazine-8574. Accessed June 15, 2018.

Cutler, D.M., and G. Miller. 2005. “The Role of Public Health Improvements in Health Advances: The Twentieth-Century United States.” *Demography* 42 (1): 1–22.

Dagdeviren, H. 2008. “Waiting for Miracles: The Commercialization of Urban Water Services in Zambia.” *Development and Change* 39 (1): 101–21.

Dagdeviren, H., and S.A. Robertson. 2011. “Access to Water in the Slums of Sub-Saharan Africa.” *Development Policy Review* 29 (4): 485–505.

Daily Nation. 2018. “Heavy Rains Flood Kenya’s Capital Nairobi.” https://www.nation.co.ke/news/Heavy-downpour-floods-streets-of-Nairobi/1056-4342344-vm69dz/index.html. Accessed June 15, 2018.

DCO (Directorate of Census Operations). 2011. *District Census Handbook: Mumbai*. Series 28. Mumbai: Census of India.

DCS (Department of Census and Statistics). 2010. “Census of Population and Housing 2011.” Government of Sri Lanka. http://www.statistics.gov.lk/PopHouSat/CPH2011/index.php. Accessed July 31, 2017.

DCS. 2016. Household Income Expenditure Survey 2016. Colombo, Sri Lanka: Department of Census and Statistics, Ministry of National Policies and Economic Affairs.

Donoso, G. 2017. “Urban Water Pricing in Chile: Cost Recovery, Affordability, and Water Conservation.” *Wiley Interdisciplinary Reviews: Water* 4 (2): 1–10.

DWASA (Dhaka Water Supply and Sewerage Authority). 2016. Annual-Report, 2015–16. Dhaka: DWASA.

EMCALI (Empresas Municipales de Cali). 2017. “Acueducto y Alcantarillado.” https://www.emcali.com.co/web/acueducto. Accessed June 12, 2017.

Ercumen, A., B.F. Arnold, E. Kumpel, Z. Burt, I. Ray, K. Nelson, and J.M. Colford Jr. 2015. “Upgrading a Piped Water Supply from Intermittent to Continuous Delivery and Association with Waterborne Illness: A Matched Cohort Study in Urban India.” *PLOS Medicine* 12 (10): e1001892.

Farolfia, S., and J. Gallego-Ayalab. 2014. “Domestic Water Access and Pricing in Urban Areas of Mozambique: Between Equity and Cost Recovery for the Provision of a Vital Resource.” *International Journal of Water Resources Development* 30 (4): 728–44.

Ferrie, J.P., and W. Troesken. 2008. “Water and Chicago’s Mortality Transition, 1850–1925.” *Explorations in Economic History* 45 (1): 1–16.

Finnegan, W. 2002. “Leasing the Rain.” *New Yorker*, March 31.

Foster, V., and C. Briceño-Garmendia, eds. 2010. Africa’s Infrastructure: A Time for Transformation. Washington, DC: World Bank.

Frauendorfer, R., and R. Liemberger. 2010. “The Issues and Challenges of Reducing Non-revenue Water.” Mandaluyong City, Philippines: Asian Development Bank.

Fuente, D., J. Gatua, M. Ikiara, J. Kabubo-Mariara, M. Mwaura, and D. Whittington. 2016. “Water and Sanitation Service Delivery, Pricing, and the Poor: An Empirical Estimate of Subsidy Incidence in Nairobi, Kenya.” *Water Resources Research* 52 (6): 4845–62.

Furlong, K. 2012. “Good Water Governance without Good Urban Governance? Regulation, Service Delivery Models, and Local Government.” *Environment and Planning A: Economy and Space* 44 (11): 2721–41.

Furlong, K. 2014. “STS Beyond the ‘Modern Infrastructure Ideal’: Extending Theory by Engaging with Infrastructure Challenges in the South.” *Technology in Society* 38 (August): 139–47.

Galaitsi, S.E., R. Russell, A. Bishara, J.L. Durant, J. Bogle, and A. Huber-Lee. 2016. “Intermittent Domestic Water Supply: A Critical Review and Analysis of Causal-Consequential Pathways.” *Water* 8 (7): 274.

Gandy, M. 2014. *The Fabric of Space: Water, Modernity, and the Urban Imagination*. Cambridge, MA: MIT Press.

Gómez-Lobo, A., and D. Contreras. 2003. “Water Subsidy Policies: A Comparison of the Chilean and Colombian Schemes.” *World Bank Economic Review* 17 (3): 391–407.

Government of Maharashtra. 2015. “Economic Survey of Maharashtra 2014–15.” Mumbai: Directorate of Economics and Statistics, Government of Maharashtra.

Government of Malawi. 2012. “Household Water Treatment and Safe Storage in Malawi: A Preliminary Consultative Study.” Lilongwe: Government of Malawi.

Graham, S., and S. Marvin. 2002. Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition. Abingdon, UK: Routledge.

Guerrero, T.A., K. Furlong, and J. Arias. 2015. “Complicating Neoliberalization and Decentralization: The Non-linear Experience of Colombian Water Supply, 1909–2012.” *International Journal of Water Resources Development* 32 (2): 172–88.

GWCL (Ghana Water Company Limited). 2018. “Public Utilities Regulatory Commission (PURC): Publication of Water Tariffs.” http://www.gwcl.com.gh/approved_tariffs.html. Accessed April 5, 2017.

