

The missing link in climate adaptation

How improved access to water and sanitation is helping cities adapt to climate change

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Cover image: Coping with water scarcity in Nakuru, Kenya. **Credit:** Brian Otieno

Introduction

Flash floods in China and the United Kingdom, fires in the USA, Greece and Turkey; 2021 is perhaps the year that climate change became real to millions in the world's richest nations.

But for those living in poorer countries, in sub-Saharan Africa and south Asia, climate change has been the reality for many years. Climate change is not a threat of the future – it is happening right now.

And for the poorest living in urban areas, one of the most significant ways in which climate change is affecting their lives is through access to water and sanitation.

Most cities in sub-Saharan Africa and south Asia already struggle to provide equitable access to clean water and safe sanitation. Rapid population growth has far outstripped the ability of urban authorities to provide services.

Equitable access to clean drinking water and a well-functioning sanitation system are critical components of a resilient city. Cities which lack universal access to these basic human rights see



Image: Intensive rainfall causes flooding in a low-income community in Chattogram, Bangladesh

impacts on social stability, health, livelihoods and a range of other issues.

Compared with other areas, cities have important advantages when it comes to dealing with the impacts of climate change (Urban Climate Change Research Network, 2018) due to the

Six ways in which climate change is affecting water and sanitation in cities



Reduced rainfall: less rainfall means less water for households. The poorest in cities, already dependent on intermittent services, are most affected by water shortages.



More intense rainfall: increasingly heavy rain results in flooding, damaging water and sanitation facilities and spreading untreated sanitation waste in communities.



Rising sea levels: in many coastal cities, the poorest live on land that is at risk from flooding; in addition, coastal aquifers are at risk from saline intrusion.



Extreme weather events: increased frequency of cyclones and tropical storms causes damage for fragile WASH infrastructure.



Rising temperatures: warmer temperatures lead to increased demand for drinking water, with the poorest city residents particularly at risk due to the phenomenon of urban heat islands.



Internal displacement: climate change is driving more people from rural areas to cities. Many end up in informal settlements, increasing demand for water and sanitation services.

concentration of power in these locations, the way in which city leaders are accountable to their constituents, and the dynamic, adaptive nature of cities.

And yet, accelerating climate change is worsening access to water and sanitation. Poor communities are suffering from water shortages arising from frequent droughts; harsh storms are damaging water and sanitation facilities; and heavy rainfall and sea level rise is causing raw sewage to spread across communities.

Water and sanitation service providers are struggling to respond to the needs of communities, and climate change is making it harder for these providers to expand services to keep pace with urbanisation. This challenge represents a major threat towards the ability of cities to adapt to climate change and could compromise their future sustainability.

This report, *The missing link in climate adaptation*, analyses the impacts of climate change on access to water and sanitation across cities and towns in seven countries. It outlines the challenges that service providers are facing and documents initiatives that are taking place to tackle the issue. Based on this analysis, WSUP presents four recommendations for helping water and sanitation providers to tackle the threat caused by climate change.

Making the link between climate adaptation and water and sanitation services

In recent years, as climate adaptation efforts in sub-Saharan Africa and south Asia have accelerated, the ability of low-income communities to access water and sanitation has not formed part of the discussion.

Climate change is bringing a wealth of challenges to cities, such as heat rise, increased migration, flooding and impacts from extreme weather. Adapting to these changes is becoming a key priority for city leaders.

Working with nature

As climate change wreaks havoc in densely populated urban communities, we urgently need to look at new approaches to protecting the poorest.

Finding ways to accommodate rapid urbanisation within the natural ecosystem is vital. Unmanaged abstraction of groundwater is a frequent occurrence in many cities. In Dhaka, Bangladesh, 97% of the human waste produced by its 16 million inhabitants flows straight into the waterways that surround them.

WSUP advocates for city authorities to focus on making the best use of their existing water resources, rather than continually searching for new water sources. Reducing water leaks, improving water pressure, dismantling illegal connections and installing more customer meters can dramatically improve the efficiency of a network, so that more customers receive more water – without necessarily consuming more water.

In addition, water service providers need to recognise the environmental consequences of poor sanitation. Unmanaged sanitation results in contamination of water supplies and even food crops, which has an impact back on people's health, meaning that cities cannot fulfil their goals of supplying clean water to all residents without addressing their sanitation challenges.

Specific interventions which can improve people's access to clean water and sanitation, and protect nature, include:

- Using rainwater harvesting to source water for sanitation facilities
- Using managed aquifer recharge techniques to top-up aquifers following periods of heavy rain
- Using reed bed technology to improve wastewater treatment
- Turning faecal waste into charcoal briquettes, reducing drivers for deforestation

Many, if not most, of the risks around climate change are felt through water – such as flooding, sea level rise, and drought.

But **access to water and sanitation services** are often neglected in this debate, particularly the needs of vulnerable urban communities, those most exposed to poor water and sanitation services.

At a city level, and within the WASH sector, we see little analysis relating to how climate change will impact on access to water and sanitation. Many of the service providers that WSUP exists to support – such as regional utilities, municipal authorities, and smaller private operators – have limited ability to assess climate-related challenges. Leaders in the sector may well be aware of the threat, but the ability for service providers to respond appears limited.

This report, however, shows some of the issues that climate change is causing for access to water and sanitation in cities. Whilst the impacts vary from country to country, the result is the same: poor, urban communities, already disadvantaged by irregular access to clean water and safe sanitation, are further hit.

But the low profile that the topic of water and sanitation access has within the climate adaptation agenda, and the inability of city institutions to dedicate time to understanding the issue as well as poor coordination between government departments, means that comprehensive responses are lacking. Water and sanitation services are not a core part of many cities' adaptation strategies, and national WASH policies often do not address climate change.

In addition, for residents themselves, it is very difficult to distinguish on a day-to-day basis between what is simply 'bad service', and what is an impact of climate change.

The challenges described in this report shows that this needs to change.

In order to address these challenges, WSUP believes that a convergence is required, between the water and sanitation sector on the one hand; and the climate adaptation sector on the other.

Averting Day Zero in Cape Town, South Africa

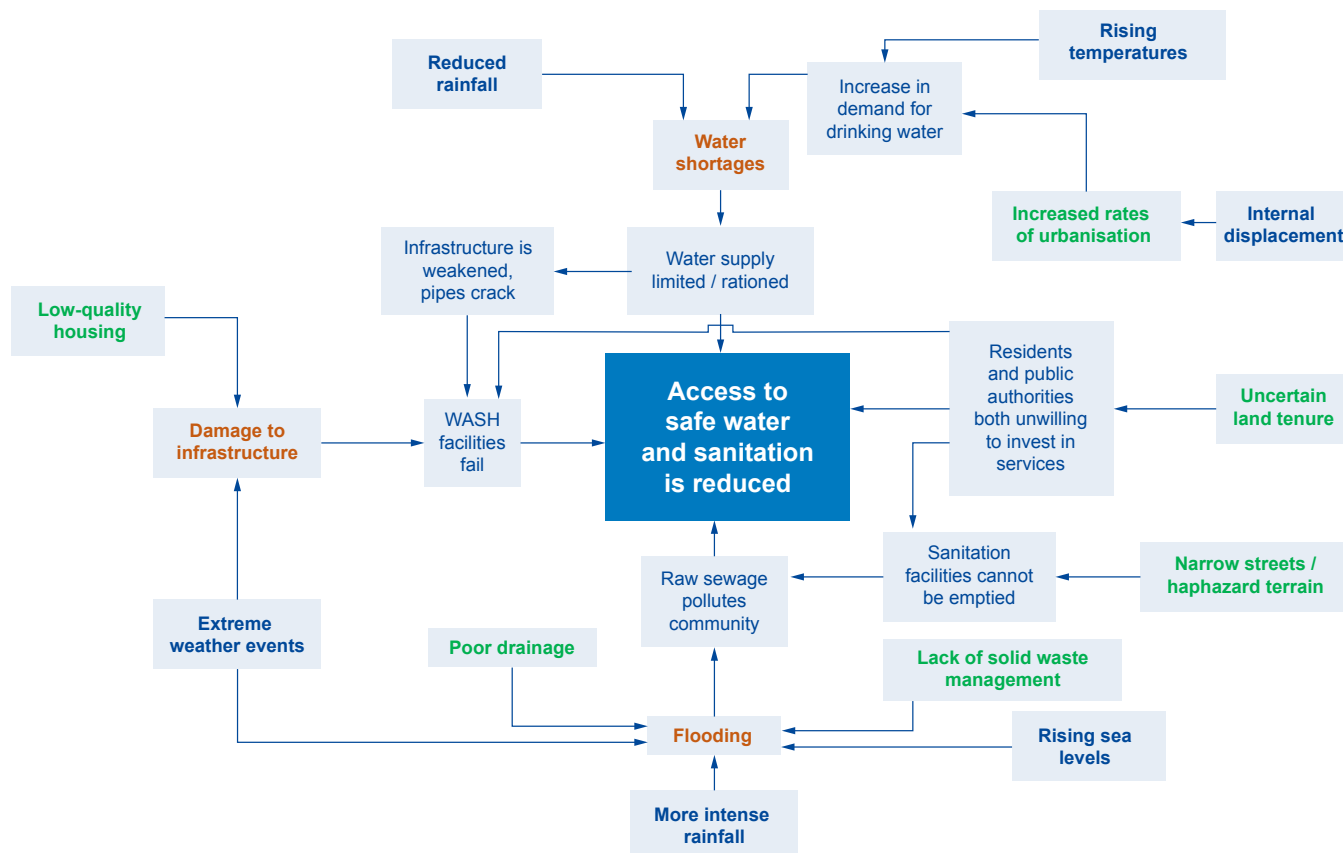
The drought that almost pushed Cape Town to the brink in 2018 was made three times more likely by climate change (World Weather Attribution, 2018). The Day Zero emergency came after a three-year drought, and has demonstrated the importance of city authorities recognising the increasing likelihood of extreme weather disrupting water supply. It shows that measures including long-term supply and demand planning, communications strategies to encourage consumers to reduce consumption, and citywide pressure reductions are all vital options for cities around the world as they grapple with uncertain water supplies (Parks et al, 2019).

“Floods have become an annual occurrence in Kumasi, usually resulting in casualties. As part of our adaptation measures to build resilience, we are expanding on our drainage system, and more importantly, we are exploring ways to provide sanitation systems that ensure effective containment and treatment to reduce the health risks of these floods.”

Joshua Tetteh Nortey
Senior Planning Officer
Kumasi Metropolitan Assembly, Ghana

The WASH sector needs to do more to understand the extent to which WASH services will be affected by climate change, and identify the risks faced by different regions. Similarly, those policymakers focused on climate adaptation need to do more to drive action which focuses not just on the broader *availability* of water, but more narrowly on extending *services* to those who are the most vulnerable to climate change.

Figure 1: how WASH issues caused by climate change are exacerbated by other urban challenges



Creating an integrated urban response

In cities, however, access to clean water and safe sanitation cannot be tackled without considering other social, economic and environmental development issues.

Poor communities are disadvantaged not just by the lack of safe water and sanitation services, but by many other factors.

Firstly, by the physical characteristics. The high density and unplanned nature of low-income communities means that critical functions like drainage are often ignored, which exacerbates the problems caused by flooding. Lack of solid waste management means rubbish is dumped within the community, increasing the risk of local inundation and leading to pools of stagnant water which can spread disease. The risk of disease is further exacerbated by unmanaged sanitation and the risk of faecal pathogens spreading into communities as a result of the flooding. This contamination can in turn get into water supply, especially where pipes have been damaged or cracked.

Secondly, by the location. Many low-income communities are cited in vulnerable locations, and in particular areas vulnerable to flooding, for example low-lying areas, areas close to rivers, or by the sea; or in places where extension of services can be difficult, such as steep slopes, or in peri-urban communities far from city centres. These locations are exacerbating the impacts of climate change on poor communities' ability to access services.