GWI (Global Water Intelligence). 2016. *Global Water Intelligence.* December.

Hanif, M. 2018. “Let Them Drink Bottled Water.” *New York Times*, November 23. https://www.nytimes.com/2018/11/23/opinion/pakistan-water-contamination-bottled.html?smprod=nytcore-ipad&login=smartlock&auth=login-smartlock. Accessed February 15, 2019).

Herrera, V., and A.E. Post. 2014. “Can Developing Countries Both Decentralize and Depoliticize Urban Water Services? Evaluating the Legacy of the 1990s Reform Wave.” *World Development* 64 (December): 621–41.

Heymans, C., R. Eberhard, D. Ehrhardt, and S. Riley. 2016. *Providing Water to Poor People in African Cities Effectively: Lessons from Utility Reforms*. Water and Sanitation Program Report. Washington, DC: World Bank Group.

Hutton, G. 2012. “Monitoring ‘Affordability’ of Water and Sanitation Services after 2015: Review of Global Indicator Options.” Working Paper. Geneva: United Nations Office of the High Commissioner for Human Rights.

Hutton, G., and L. Haller. 2004. *Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level*. Geneva: World Health Organization.

Hutton, G., and M. Varughese. 2016. *Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene: Summary Report*. Washington, DC: World Bank.

IBGE (Instituto Brasileiro de Geografia e Estatística). 2009. *Final Report of the Household Census of the Rocinha Complex Rio de Janeiro—Dec/2009 PAC Rocinha*. Rio de Janeiro: IBGE.

IBGE. 2010a. (Database.) *Census 2010*. http://censo2010.ibge.gov.br/. Accessed September 15, 2017.

IBGE. 2010b. (Database.) *São Paulo*. https://cidades.ibge.gov.br/brasil/sp/sao-paulo/panorama. Accessed November 15, 2017.

IBGE. 2017. “Pesquisa Nacional por Amostra de Domicílios.” https://ww2.ibge.gov.br/home/estatistica/pesquisas/pesquisa_resultados.php?id_pesquisa=40. Accessed July 20, 2017.

ICDDR,B (International Centre for Diarrhoeal Disease Research, Bangladesh). 2015. *Baseline Population and Socio Economic Census*. Dhaka, Bangladesh: ICDDR,B.

ICDS (Integrated Child Development Services Scheme). 2016. *Siddarth Nagar Slum Survey*. Mumbai: ICDS.

INE (Instituto Nacional de Estadística) Bolivia. 2017. “Salarios, Remuneraciones y Empleo Sector Privado.” http://www.ine.gob.bo/index.php/mercado-laboral/introduccion-7. Accessed November 15, 2017.

INE Mozambique. 2015. *Relatório Final do Inquérito ao Orçamento Familiar—IOF 2014/15*. Maputo: INE Mozambique.

INE Venezuela. 2011a. “Censo 2011.” http://www.ine.gob.ve/index.php?option=com_content&view=category&id=95&Itemid=26. Accessed June 19, 2017.

INE Venezuela. 2011b. “Informe Geoambiental 2011 Distrito Capital.” http://www.ine.gob.ve/index.php?option=com_content&view=category&id=68&Itemid=49#. Accessed June 19, 2017.

Information Nigeria. 2013. “Lagosians in Highbrow Areas May Be Drinking Own Faeces—Investigation.” http://www.informationng.com/2013/11/lagosians-in-highbrow-areas-may-be-drinking-own-faeces-investigation.html. Accessed March 15, 2018.

Ismail, Z., and W.F.W.A. Puad. 2007. “Non-revenue Water Losses: A Case Study.” *Asian Journal of Water, Environment and Pollution* 4 (2): 113–17.

ITN-BUET (International Training Network–Bangladesh University of Engineering and Technology). 2015. “WASH (Water, Sanitation and Hygiene) Challenges in Slum Areas of Bangladesh.” Dhaka, Bangladesh: Oxfam.

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.

Kaminsky, J., and E. Kumpel. 2018. “Dry Pipes: Associations between Utility Performance and Intermittent Piped Water Supply in Low and Middle Income Countries.” *Water* 10 (8): 1032.

Karunananthan, M. 2019. “Can the Human Right to Water Disrupt Neoliberal Water Policies in the Era of Corporate Policy-Making?” *Geoforum* 98 (January): 244–53.

Ketzenbaum, L., and J.-L. Rosenthal. 2014. “Income versus Sanitation: Mortality Decline in Paris, 1880–1914.” Working Paper. Paris: Paris School of Economics.

Kimmelman, M. 2017a. “Jakarta Is Sinking So Fast, It Could End Up Underwater.” *New York Times*, December 21. https://www.nytimes.com/interactive/2017/12/21/world/asia/jakarta-sinking-climate.html. Accessed May 15, 2018.

Kimmelman, M. 2017b. “Mexico City, Parched and Sinking, Faces a Water Crisis.” *New York Times*, February 17. https://www.nytimes.com/interactive/2017/02/17/world/americas/mexico-city-sinking.html?_r=0. Accessed April 6, 2018.

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.

Kingdom, B., R. Liemberger, and P. Marin. 2006. “The Challenge of Reducing Non-revenue Water in Developing Countries—How the Private Sector Can Help: A Look at Performance-Based Service Contracting.” World Bank Water Supply and Sanitation Sector Board Discussion Paper 8. Washington, DC: World Bank Group.