This report demonstrates how the inter-connected nature of urban challenges requires an integrated response: cutting across different sectors, such as drainage and solid waste management, to build stronger water and sanitation services for all.

Service provision under threat

Climate change is affecting the poorest urban communities, but to address the issues faced by residents we need to look more widely, at the institutions responsible for delivering services.

Water and sanitation service providers in fast-growing cities are scarcely able to cope with

“We must work together to offer innovative and effective solutions to tackle the adverse impact of climate change on the poor people of the city.”

*Md Rezaul Karim Chowdhury
Mayor, Chattogram City Corporation, Bangladesh*

the status quo and are unprepared for climate change. As the impacts of climate change increase in future years, these service providers will face greater and more complex challenges as they strive to fulfil their responsibilities and provide universal access to water and sanitation.

The solutions to this challenge are complex and wide-ranging. Based on WSUP's experience supporting service providers in our focus countries, the report presents four recommendations we believe are key in building an effective response to the urgent threat posed by climate change:

- **Use every drop:** To extend services citywide in a context of less water, utilities and other service providers must be supported in optimising water use efficiency. This in turn involves a comprehensive response impacting all aspects of utility operations. It requires cutting water losses, effective demand management, and sustainable management of water resources.
- **Protect the infrastructure:** Service providers must be supported in ensuring the provision of climate-resilient, sustainable WASH infrastructure. At the same time, information must be made easily accessible to the households investing in and maintaining these facilities. Climate adaptation must be mainstreamed into infrastructure planning and provision, requiring the development of specific skills and expertise.
- **Strengthen systems:** Climate resilience will only be achieved if we take the long-term view and ensure the elements of a functional, adaptive WASH system are in place. This means taking account of climate change — and associated impacts and uncertainties — in regulations, standards and financing frameworks. Flexibility will be key, ensuring service providers are positioned to adapt to emerging or unexpected conditions resulting from climate change.

- **Integrate with wider city resilience:** Urban climate resilience is not limited to water and sanitation. It demands an integrated approach. This means the development of climate-adaptive urban planning frameworks — involving water and sanitation but also connected services like solid waste management and drainage. It also requires cross-sectoral coordination at all levels: for example, decision-makers in water and sanitation must be encouraged to engage with climate-relevant sectors such as environmental protection, and with stakeholders supporting nature-based solutions.

About the report

This report aims to highlight how climate change is impacting the ability of the urban poor to access water and sanitation, and how we can support service providers to respond effectively. Reflecting that climate change is a cross-cutting issue, the report is written to be accessible to WASH and non-WASH audiences.

Whilst this report only considers the need to incorporate WASH into climate adaptation strategies, we recognise that WASH has a role to play in mitigation, too. Water production is highly energy intensive, and sanitation treatment results in greenhouse gas emissions, for example. However, the goal of this report is to highlight the risks being faced by the poorest urban communities in the face of climate change, and further advance the protections that they need.

The report is structured as a set of short case studies. We have focused on WSUP programme countries: Bangladesh, Ghana, Kenya, Madagascar, Mozambique, Uganda and Zambia. All of these countries are already being impacted by climate change in different ways.

The case studies outline interventions that have been supported by WSUP, as illustrations of how improved water and sanitation services are making a vital contribution to the ability of urban communities to adapt to climate change.



Image: Waste dumped in open drains in Rangpur enters the environment without proper treatment. **Credit:** Green Ink

BANGLADESH

Bangladesh is one of the most climate-vulnerable countries in the world. Low-lying and densely populated, the country is already being exposed to the threats of tropical storms, flooding, rising sea levels and rising temperatures. These threats are impacting directly on water and sanitation in urban low-income communities, requiring a rapid and multi-pronged response from city authorities and supporting institutions.

The challenge

Rising temperatures and erratic rainfall in Bangladesh are reducing the availability of surface and groundwater (USAID, 2020). Cities are currently not meeting the increase in demand. Potable water is also threatened by saline intrusion caused by sea level rise and storm surges (USAID, 2018).

Rising sea levels and extreme weather events are forcing people to migrate from rural and coastal areas to cities in search of places to live and work (World Bank Group, 2018). This unmanaged demographic shift will increase the pressure on city authorities to improve WASH services in unplanned, informal communities.

Increasing frequency and severity of rainfall is damaging the functionality and accessibility of urban water supply and sanitation infrastructure (USAID, 2018). The majority of urban sanitation facilities aren't connected to a sewer, like pit latrines and septic tanks. Properly made and maintained septic tanks should be resilient to flooding; but floodwaters are now rising above the level of septic tanks' outlet pipes, causing contamination of water. Persistent heavy rainfall is leading to frequent waterlogging of sanitation facilities, reducing their lifespan and pushing low-income communities to reinvest. In the urban

areas outside major cities, many residents use pit latrines which are much more liable to collapse or leak during a flood. These issues can be made worse by high levels of rural-to-urban migration, which mean that toilet users may initially be unfamiliar with shared sanitation facilities and the behaviours required to maintain them effectively.

Sanitation facilities need to be regularly emptied and waste treated and disposed of. However, in the absence of such services, waste is typically dumped illegally in open spaces in the local area, often in a water body, or toilets and tanks are connected directly to the storm drain network. Waste is therefore not contained properly and enters the environment with little to no primary treatment. Flooded infrastructure exacerbates this problem, which, combined with higher temperatures, creates an environment favourable for the spread of water-borne diseases like cholera (Hashizume et al, 2007) (USAID, 2018).

At a glance



Rising sea levels: Sea level rise is increasing the salinity of water and soil in coastal areas (Ministry of Foreign Affairs of the Netherlands, 2018) (USAID, 2018)



Extreme weather events: Bangladesh is the world's most vulnerable country to tropical cyclones (Ministry of Foreign Affairs of the Netherlands, 2018) (USAID, 2018)



Rising temperatures: By 2050, temperatures are projected to increase by 1.8 - 2.1°C (USAID, 2020)



Internal displacement: The number of people displaced by the impacts of climate change could reach 13.3 million by 2050 (World Bank Group, 2018)

Building climate resilience through improved WASH

Introducing formal sanitation services to low-income communities

Research commissioned by WSUP demonstrates how harmful pathogens from unmanaged human waste spread through communities, a phenomenon exacerbated by heavy rains and poor drainage (Amin et al, 2020; Foster et al, 2021). The urgent need to counteract the negative health impacts of heavy rain and flooding informed the development of the SWEEP model, a faecal waste management service. A partnership between the Bangladeshi public and private sectors, facilitated by WSUP, SWEEP has served 2.6 million people and safely removed 29 million litres of human waste from communities since 2015.