Kishimoto, S., E. Lobina, and O. Petitjean, eds. 2015. *Our Public Water Future: The Experience with Remunicipalisation*. Amsterdam: Transnational Institute; London: Public Services International Research Unit; Paris: Multinationals Observatory; Cape Town: Municipal Services Project; Brussels: European Federation of Public Service Unions.

Klingel, P. 2012. “Technical Causes and Impacts of Intermittent Water Distribution.” *Water Science and Technology: Water Supply* 12 (4): 504–12.

Knutsson, D. 2016. “The Effect of Introducing Clean Piped Water on Mortality in Stockholm: 1850–1872.” Stockholm: Stockholm University.

Koppaka, R. 2011. “Ten Great Public Health Achievements: Worldwide, 2001–2010.” *Morbidity and Mortality Weekly Report* 60 (24): 814–18.

Kumar, T., A.E. Post, and I. Ray. 2018. “Flows, Leaks and Blockages in Informational Interventions: A Field Experimental Study of Bangalore’s Water Sector.” *World Development* 106 (June): 149–60.

Kumpel, E., and K.L. Nelson. 2013. “Comparing Microbial Water Quality in an Intermittent and Continuous Piped Water Supply.” *Water Research* 47 (14): 5176–88.

Kumpel, E., and K.L. Nelson. 2016. “Intermittent Water Supply: Prevalence, Practice, and Microbial Water Quality.” *Environmental Science & Technology* 50 (2): 542–53.

Kumpel, E., C. Woelfle-Erskine, I. Ray, and K.L. Nelson. 2017. “Measuring Household Consumption and Waste in Unmetered, Intermittent Piped Water Systems: Water Use in Intermittent Piped Systems.” *Water Resources Research* 53 (1): 302–15.

Langford, M., and A.F. Russell, eds. 2017. *The Human Right to Water: Theory, Practice and Prospects*. Cambridge, UK: Cambridge University Press.

Lawhon, M., D. Nilsson, J. Silver, H. Ernstson, and S. Lwasa. 2018. “Thinking Through Heterogeneous Infrastructure Configurations.” *Urban Studies* 55 (4): 720–32.

LBS (Lagos Bureau of Statistics). 2013. *Household Survey 2013: Main Report*. Lagos: LBS, Ministry of Economic Planning and Budget, Lagos State Government.

LBS. 2016. *Household Survey*. Lagos: LBS, Ministry of Economic Planning and Budget, Lagos State Government.

Lilford, R.J., O. Oyebode, D. Satterthwaite, G.J. Melendez-Torres, Y.-F. Chen, B. Mberu, S.I. Watson, et al. 2016. “Improving the Health and Welfare of People Who Live in Slums.” *Lancet* 389 (10068): 559–80.

LWC (Lagos Water Corporation). 2014. *Lagos State Water Regulatory Commission 2014 Annual Report*. Lagos: LWC.

Mack, E.A., and S. Wrase. 2017. “A Burgeoning Crisis? A Nationwide Assessment of the Geography of Water Affordability in the United States.” *PLOS ONE* 12 (1): e0176645.

Mail & Guardian (Johannesburg). 2009. “Court Rules Prepaid Water Meters Not Illegal.” October 8. https://mg.co.za/article/2009-10-08-court-rules-prepaid-water-meters-not-illegal. Accessed June 10, 2018.

MajiData. 2017. (Database.) *Water and Sanitation Data Portal*. http://majidata.go.ke/public-portal/. Accessed July 1, 2017.

Majuru, B., M. Suhrcke, and P.R. Hunter. 2016. “How Do Households Respond to Unreliable Water Supplies? A Systematic Review.” *International Journal of Environmental Research and Public Health* 13 (12): 1222.

Makwara, E.C. 2011. “Water: An Economic or Social Good?” *Journal of Social Development in Africa* 26 (2): 141.

Maramkal, M. 2017. “South India’s Drought Part 5: As Karnataka Reels under Severe Water Crisis, Residents Brace Unofficial Rationing.” Firstpost, May 2. https://www.firstpost.com/india/south-indias-drought-part-5-as-karnataka-reels-under-severe-water-crisis-residents-brace-unofficial-rationing-3405698.html. Accessed June 15, 2018.

Marson, M., and I. Savin. 2015. “Ensuring Sustainable Access to Drinking Water in Sub Saharan Africa: Conflict between Financial and Social Objectives.” *World Development* 76 (December): 26–39.

Mbogo, M. 2018. “Water Rationing in Nairobi, Kenya to Continue until 2026.” *Construction Review* Online, May 3. https://constructionreviewonline.com/2018/02/water-rationing-nairobi-kenya-continue-till-2026/. Accessed June 15, 2018.

MCC (Mzuzu City Council). 2010. *Socio-economic Profile*. Mzuzu, Malawi: MCC.

MCC. 2017. *Environmental Quarterly Health Data Report*. Administrative records. Mzuzu, Malawi: MCC.

McDonald, D.A., ed. 2014. *Rethinking Corporatization and Public Services in the Global South*: London: Zed.

McGranahan, G., C. Njiru, M. Albu, M. Smith, and D. Mitlin. 2006. *How Small Water Enterprises (SWEs) Can Contribute to the Millennium Development Goals: Evidence from Accra, Dar es Salaam, Khartoum and Nairobi.* Loughborough, UK: Water, Engineering and Development Centre, Loughborough University.

Mcloughlin, C., and D. Harris. 2013. *The Politics of Progress on Water and Sanitation in Colombo, Sri Lanka.* London: Overseas Development Institute.

Mitlin, D., and S. Bartlett. 2018. “Editorial: Co-production—Key Ideas.” *Environment and Urbanization* 3 (2): 1–12.

Mitlin, D., and A. Walnycki. 2016. “Why Is Water Still Unaffordable for Sub-Saharan Africa’s Urban Poor?” *IIED [International Institute for Environment and Development] Briefing,* March.

MoH (Ministry of Health) Uganda. 2016. “National Population and Housing Census Final Report 2014.” Kampala: Ministry of Health Uganda.

MoHCDGEC (Ministry of Health, Community Development, Gender, Elderly and Children), MoH (Ministry of Health), NBS (National Bureau of Statistics), OCGS (Office of the Chief Government Statistician), and ICF International. 2016. Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) 2015–16. Dar es Salaam, Tanzania: MoHCDGEC, NBS; Zanzibar: MoH, OCGS; and Rockville, MD: ICF International.

Mohd, R., and I. Malik. 2017. “Sanitation and Hygiene Knowledge, Attitude and Practices in Urban Setting of Bangalore: A Cross-Sectional Study.” *Journal of Community Medicine & Health Education* 7 (4): 540.

MoPPUD (Ministry of Physical Planning and Urban Development). 2013. Mainland Central Model City Plan 2032: Planning Strategy. Lagos: Lagos State Government.

Muller, A., and D. Mitlin. 2004. “Windhoek, Namibia—towards Progressive Urban Land Policies in Southern Africa.” *International Development Planning Review* 26 (2): 167–86.

Municipality of Santiago de Cali. 2015. “Cali en Cifras (2015 Acrhive).” http://www.cali.gov.co/publicaciones/107143/cali_en_cifras_planeacion/. Accessed November 15, 2017.

Municipality of Santiago de Cali. 2017. (Database.) Libro Cali en Cifras—Capitulos. http://www.cali.gov.co/planeacion/publicaciones/137802/cali-en-cifras/. Accessed June 12, 2017.

Municipality of Santiago de Cali. 2018. http://www.cali.gov.co/dagma/. Accessed June 12, 2017.

Musgrave, R.A. 1969. “Provision for Social Goods.” Edited by J. Margolis and H. Guitton, Public Economics: An Analysis of Public Production and Consumption and Their Relations to the Private Sector: Proceedings of a Conference Held by the International Economic Association. London: Macmillan.

Nagaraj, A. 2018. “As Groundwater Runs Short, Water Battles Grow in Parched Chennai.” Place, November 8. http://www.thisisplace.org/i/?id=bf206690-7b5a-4d74-b8ad-f4b832a46d48&utm_source=Newsletter&utm_medium=Email&utm_campaign=Place. Accessed February 10, 2019.

Naidoo, Y. 2009. “Cape Residents, Unions Slam City Water Device.” West Cape News, June 21. http://westcapenews.com/?p=892. Accessed June 10, 2018.

Nauges, C., and D. Whittington. 2017. “Evaluating the Performance of Alternative Municipal Water Tariff Designs: Quantifying the Tradeoffs between Equity, Economic Efficiency, and Cost Recovery.” *World Development* 91 (March): 125–43.

NCAER (National Council of Applied Economic Research). 2008. “The Next Urban Frontier: Twenty Cities to Watch.” New Delhi: NCAER.

NCWSC (Nairobi City Water and Sewerage Company). 2017a. “Draft Nairobi Water Distribution Master Plan Report.” Nairobi: NCWSC.

NCWSC. 2017b. “Water Tariffs.” https://www.nairobiwater.co.ke/index.php/en/watertariffs. Accessed June 30, 2017.

Nganyanyuka, K., J. Martinez, A. Wesselink, J.H. Lungo, and Y. Georgiadou. 2014. “Accessing Water Services in Dar es Salaam: Are We Counting What Counts?” *Habitat International* 44 (October): 358–66.

Nilsson, D. 2016. “The Unseeing State: How Ideals of Modernity Have Undermined Innovation in Africa’s Urban Water Systems.” *NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin* 24 (4): 481–510.

Njagi, K. 2018. “Nairobi Looks for New Water to Ease Its Growing Thirst.” Reuters, June 12. https://www.reuters.com/article/us-kenya-water-climatechange/nairobi-looks-for-new-water-to-ease-its-growing-thirst-idUSKBN1J8269. Accessed June 15, 2018.

Nleya, N. 2008. “Development Policy and Water Services in South Africa: An Urban Policy Perspective.” *Development Southern Africa* 25 (3): 269–81.

NPC (National Population Commission) and ICF International. 2014. Nigeria Demographic and Health Survey 2013. Abuja, Nigeria: NPC; and Rockville, MD: ICF International.

NRWB (Northern Region Water Board). 2017. “Daily and Monthly Reports.” Administrative records. Mzuzu, Malawi: NRWB.