The regular emptying of septic tanks that the SWEEP service enables, especially if timed to occur ahead of the rainy season, ensures that toilets don't become non-functional due to overuse and or intrusion of floodwater. It prevents pathogens found in faecal waste from mixing with rainwater and contaminating the local community, as well as reducing the amount of faecal waste that enters water bodies via connections to drains.

The service is now starting to be implemented in urban areas outside of the major cities where toilets are generally built with pit latrines, which are not properly sealed and so are highly vulnerable to flooding.

Securing the sustainability of at-risk WASH facilities

Climate change is forcing people from coastal and rural areas to migrate to cities, where they are then often forced to live in over-crowded, poorly served and

"Migrants settling in the low-lying outskirts of the city are mostly climate refugees, using less-lasting onsite sanitation solutions that need frequent emptying. SWEEP is serving this purpose and preventing water pollution."

Md. Amdad Hossain
Superintending Engineer,
Rangpur City Corporation

unplanned neighbourhoods (World Bank Group, 2018). This influx of people is a challenge for the sustainability of WASH facilities, given facilities are usually shared between several families.

To ensure that WASH facilities don't get degraded by families not used to the realities of cramped, urban living, WSUP has found that behaviour change communications materials can help ensure communal facilities are used in a manner that will prolong the infrastructures' lifespan.

Ensuring water supply to low-income communities

As the population of informal settlements becomes ever larger due to climate migration, the need for water providers to scale up their distribution networks becomes greater. In Dhaka, the city's water and sanitation utility, DWASA, established a low-income customer unit with the support of WSUP. The unit is responsible for delivering piped water to slums in Dhaka, ensuring that low-income residents, including climate migrants, can access official, price-controlled water rather than relying on illegal and expensive water cartels.



Image: The coastal city of Mombasa is struggling to meet the water needs of all its residents due to high water scarcity. **Credit:** Bisha Pwani

KENYA

In Kenya, climate change is posing a significant threat to the country's water security. Urban water utilities are at the forefront of efforts to build resilience and ensure an effective long-term response. In this context, support to utilities to tackle water scarcity is critically important.

The challenge

Kenya's exposure to the effects of climate change is putting severe pressure on its already strained water resources. Increasingly, severe droughts and flooding are impacting water availability and diminishing water quality, which is affecting domestic water supply and sanitation. The country relies predominantly on surface water, which is highly susceptible to climate change, particularly as rising temperatures accelerate rates of evapotranspiration (USAID, 2018a) (World Bank Group, 2020). Flooding in Kenya's Rift Valley, meanwhile, is accelerating migration from rural to urban areas (Baker & Samaki, 2021), placing increased demand on urban services.

Urban centres already suffer water shortages. On the coast the city of Mombasa only supplies half the water that its residents need, leading to water rationing which particularly impacts the poor. Mombasa is also at risk from rising sea levels, which may make water shortages more acute as freshwater aquifers become contaminated with salty water, as well as significantly increasing risk of flooding in low-lying parts of the city (USAID, 2018a) (World Bank Group, 2020).

Heavy rains and resulting floods are also putting urban infrastructure at risk, particularly for poor and vulnerable groups (World Bank Group, 2020). In cities including Kisumu, flooding has caused water and sewer pipes to burst, which not only reduces the amount of water that reaches customers, but also causes water supply to be contaminated (Masimbe, 2018).

Nairobi is home to some of the largest slums in Africa, and heavy rains cause regular flooding in the settlements close to the flood-prone Ngong, Nairobi and Mathare rivers, like Mukuru and Kibera (Mbugua, 2018). Floodwater mixes with faecal waste from open drains and latrines which then finds its way into people's homes, affecting people's health and well-being. In 2017, more than 4,000 cholera cases were reported, 70% of which were in Nairobi, which experienced heavy flooding (Mugo, Metcalfe & Du, 2020).

At a glance



Reduced rainfall:

A likely increase in the duration of dry spells, as well as loss of glacial loss on Mount Kenya, will put increased pressure on Kenya's already stressed water resources (USAID, 2018a)



More intense rainfall:

Extreme rainfall is expected to become longer, more intense and more frequent (USAID, 2018a)



Rising sea levels:

Coastal aquifers supplying water for three million people are at risk of saltwater intrusion, due to sea level rise (USAID, 2018a) (World Bank Group, 2020)



Rising temperatures:

Temperatures in Kenya are projected to continue rising by 1.7°C by 2050 (World Bank Group, 2020)

Building climate resilience through improved WASH

Partnering with utilities to improve water use efficiency

Effective water and sanitation service providers are essential to protect water and sanitation services for the poorest from the effects of climate change.

However, water utilities are facing many organisational challenges, and far too much water is currently lost through leaks, theft and inaccurate billing (known as non-revenue water, or NRW). Kenya has an average NRW rate of 43%, well above the global average of 22% (WASREB, 2018). This inefficiency must be tackled if water service providers are to successfully adapt to the country's more insecure water future.

WSUP has been supporting utilities to undergo organisational changes that will improve water resource management while ensuring that everyone can access sustainable water and sanitation services. In 2018, Nairobi City Water & Sewerage Company (NCWSC) embarked on an ambitious metering initiative, in which a targeted 10,000 prepaid dispensers (PPDs) would be installed across informal settlements in Nairobi. WSUP is supporting NCWSC to scale up PPDs and get rid of water cartels which push unsafe, expensive water on low-income communities. The introduction of simplified sewers, currently being trialled in Nairobi's Mukuru settlement, aims to result in lower water consumption compared to traditional sewers, as well as reducing the risk of faecal contamination from the increasing floods.