NWSC (National Water and Sewerage Corporation). 2015. Corporate Plan July 2015–June 2018. Kampala, Uganda: NWSC.

NWSDB (National Water Supply & Drainage Board). 2011. *Annual Report 2011*. Colombo, Sri Lanka: NWSDB.

OECD (Organisation for Economic Co-operation). 2013. “Principles for the Governance of Regulators.” Paris: OECD.

OECD. n.d. “OECD Principles on Water Governance.” www.oecd.org/governance/oecd-principles-on-water-governance.htm. Accessed March 15, 2019.

Ogasawara, K., and T. Inoue. 2015. “Public Health Improvements and Mortality in Early Twentieth-Century Japan.” Tokyo: Tokyo Institute of Technology.

OHCHR (Office of the United Nations High Commissioner for Human Rights), UN-Habitat (United Nations Human Settlement Programme), and WHO (World Health Organization). 2010. "The Right to Water." Fact Sheet 35. Geneva: OHCHR.

Oxford Economics. 2016. Oxford Economics Database. http://www.oxfordeconomics.com/. Accessed February 15, 2017.

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.

Pattanayak, S.K., J.C. Yang, D. Whittington, and K.C. Bal Kumar. 2005. “Coping with Unreliable Public Water Supplies: Averting Expenditures by Households in Kathmandu, Nepal.” *Water Resources Research* 41 (2): W02012.

PDG (Palmer Development Group). 2007. “Free Basic Water.” Directorate: Policy and Strategy. Cape Town: Department of Water Affairs and Forestry.

Pestova, N. 2016. “The Human Right to Water in the City Context: Insights from Domestic Litigation.” In *Global Urban Justice*, edited by B. Oomen, M.F. Davis, and M. Grigolo, 157–59. Cambridge, UK: Cambridge University Press.

Petersen, T. 2017. “City’s Devices Restrict Water to 350L.” *Weekend Argus*, October 8. https://www.iol.co.za/weekend-argus/citys-devices-restrict-water-to-350l-11517940. Accessed June 10, 2018.

PPRC (Power and Participation Research Center). 2016. Middle Income Aspirations: Realities and Challenges, an Empirical Study. Dhaka, Bangladesh: PPRC.

PPRC and UNDP (United Nations Development Programme). 2015. Governance and Economic Survey. Dhaka, Bangladesh: PPRC and UNDP.

Prefeitura Municipal de São Paulo. 2017a. (Database.) GeoSampa: Mapa Digital da Cidade de São Paulo. http://geosampa.prefeitura.sp.gov.br/PaginasPublicas/_SBC.aspx#. Accessed June 30, 2017.

Prefeitura Municipal de São Paulo. 2017b. (Database.) HabitaSampa Mapa. http://mapa.habitasampa.inf.br/. Accessed June 30, 2017.

Rahman, P. 2008. “Water Supply in Karachi: Situation/Issues, Priority Issues and Solutions.” Karachi, Pakistan: Orangi Pilot Project-Research and Training Institute.

Ranganathan, M. 2014. “Paying for Pipes, Claiming Citizenship: Political Agency and Water Reforms at the Urban Periphery.” *International Journal of Urban and Regional Research* 38 (2): 590–608.

Rocha-Melogno, L., R. Yoo, O. Broesicke, A. Kallergis, J. Garcia, E. Herbas, A. Torrez-Daza, et al. 2018. “Rapid Drinking Water Safety Estimation in Cities: Piloting a Globally Scalable Method in Cochabamba, Bolivia.” *Science of the Total Environment* 654 (March): 1132–45.

Romero, S. 2015. “Taps Start to Run Dry in Brazil’s Largest City.” *New York Times*, February 16. https://www.nytimes.com/2015/02/17/world/americas/drought-pushes-sao-paulo-brazil-toward-water-crisis.html. Accessed June 15, 2018.

Rouse, M.J. 2013. *Institutional Governance and Regulation of Water Services: The Essential Elements*. 2nd ed. London: IWA.

Roy, A. 2005. “Urban Informality: Toward an Epistemology of Planning.” *Journal of the American Planning Association* 71 (2): 147–58.

Roy, A., and N. AlSayyad, eds. 2004. *Urban Informality: Transnational Perspectives from the Middle East, Latin America, and South Asia*. Lanham, MD: Lexington.

Rugemalila, R., and L. Gibbs. 2015. “Urban Water Governance Failure and Local Strategies for Overcoming Water Shortages in Dar es Salaam, Tanzania.” *Environment and Planning C: Politics and Space* 33 (2): 412–27.

Sabesp. 2018. “Água.” http://site.sabesp.com.br/site/interna/subHome.aspx?secaoId=30. Accessed June 21, 2017.

Sarni, W., C. White, R. Webb, K. Cross, and R. Glotzbach. 2019. "Digital Water: Industry Leaders Chart the Transformation Journey." International Water Association and Xylem Inc.

Satterthwaite, D. 2011. *Engaging with the Urban Poor and Their Organizations for Poverty Reduction and Urban Governance*. New York: United Nations Development Programme.

Satterthwaite, D. 2016a. “Missing the Millennium Development Goal Targets for Water and Sanitation in Urban Areas.” *Environment and Urbanization* 28 (1): 99–118.

Satterthwaite, D. 2016b. “A New Urban Agenda?” *Environment and Urbanization* 28 (1): 3–12.

SDI (Shack/Slum Dwellers International). 2016. Annual Report, 2016. Cape Town: SDI.

Shand, W. 2018. “Making Spaces for Co-production: Collaborative Action for Settlement Upgrading in Harare, Zimbabwe.” *Environment and Urbanization* 30 (2): 519–36.

Silver, J. 2015. “Disrupted Infrastructures: An Urban Political Ecology of Interrupted Electricity in Accra.” *International Journal of Urban and Regional Research* 39 (5): 984–1003.

SNIS (Sistema Nacional de Informações sobre Saneamento). 2006. Água e Esgoto. São Paulo: Ministério das Cidades, Secretaria Nacional de Saneamento Ambiental.

SNIS. 2017. “Coleta de Dados SNIS—Água e Esgotos.” http://www.snis.gov.br/coleta-de-dados-snis-agua-e-esgotos. Accessed June 20, 2017.

Sparkman, D., and G. Sturzenegger. 2016. Water and Sanitation Markets in Latin America and the Caribbean. Washington, DC: Inter-American Development Bank.

Spiller, P.T., and W.D. Savedoff. 1999. “Government Opportunism and the Provision of Water.” In *Spilled Water: An Institutional Commitment to the Provision of Water Services*, edited by P.T. Spiller and W.D. Savedoff, 1–34. Washington, DC: Inter-American Development Bank.

Stockman, L.J., T.K. Fischer, M. Deming, B. Ngwira, C. Bowie, N. Cunliffe, J. Bresee, and R.E. Quick. 2007. “Point-of-Use Water Treatment and Use among Mothers in Malawi.” *Emerging Infectious Diseases* 13 (7): 1077–80.

Subbaraman, R., L. Nolan, K. Sawant, S. Shitole, T. Shitole, M. Nanarkar, A. Patil-Deshmukh, and D.E. Bloom. 2015. “Multidimensional Measurement of Household Water Poverty in a Mumbai Slum: Looking beyond Water Quality.” *PLOS ONE* 10 (7): e0133241.

Swyngedouw, E. 2004. *Social Power and the Urbanization of Water: Flows of Power*. New York: Oxford University Press.

Taylor, D.D., A.H. Slocum, and A.J. Whittle. 2018. “Analytical Scaling Relations to Evaluate Leakage and Intrusion in Intermittent Water Supply Systems.” *PLOS ONE* 13 (5): e0196887.

Thompson, J., I.T. Porras, E. Wood, J.K. Tumwine, M.R. Mujwahuzi, M. Katui-Katua, and N. Johnstone. 2000. “Waiting at the Tap: Changes in Urban Water Use in East Africa over Three Decades.” *Environment and Urbanization* 12 (2): 37–52.

UN (United Nations). 1991. *The Dublin Statement on Water and Sustainable Development*. Dublin: United Nations.

UN. 2014. *World Urbanization Prospects: The 2014 Revision*. New York: United Nations.

UN and WSSCC (Water Supply and Sanitation Collaborative Council). n.d. *The Human Right to Water and Sanitation*. Geneva: United Nations and Water Supply and Sanitation Collaborative Council.

UN DESA (United Nations Department of Economic and Social Affairs). 2017. “Sustainable Development Goal 6.” https://sustainabledevelopment.un.org/sdg6. Accessed May 15, 2018.

UN-Habitat (United Nations Human Settlement Programme). 2003. *Water and Sanitation in the World’s Cities: Local Action for Global Goals*. London: Earthscan.

UNHRC (United Nations Human Rights Council). 2015. *Report of the Special Rapporteur on the Human Right to Safe Drinking Water and Sanitation*. Geneva: UNHRC.

URAC (Urban Research & Advocacy Centre). 2017. *Neighbourhood 4 (Ching’ambo) Enumeration Study Report*. Mzuzu, Malawi: URAC.

Valdés Fernandez, F.P. 2007. *Case Study: System of Households’ Water Use Subsidies in Chile*. Stockholm: Global Water Partnership.

Van den Berg, C., and A. Danilenko. 2010. *The IBNET Water Supply and Sanitation Performance Blue Book: The International Benchmarking Network for Water and Sanitation Utilities Databook*. Washington, DC: World Bank.

Venkatesh, S., S. Goswami, and S. Sengupta. 2018. “Last Few Drops.” *Down to Earth*, March.

Wakode, H.B., K. Baier, R. Jha, and R. Azzam. 2018. “Impact of Urbanization on Groundwater Recharge and Urban Water Balance for the City of Hyderabad, India.” *International Soil and Water Conservation Research* 6 (1): 51–62.

Walnycki, A. 2015. “Rights on the Edge of the City: The Right to Water and the Peri-urban Water Committees of Cochabamba.” Working Paper. London: International Institute for Environment and Development.

Walton, B. 2017. “SDG Report: Billions Lack Safe Drinking Water and Sanitation at Home.” Circle of Blue, July 12. https://www.circleofblue.org/2017/water-quality/sdg-report-billions-lack-safe-drinking-water-sanitation-home/. Accessed August 15, 2018.

WASREB (Water Services Regulatory Board). 2016. *Impact: A Performance Review of Kenya’s Water Services Sector, 2014–2015*. Issue 9. Nairobi: WASREB.