"As the WASH sector builds resilience, there is need to manage water demand, among competing needs, while putting more focus on water losses to mitigate the challenge of climate change."

Richard Cheruiyot
Director, Monitoring and Enforcement
Water Services Regulatory Board
(WASREB)

Improving long-term urban planning

Efforts to integrate climate change into longer-term urban planning are essential for the development and implementation of climate-smart, inclusive sanitation provision.

In Malindi, for example, city leaders have created an inclusive citywide plan (Akinyi et al, 2021) to ensure all residents have access to safe sanitation, with the support of WSUP and other organisations. This citywide inclusive sanitation plan outlines a phased approach for sanitation, excreta and wastewater management and re-use, identifying four types of sanitation systems to address the income and density differences in Malindi. The plan also integrates sanitation and solid waste management, recognising the importance of coordinating action across these two areas, particularly given the impact caused by flooding.



Image: Flooding in low-lying communities in Madagascar, caused by climate change, raises health risks. Credit: Tsilavo Rapiera

MADAGASCAR

As the fourth largest island in the world, the threats posed to Madagascar by climate change reflect the diversity of the country itself. Water and sanitation systems in the country are highly vulnerable to a wide range of climate change impacts. WSUP's response has focused on long-term system strengthening — including with the national water utility, JIRAMA, a key actor in ensuring climate resilience.

The challenge

Madagascar is categorised by ND-GAIN as “highly vulnerable” to climate change but poorly prepared to respond (African Development Bank, 2018). Given Madagascar's status as one of the poorest countries in the world, with 92% of the population living on less than \$2 per day (JIRAMA, 2017), the country's exposure to climate change could have severe consequences.

Climate-related risks in Madagascar are multiple and highly regional. Increased drought is projected in the southwest; flooding and cyclones in the centre and north; sea level rise and storm surges along the coasts; and heat stress in low-lying inland areas. Overall rainfall is likely to reduce, although the intensity of rainfall is increasing (USAID, 2018b).

Droughts are a common feature of life in southern Madagascar and are driving internal migration to cities. This in turn is leading to the proliferation of densely populated slums in low-lying areas (Federal Ministry for Economic Cooperation and Development, 2021).

The increased intensity of cyclones and heavy rainfall poses significant risk to water, sanitation and hygiene infrastructure. Cyclone Enawo in 2017 damaged or destroyed 250 water systems and contaminated more than 1,300 wells. These trends are putting additional pressure on per capita water availability (USAID, 2018b).

Unmanaged sanitation is a major issue in urban areas, the impacts of which are worsened by flooding. The increased likelihood of flooding in low-lying communities as a result of climate change raises health risks associated with spread of faecal waste, such as the rapid spread of diarrheal disease. Poor solid waste management is also a contributing factor for flooding. For example, the southern city of Toliara is, at its highest point, just eight metres above sea level. The city encompasses multiple informal communities along its low-lying coastal flood zones, with almost non-existent sanitation services (USAID, 2018b).

At a glance



Reduced rainfall: As of August 2021, the south of the country was facing its worst drought for four decades (UN, 2021)



Rising sea levels: Sea levels could rise by 19-47cm by the mid-2050s (USAID, 2018b)



Extreme weather events: Cyclone intensity in the Indian Ocean is expected to increase by 50% over the next 80 years, although fewer will make landfall (USAID, 2016)



Rising temperatures: Temperatures are forecast to rise by between 1.5 and 3.2°C by 2080, putting pressure on the country's water resources (GIZ)

Building climate resilience through improved WASH

Building the resilience of the national water utility

The effectiveness of the national water and electricity supplier, JIRAMA, is central to the country's ability to provide adequate water access in the face of climate change, particularly in urban areas.

JIRAMA suffers from a lack of water sources and has been facing a water shortage since the El Niño-induced drought of 2017. The distribution of water is uneven and inefficient, with much of the utility's clean water lost before it reaches consumers; in 2020, the amount of water it lost would have supplied 650,000 people each with 50 litres of water per day (source: JIRAMA).

For more than ten years, WSUP has supported JIRAMA in its efforts to improve its water services, increase water capacity and extend water supply to unserved areas in Antananarivo and its peri-urban communities. As a result, JIRAMA has increased the number of community water facilities and reduced water leaks, theft and inaccurate billing. A EUR 71.5 million investment led by the European Investment Bank will increase water production for Antananarivo and improve the distribution network.

Climate-proofing WASH infrastructure

The development of climate-resilient community WASH infrastructure is helping to alleviate the impact of heavy rain and coastal erosion caused by cyclones. In areas with drainage issues, for example, soakaways reduce stagnant water that could otherwise be a breeding ground for disease-spreading insects.

“For the past two years, we have seen surface water drying up, and water that is harder to treat, resulting in a growing need to invest more to preserve water quality while the needs are increasing exponentially.”

Rija Ramarosandratana, Principal Water Director, JIRAMA

The creation in 2009 of local groups known as RF2s to provide solid waste management services and cleaning of drainage channels, financed by revenues from water services, is helping protect facilities against damage caused by flooding. Since the creation of the model, which was supported by WSUP, it has been scaled up with backing from the World Bank Group (World Bank Group, 2018a) and other institutions.

The challenge of improving sanitation

WSUP has identified a range of barriers to improving sanitation, including the lack of clarity over institutional mandates, limited budget allocation from government, and regulatory ineffectiveness. Significantly, there is no wastewater treatment in the capital Antananarivo at all. As increased flooding increases the negative impact of unmanaged sanitation, addressing these issues is becoming even more important.



Image: Cyclone Idai destroyed 11,000 homes in Beira and caused severe damage to the water and sanitation systems.
Credit: Stand Up Media

MOZAMBIQUE

Located on Africa's southeast coast, Mozambique is vulnerable to increasingly frequent storms from the Indian Ocean, in addition to saltwater intrusion from sea level rise and unreliable rainfall inland. The impacts of climate change have already been severe, including for the residents of Beira. In partnership with FIPAG, the utility, WSUP has been at the forefront of rebuilding water and sanitation services in the city following Cyclone Idai in 2019.