WaterAid. n.d. *WaterAid Bangladesh Contribution to Submission on Urbanisation and Water*. Bangladesh: WaterAid.

Watts, J. 2014. “Brazil Drought Crisis Leads to Rationing and Tensions.” *Guardian* (Manchester, UK), September 4. https://www.theguardian.com/weather/2014/sep/05/brazil-drought-crisis-rationing. Accessed June 15, 2018.

Weizsäcker, V., E. Ulrich, O.R. Young, M. Finger, and M. Beisheim. 2005. *Limits to Privatization: How to Avoid Too Much of a Good Thing*. A Report to the Club of Rome. London: Earthscan.

Werchota, R., and D. Nordmann. 2015. *Using the Water Kiosk to Increase Access to Water for the Urban Poor in Kenya*. Bonn, Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit.

Weru, J., P. Njoroge, M. Wambui, R. Wanjiku, J. Mwelu, A. Chepchumba, E. Otibine, O. Okoyo, and T. Wakesho. 2017. “The Akiba Mashinani Trust, Kenya: Role of a Local Fund in Urban Development.” Working Paper. London: International Institute for Enviornment and Development.

WHO (World Health Organization). 2012. *Global Costs and Benefits of Drinking-Water Supply and Sanitation Interventions to Reach the MDG Target and Universal Coverage*. Geneva: WHO.

WHO. 2017. *Safely Managed Drinking Water—Thematic Report on Drinking Water 2017*. Geneva: WHO.

WHO and UNICEF (United Nations Children’s Fund). 2000. *Global Water Supply and Sanitation Assessment 2000 Report*. Geneva: WHO; New York: UNICEF.

WHO and UNICEF. 2006. *Core Questions on Drinking-Water and Sanitation for Household Surveys*. Geneva: WHO; New York: UNICEF.

WHO and UNICEF. 2015. *Progress of Sanitation and Drinking Water: 2015 Update and MDG Assessment*. Geneva: WHO; New York: UNICEF.

WHO and UNICEF. 2017. *Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines*. Geneva: WHO; New York: UNICEF.

WHO and WEDC (Water, Engineering and Development Centre). 2013. “How Much Water Is Needed in Emergencies.” Technical Notes on Drinking-Water, Sanitation and Hygiene in Emergencies. Geneva: WHO.

Woodhouse, P., and M. Muller. 2017. “Water Governance—an Historical Perspective on Current Debates.” *World Development* 92 (April): 225–41.

World Bank. 2009. *Setting Up Pro-poor Units to Improve Service Delivery: Lessons from Water Utilities in Kenya, Tanzania, Uganda and Zambia*. Water and Sanitation Program Field Note. Washington, DC: World Bank.

World Bank. 2014. *Running Water in India’s Cities: A Review of Five Recent Public-Private Partnership Initiatives Creating Sustainable Services through Domestic Private Sector Participation*. Washington, DC: World Bank.

World Bank. 2016. “Kenya Urbanization Review: Nairobi Statistical Abstract.” Nairobi: The World Bank.

World Bank. 2017a. *Private Participation in Infrastructure Database*. http://ppi.worldbank.org/snapshots/region/latin-america-and-the-caribbean. Accessed April 5, 2017.

World Bank. 2017b. “Sanitation and Water for All: How Can the Financing Gap Be Filled?” Country Preparatory Process Discussion Paper. Washington, DC: World Bank.

World Bank. 2017c. “A Thirst for Change: The World Bank Group’s Support for Water Supply and Sanitation, with Focus on the Poor.” Washington, DC: World Bank.

World Resources Institute. 2018. "WRI Ross Center for Sustainable Cities' Water and Sanitation 15-City Study (Database)." Available online at www.citiesforall.org.

WSUP (Water & Sanitation for the Urban Poor). 2016a. *Dhaka Survey—Kallyanpur*. London: WSUP.

WSUP. 2016b. *Relatório de Água e Saneamento Dos 11 Bairros do Distrito de Nhalhamankulu Pelos Líderes Locais—Ii Levantamento*. Maputo, Mozambique: WSUP.

WSUP. 2017. “Balancing Financial Viability and User Affordability: An Assessment of Six WASH Service Delivery Models.” Topic Brief. London: WSUP.

WWAP (United Nations World Water Assessment Programme). 2016. *The United Nations World Water Development Report 2016: Water and Jobs*. Paris: United Nations Educational, Scientific and Cultural Organization.

WWAP. 2019. *The United Nations World Water Development Report 2019: Leaving No One Behind*. Paris: United Nations Educational, Scientific and Cultural Organization.

WWAP/UN-Water (United Nations Water). 2018. *The United Nations World Water Development Report 2018: Nature-Based Solutions for Water*. Paris: United Nations Educational, Scientific and Cultural Organization.

Zerah, M.H. 1998. “How to Assess the Quality Dimension of Urban Infrastructure: The Case of Water Supply in Delhi.” *Cities* 15 (4): 285–90.

Zuin, V., M. Nicholson, and J. Davis. 2013. *Water Access, Poverty, and Policy Changes in Peri-urban Maputo*. Maputo, Mozambique: Water Regulatory Council of the Government of Mozambique, Water and Sanitation for the Urban Poor, and World Bank.