The challenge

Mozambique was hit by two cyclones in 2019, Kenneth and Idai, with devastating impacts on water and sanitation. In Beira, the question is when, not if, another storm will hit with the same ferocity. Cyclone Idai, one of the strongest to hit southern Africa, destroyed 11,000 homes in Beira and caused severe damage to the water network. The water network lost its source of power and was out of action for over a week, and parts of the water system were seriously damaged by the high winds.

The drainage and sewer system, which covers just 10% of the city, was also overwhelmed. Communities dependent on basic sanitation like pit latrines saw the flood waters mix with raw sewage, creating a serious risk to public health. The disaster revealed that institutions responsible for water, sanitation and housing did not have disaster response strategies in place, slowing down and confusing the relief efforts.

Poor communities in other Mozambican cities often live in low-lying areas which are at risk of flooding. The absence of effective urban sanitation waste management in these settlements, which are unplanned and densely populated, means that pit latrines regularly overflow during heavy rains, causing a public health risk (USAID, 2018c).

In the south, reduced rainfall has caused severe problems in the cities of Maputo and Matola (Mavume et al, 2021). These challenges, which escalated during the drought of 2017-18, have been compounded by poor water management in Maputo and high levels of leakage throughout the water network. Rising temperatures across the country will result in higher evapotranspiration, leading to lower groundwater tables; at the same time, the warmer climate will also increase demand for water (Ministry of Foreign Affairs of the Netherlands, 2018a).

The country's major urban centres are mostly situated on the coast, including Beira, Maputo, Nampula and Quelimane, placing water sources at risk from saline intrusion as sea levels rise.

At a glance



Reduced rainfall: Annual rainfall has fallen 3.1% per decade between 1960 and 2006, and projections show significant decrease in predictability of rainfall in coming decades (Ministry of Foreign Affairs of the Netherlands, 2018)



Rising sea levels: An expected rise in sea levels of 13-56cm by 2090 could reduce clean water for many communities amongst the 60% of the population which is based on the coast (USAID, 2018c) (Ministry of Foreign Affairs of the Netherlands, 2018a)



Extreme weather events: The 2018-2019 southwest Indian Ocean tropical cyclone season was the deadliest season ever recorded, with Mozambique hit by two major cyclones in one season for the first time (Mavume et al, 2021) (Cambaza et al, 2019)

Building climate resilience through improved WASH

Climate-proofing water and sanitation infrastructure in Beira

Following Cyclone Idai, the utility FIPAG has introduced more climate-resilient construction standards and extended the water system, with the support of WSUP. These efforts have been critically important in protecting low-lying parts of the city from future disasters, as well as ensuring communities that have been forced to resettle away from the central and flood-prone parts of the city have access to basic services.

The crisis also highlighted the need for improving sanitation for the 90% of residents not connected to the sewer network. The city needs infrastructure – such as toilets, and septic tanks – that can withstand flooding, as well as improved sanitation waste collection services, which will reduce the likelihood of faecal contamination of the environment following heavy rain. This is now a priority for Serviço Autónomo de Saneamento da Beira (SASB), the sanitation authority in the city. At the same time, work to improve solid waste management is helping to reduce the risk of rubbish blocking drainage channels during intense rain storms.

Improving water management in Maputo

Given the risk of frequent droughts in Maputo and its neighbouring city of Matola, improving the efficiency of water systems is essential to make the most of the limited water resources. The utility Águas da Região de Maputo (AdeM) has introduced a new model with the support of WSUP which involves community-based organisations delivering services into some of the most densely populated low-income communities. The result has been improved customer satisfaction, reduced water losses from leaks, and increased utility revenue which can be reinvested into more service improvements (Kingham et al, 2018).

In the peri-urban communities beyond AdeM's service area, the priority is to improve the effectiveness of small-scale water operators. WSUP has worked with many of these, helping them to make more efficient use of water supplies and serve more customers. However, the sheer number of unregulated private water providers threatens the overall viability of Maputo's groundwater system, with a risk of saline intrusion and other contamination from excessive abstraction of groundwater.

In the future, improved drought planning could include reducing losses from leaks, theft and inaccurate billing (non-revenue water, or NRW); adopting a mix of water resource options including surface water and emergency groundwater sources; and preparing the deployment of public standposts and water distribution via tankers in crisis situations.



Image: In southern Zambia, droughts are having a major impact on water availability in low-income communities.

ZAMBIA

A landlocked country in Southern Africa, Zambia is highly vulnerable to climate change on two fronts. In the south, droughts are already having a massive impact on water availability. In Lusaka, flooding is a key issue, worsening the impacts of poor sanitation and directly contributing to disease outbreaks. These threats are prompting a response at the Ministry level and from water and sanitation authorities and supporting institutions.

The challenge

The Zambezi river basin is one of the most vulnerable watersheds to the effects of climate change in Africa (Desanker & Magadza, 2001).

Lusaka, one of the fastest growing cities in Africa, depends on the Kafue River and groundwater for its water supply, and the Zambezi River supplies water to the country's southern regions. Water in both the Kafue and Zambezi river basins is falling, a result of reduced rainfall and higher temperatures (Hamududu & Ngoma, 2019). As a result of these changes, the country is struggling to provide its people with safe drinking water and sanitation.

As some 85% of Zambia's energy comes from hydroelectricity, this decline reduces the amount of electricity produced, often by around 30% (USAID, 2016a). This means that utilities may not have the energy required to produce and distribute drinking water.

During prolonged dry periods, community water kiosks and household connections in cities can run dry, forcing low-income residents, particularly those in peri-urban communities, to travel further to buy water, often at much higher prices; collecting water from further away increases the likelihood of water being handled and contaminated. Additionally, utilities that

suffer from frequent power shortages will not be able to appropriately treat wastewater.

At the same time, flooding regularly contributes to the collapse of sanitation facilities (Mikhael et al, 2021). While reduced water availability is clearly a key issue, too much water is another concern in Zambia's cities and major towns. Flooding leads to the contamination of water sources, particularly in Lusaka where groundwater table levels are high, the ground is highly permeable, and the peri-urban population use boreholes for drinking water and poorly built basic sanitation systems like pit latrines.