ACKNOWLEDGMENTS

We are grateful to Ani Dasgupta, Anjali Mahendra, and Robin King for providing comments on multiple drafts of the paper. We thank the internal and external reviewers who strengthen our work. Internal reviewers were Samrat Basak, Adriana Lobo, and Vijay Jagannathan. We are particularly thankful to Vijay Jagannathan for his insights on finance and regulation. External reviewers were Graham Alabaster, Robert Bain, Chris Buckley, Neil Jeffery, Rubbina Karruna, Susan Murcott, and Dale Whittington.

We are deeply grateful to the 16 local researchers who collected the data that became the empirical basis for the paper. These researchers include Ibidun Adelekan, Afnan Agramont Akiyama, Noman Ahmed, Md Akhtaruzzamen, Carlos Aponte, Shriya Bhatia, Radha Chanchani, Tomaz Kipnis, Shuaib Lwasa, Gustavo Machado, Mtafu Manda, Baraka Mwau, Lina Maria Olaya Ortiz, Christina Semasinghe, Clara dos Santos Dimene, and Sachin Tiwale.

We thank the participants from the WRI Urban Water and Sanitation Workshop in July 2017: Ibidun Adelekan, Afnan Agramont Akiyama, Graham Alabaster, Vittal Boggaram, Chris Buckley, Arif Hasan, Vijay Jagannathan, Neil Jeffery, Marion Jenkins, Ranjiv Khush, Pawan Labhasetwar, Shuaib Lwasa, Brenda Medeiros, Gabriela Morales, Baraka Mwau, Duncan Thomas, Kala Vairavamoorthy, and Michael Westphal.

We also thank participants from the WRI Urban Water Quality Workshop: Shlomo Angel, Robert Bain, Joe Brown, Seth Frisbie, Pritha Goplan, Achilles Kallergis, Daniele Lantagne, Thomas Mahin, Erika Mitchell, Susan Murcott, K.J. Nath, Kara Nelson, Betsy Otto, and Rachel Peletz.

We are grateful to Lael Giebel, Emily Matthews, and Lauri Scherer for their editorial support. We are thankful to Zezhou Cai and Khyati Rathore for help with research assistance and data management, respectively. Valeria Gelman, Blake Hyde, and Adna Karabegovic kept the work moving forward. We thank our communications team, including Tini Tran, Craig Brownstein, Schuyler Null, and Talia Rubnitz, who helped with messaging and outreach, as well as Romain Warnault and Carni Klirs for their work on the graphics and layout.

We express our sincere gratitude to the UK Department for International Development (DFID) for funding this work and acknowledge the support of our institutional strategic partners who provide core funding to WRI: the Netherlands Ministry of Foreign Affairs, the Royal Danish Ministry of Foreign Affairs, and the Swedish International Development Cooperation.

ABOUT THIS WORLD RESOURCES REPORT

This is the seventh thematic paper in a series of working papers that comprise the World Resources Report (WRR), *Towards a More Equal City*. It will be followed by one more working paper on access to sanitation. To obtain an electronic copy of this paper, and/or other working papers, and to view supporting materials, please visit www.citiesforall.org.

FUNDERS

We deeply appreciate the following donors for their generous financial support:

United Kingdom Department for International Development
Stephen M. Ross Philanthropies
Denmark Ministry of Foreign Affairs
Ireland Department of Foreign Affairs and Trade
Netherlands Ministry of Foreign Affairs
Swedish International Development Cooperation Agency
United Nations Development Programme

ABOUT THE AUTHORS

Diana Mitlin is Professor of Global Urbanism at the Global Development Institute at the University of Manchester and Principal Researcher at the International Institute for Environment and Development. Her research focuses on understanding and reducing urban poverty, informal settlement upgrading, low-income housing, social movements, and civil society.

Victoria A. Beard is a Fellow in the WRI Ross Center for Sustainable Cities and a Professor in the Department of City and Regional Planning at Cornell University. Her research focuses on how planners and local people address urban inequality and poverty, access to core urban services, and the broader processes that create and sustain citywide transformation.

David Satterthwaite is a Senior Fellow at the International Institute for Environment and Development and a Visiting Professor at the Development Planning Unit, University College London. He is Editor of the international journal *Environment and Urbanization*. Most of his work has been on poverty and risk reduction in urban areas in Africa, Asia, and Latin America.

Jillian Du is a Research Analyst at the WRI Ross Center for Sustainable Cities. Her analytical work focuses on access to urban services, building urban climate resilience, and inclusive climate action.

ABOUT WORLD RESOURCES INSTITUTE

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of governments, businesses, and communities combine to eliminate poverty and sustain the natural environment for all people.

ABOUT WRI ROSS CENTER FOR SUSTAINABLE CITIES

WRI Ross Center for Sustainable Cities works to make urban sustainability a reality. Global research and on-the-ground experience in Brazil, China, India, Mexico, Turkey, and the United States combine to spur action that improves life for millions of people.

Based on long-standing global and local experience in urban planning and mobility, WRI Sustainable Cities uses proven solutions and action-oriented tools to increase building and energy efficiency, manage water risk, encourage effective governance, and make the fast-growing urban environment more resilient to new challenges.

Aiming to influence 200 cities with unique research and tools, WRI Sustainable Cities focuses on a deep cross-sector approach in four megacities on two continents, and targeted assistance to 30 more urban areas, bringing economic, environmental, and social benefits to people in cities around the globe.