If these sanitation facilities are not regularly emptied, they can be overwhelmed or collapse during floods, leading to faecal matter contaminating the environment and waterborne diseases spreading. As a result of climate change, heavy rainfall is expected to become more frequent or intense in the Lusaka region (FRACTAL & LuWSI, 2018).

At a glance



Reduced rainfall: The number of people affected by droughts each year is expected to rise from 1.73 million in 2016 to 7.3 million by 2100 (CIMA Research Foundation, 2018)



More intense rainfall: 6,500 cases of cholera were declared in 2017-2018 following heavy rain and flooding in Lusaka (Sinyange, Brunkard & Kapata, 2018)



Extreme weather events: More extreme weather events are likely, with increased frequency and intensity of heavy rainfall events, droughts, floods and flash floods caused by extreme precipitation (USAID, 2016a)



Rising temperatures: Temperature increases of 1.2°C to 3.4°C are expected in Zambia by 2060 (USAID, 2016a)

Building climate resilience through improved WASH

Reducing the vulnerability of sanitation systems to flooding

Recent cholera outbreaks in Lusaka, as a result of flooding from heavy rains, have been one of the drivers behind a push to improve sanitation services and in particular to improve sanitation waste management in the city. This work is being driven through the Lusaka Sanitation Program, a major US\$ 300 million initiative. Improved design of toilets is contributing to the containment of faecal waste, preventing it from contaminating the local community during floods.

Citywide sanitation waste collection services are being introduced to reduce the risk of faecal waste contaminating groundwater. Two pilot services which have been running since 2013/14, with support from WSUP, are being used as a basis for demonstrating quality of service and financial viability. These services – operating in the peri-urban communities of Kanyama and Chazanga – have helped demonstrate to municipal and national stakeholders that non-sewered services in low-income areas can and must be provided.

Supporting water and sanitation utilities to serve the poorest

In Lusaka, the Lusaka Water & Sanitation Company (LWSC) is helping peri-urban communities adapt to climate change by increasing water connections, reducing leaks and creating delegated management systems to improve services at the community level. The result has been more efficient use of water and improved water access for the poorest.

“High variability, with frequent droughts, seasonal and flash floods, extreme temperatures, and dry spells are expected to intensify with climate change. These have already adversely impacted on food, water, and energy security as well as the general livelihoods of our people.”

*Zambian President
Hakainde Hichilema
September 2021*

In Livingstone, the utility Southern Water & Sanitation Company (SWSCO) is investing in new water extensions for the city's informal settlements, again with WSUP's support.

Integrating climate resilience into utility operations

In Southern Zambia, the drought of 2018-19 has encouraged SWSCO to accelerate the integration of climate resilience into its operations. Using WSUP's Utility Strengthening Framework, SWSCO identified a number of urgent projects to prioritise if it is to withstand the effects of increasingly common droughts. These projects include non-sewered sanitation, service improvements for peri-urban communities, tackling water quality, reducing water leaks across the network, and a renewed focus on customer service.

GHANA

The challenge

Erratic and intense rainfall causes floods in cities like Accra, where overflowing pit latrines, septic tanks and damaged sewers contaminate the environment, including surface water and piped water. This increases the prevalence of cholera, diarrhoea, malaria and meningitis, particularly in densely populated urban areas where temporary and low-income settlements lack access to clean water and either share toilets between multiple households or pay to use (often dirty) public toilets (Clemenz et al, 2020).

In coastal areas, this issue is compounded by sea level rise, as water sources are compromised by salinisation and run-off (World Bank Group, 2021). Some of Accra's aquifers are already saline, forcing the population to rely on surface water which is more vulnerable to contaminants (Clemenz et al, 2020).

About 25% of the population does not have access to clean water, and declining rainfall levels, drought and rising temperatures are putting pressure on available water resources (USAID, 2017).



Image: Poor sanitation systems contaminate the environment, thereby increasing the spread of diseases.

Building climate resilience through improved WASH

Building resilient sanitation systems

As flooding increases in urban communities due to climate change, improving sanitation systems becomes ever more important. The low coverage of safe sanitation facilities in Ghana is compounded by a range of factors, including high cost and a lack of financing options, issues which WSUP has worked to resolve. In Kumasi, the ongoing restoration of the city's sewage treatment plant, supported by WSUP, is a vital step towards improving management of sanitation waste and reducing the amount of environmental contamination occurring in resulting floods.

Improving water management

Rising likelihood of droughts is increasing the need for the country's two main water service providers for cities and small towns, Ghana Water Company Limited and Community Water and Sanitation Agency, to reduce water losses and extend coverage to the poorest communities. WSUP supported the creation within GWCL of a specialist low-income customer team in 2015 and has since supported the utility to extend services to over 100,000 low-income customers; and has worked with CWSA to improve water access in small towns in the Ashanti region.

At a glance



Reduced rainfall: Rainfall is expected to decrease by 4% by 2040 (USAID, 2017) and the duration of long-lasting heat waves is expected to increase by 22 days by 2100 (Ministry of Foreign Affairs of the Netherlands, 2018b)



More intense rainfall: More erratic and intense rainfall during the wet season is increasing the risk of flooding (USAID, 2017)



Rising sea levels: The coastline, including Ghana's capital, Accra, is expected to face a sea level rise of 13-45cm in 100 years (Ministry of Foreign Affairs of the Netherlands, 2018b)

UGANDA

The challenge

Uganda ranks 167 out of 182 countries in the ND-GAIN index for climate vulnerability, and is considered to be very vulnerable, yet poorly equipped to address climate change effectively (ND-GAIN, 2021).

Rainfall has declined in recent years, reducing the amount of surface water and groundwater. At the same time, the percentage of rainfall occurring from heavy precipitation events is increasing, resulting in increased risk of floods and greater volumes of soil sediment washing into water supply, reducing water quality.

The reduction in rainfall is combining with the world's second fastest population growth rate to put significant pressure on water resources.

Across the country, the growth of villages to small towns is increasing demand for water. As wells dry up, people are looking to surface water, but this is often contaminated as a result of flash floods.

In the major cities, populations are becoming more concentrated in slum areas, exacerbating water access issues.



Image: Unpredictable rainfall calls for better management of water resources.

Building climate resilience through improved WASH

Improving water management in Western Uganda

In 2017 Uganda created a number of new water authority Umbrellas, each responsible for water supply services to small towns and rural growth across a region of the country. The Umbrella for Water and Sanitation – Mid West is one such entity and WSUP's consulting arm WSUP Advisory has been working with the Umbrella to extend services across 9,500 km² of the country.

The Umbrella is currently managing 56 water schemes and is likely to take over a further 50 schemes over the next few years, increasing the population served to almost 800,000 people. WSUP is helping improve performance, reach more customers and plan for the future, including addressing the challenges of climate change.

In 2020, WSUP supported the Umbrella to improve water quality in the town of Bundibugyo through the construction of a new water treatment facility. Drawing water from fast-flowing mountain streams in the Rwenzori Range, the water intake for this scheme remains vulnerable to flood damage which would leave the 20,000 inhabitants of the town without water supply. The likelihood of such destructive flooding is increasing because of climate change.

At a glance



Reduced rainfall: Although rainfall in Uganda is increasing, unpredictability is leading to drought risk. In 2004/5, water levels in Lake Victoria dropped to their lowest level since 1951 (GIZ)



More intense rainfall: Heavy precipitation could increase by 25% between 2000 and 2080, escalating the risk of flooding and landslides (GIZ)



Rising temperatures: Temperatures could increase by 1.8% by the 2050s, increasing evaporation and reducing surface water levels. (World Bank Group, 2020a)

Recommendations

In this section we present four key recommendations for promoting climate-resilient urban WASH. The recommendations are grounded in WSUP's experience of supporting service providers in our focus countries.

We believe the following steps could be key in supporting cities and service providers to respond effectively to the urgent threat posed by climate change.

Use every drop

Climate change poses a huge threat to security of water supply at the city level, including through water scarcity and drought. Across countries such as Kenya, Madagascar and Zambia, climate change is putting severe pressure on water resources. Delivering water services to everyone in the city, in water-scarce contexts, over the long term, is a massive challenge.

The solutions are complex and wide-ranging. They include urgent action to protect upstream water sources. But crucially, utilities must cut down water losses within their own networks.

Using every drop requires utilities to strengthen all aspects of their operations. It means digital innovation, to better monitor and manage flow and water pressure in underground pipes. It also means reduced leaks across the network; improved billing and revenue collection; recycling and re-use; and improved customer service.

Demand management is also important. All urban residents, as well as the wider population, must be encouraged to use less water. This can be promoted through measures including changing fixtures (for example, the installation of low water-use toilets and showers); and through behaviour change messaging. These steps can enable utilities to provide the required service with reduced quantities of water.

To extend services citywide in a context of less water, utilities must be encouraged and supported in using every drop of water available.

Protect the infrastructure

The impacts of climate change are already placing a huge toll on water and sanitation infrastructure in the countries where WSUP works. Flooding is causing poorly built pit latrines to collapse and septic tanks to overflow in densely populated slum communities, posing a huge public health risk. Extreme weather events like cyclone Idai are leading to the destruction of water and sewage networks.

Service providers must be supported in a shift towards climate-resilient infrastructure. Information must be made easily accessible to the households investing in facilities. Climate adaptation must be *mainstreamed* into infrastructure planning and provision.

This will require the development of key skills, and the application of specific knowledge and expertise. Infrastructure designs must be adapted, where the context demands it. Water and sanitation facilities must be constructed to a higher standard and made more robust. Steps must be taken to protect against groundwater and surface water contamination. Major infrastructure, including treatment plants, must be well maintained. And investment will be required in behaviour change, to ensure household and communal facilities are looked after by users.

Strengthen systems

Climate resilience is a long-term challenge which requires a broad response. There are urgent steps which can and must be taken to ensure emergency preparedness. But the task is much greater than that. Climate-resilient urban WASH means resilient systems that enable institutions to understand, prepare and adapt to changing circumstances.

To strengthen systems we must start with the building blocks. Across countries, we need to ensure the foundations are in place for service providers to accelerate water and sanitation access at the city level.

This means water and sanitation policies and regulations which clearly promote climate change adaptation. And given the poorest are the most vulnerable to climate change impacts, clear responsibilities and strong accountability for service delivery to low-income communities are essential.

Because climate change is introducing uncertainty, service providers need the freedom to adapt to emerging or unexpected conditions. This means that flexibility must be built into the planning of services. Responsive financing frameworks can help ensure services are sustained through emergencies and periods of high demand. A range of approaches should be adopted to deliver water and sanitation in the city, to diversify risk and avoid dependence on any one solution (Mills et al, 2019).

Real climate resilience will only happen if we take the long-term view and ensure the elements of a functional, *adaptive* WASH system are in place.

Integrate with wider city resilience

Water and sanitation provide a foundation for long-term city resilience. Service providers need urgent support to help them understand how WASH services will be hit by climate change and to plan and implement solutions. At the city level, any urban climate adaptation strategy must include universal access to water and sanitation as a core plank.

But as a sector, we need to get better at making the connections between water and sanitation and wider urban development. Climate resilience is no exception.

Cities urgently need to develop climate-adaptive urban planning frameworks. These plans must include comprehensive improvements to informal settlements — the residents of which are some of the most vulnerable people in the world to climate change. This means increased water access, better management of faecal waste, and climate-adaptive planning of water and sanitation infrastructure in these areas. But it also means better solid waste management, better roads, better drainage.

To achieve climate-resilient water and sanitation, cross-sectoral coordination is required at the city and national levels. Decision-makers involved in supporting basic services must be encouraged to engage with wider government departments and agencies. This means proactive and formal consultation with climate-relevant sectors such as environmental protection (for example, by involving these actors in water and sanitation working groups) (Mills et al, 2019); and with stakeholders involved in supporting nature-based solutions.

All of these aspects are strongly interconnected. Urban climate resilience is not limited to water and sanitation. It demands an integrated approach.

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