

“Adaptation is only going to get more challenging as changes in the climate intensify, combining with the effects of rapid urbanization and the persistently high levels of poverty and inequality in Africa.”

Climate Adaptation and Water Scarcity in Southern Africa

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Southern Africa is no stranger to an unpredictable climate. Temperatures and rainfall have always varied dramatically. Increasingly, however, the patterns are shifting. Farmers complain about longer dry spells within the rainy season, urban officials worry about the more frequent occurrence of intense rains that lead to flooding, and everyone grumbles about the number of hot days and nights that make their homes uncomfortable.

Changing with the Climate

Eighth in a series

Since the region's climate has always been variable, people and institutions have adapted to its fluctuations in many ways. But these measures alone are proving insufficient as climate change intensifies. Adaptation at scale is needed: nations must take up the challenge alongside cities, businesses, and civil society groups.

Southern Africa is seen as particularly vulnerable to the impacts of climate change because of its high levels of poverty and inequality and its heavy reliance on natural resources. Water availability and access have a direct impact on agriculture, a sector on which over 70 percent of the population depends. They are central to both the economy and individual livelihoods in the region.

Unfortunately, food production has not kept pace with the region's growing population. The Southern Africa Development Community (SADC), an intergovernmental organization, is concerned about this trend. As David Lesolle of the University of Botswana wrote in a 2012 SADC policy paper on climate change, the regional population soared

from 152 million to 249 million people between 1990 and 2006, while food production barely budged, increasing from 22 to 24 million tons per year. The population has since risen to 277 million.

Water access at the household level is critical for productive livelihoods. Many homes in Southern Africa still do not have piped-in water, so household members have to get water from standpipes or buy it from vendors. Time spent fetching water could be better spent on other things like going to school or pursuing economic activities. In years when water is especially scarce, these opportunity costs are greater.

Health is also directly affected by water availability and quality. There are concerns that vector-borne diseases will become more prevalent with changes in the climate. Botswana, for example, is likely to face a significant increase in the proportion of the population living in malaria-prone areas by 2021.

As the African continent urbanizes, its cities' water and sewage systems will come under greater pressure. Ensuring the security of the water supply to cities and towns is particularly challenging in semiarid regions with variable climates. Many urban areas have relied on surface water from dams and rivers that are increasingly coming under strain, particularly during years of low rainfall. New approaches to water management, such as urban design that better integrates stormwater infrastructure and sustainable drainage systems, are being explored. But implementation has been slow because of constraints on governments' and contractors' capacity to adopt new approaches and limited resources to pay for them.

The importance of understanding the impact of climate on water has been recognized at the SADC

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level. An adaptation strategy for the water sector, introduced in 2011, proposes an increased focus on infrastructure development, water management measures, and water governance in the context of climate change. Water governance includes education and awareness, strengthening stakeholder participation, policy reform, and climate financing. Water management may involve deploying early warning systems, managing demand, and improving water quality.

Some technical interventions (such as improving irrigation and drainage or increasing access to groundwater) and behavioral interventions (such as providing incentives for efficient water use) could be better implemented. But more attention should be given particularly to understanding the networks, people, priorities, and policies that might improve the governance of water.

I will use two case studies to illustrate the wide range of ways in which the changing climate is affecting the water sector in Southern Africa. The first shows how climate change is already having an impact on rural livelihoods and the economy in the Limpopo River Basin, a particularly vulnerable region. The second examines the recent water crisis in Cape Town, one of South Africa's largest cities, which was nearly forced to turn the taps off early this year. Cases like these show how important it is to have climate adaptation strategies in place to reduce the risks of failure in the water sector and maximize opportunities to create a more resilient future.

VULNERABLE LIMPOPO BASIN

The Limpopo River Basin is shared by Botswana, Mozambique, South Africa, and Zimbabwe. It is a semiarid region with high climate variability: some parts of the basin can experience extreme rainfall while other parts may be suffering drought. Maximum temperatures in the basin in summer months have increased by between 1 and 1.4 degrees Celsius in the past century. This trend is expected to continue with a significant increase in the frequency of hot extremes and a decrease in cold extremes. Rising temperatures are likely to boost demand for water while adding to water loss through evaporation.

Rainfall varies widely across the basin. There has been an increase in rainfall intensity but also in the duration of dry spells. Precipitation is likely to decrease in the area by as much as 15 percent by the end of the century. The seasonality and timing of future rainfall is also expected to change,

with shifts in the start and end of the rainy season. These patterns will differ across the basin, but the most significant decrease in rainfall is expected over the summer and autumn months. Tropical cyclones along the Mozambique coast could become more intense.

By increasing sea surface temperatures, climate change is also likely to exacerbate El Niño events, in which an unusual warming of the equatorial Pacific Ocean can affect weather patterns around the world. El Niño events are a major driving force behind long-term natural climate variability. In Southern Africa, both flooding and droughts have been linked to El Niño—and the flooding events are expected to increase in frequency and intensity.

LIVELIHOODS AT RISK

Agriculture, especially irrigation, accounts for half of total water usage in the Limpopo basin. Rain-fed agriculture is widespread, particularly for grains and pulses including maize, sorghum, millet, and beans. Maize and sorghum yields are expected to decline by 10 to 35 percent in Botswana by 2050, which would have a drastic impact on local food security. In Mozambique and Zimbabwe, crop failures after droughts have forced people to move to urban centers in search of food. Unfortunately, the cities offer insufficient economic opportunities to support these migrants.

While agriculture is the dominant use of water in the Limpopo basin, urban centers use 30 percent; the remaining demand is spread evenly among the rural, mining, and power sectors. Expansion of irrigation is expected to remain relatively modest by 2025, but it is anticipated that rapid growth in urban populations and mining and energy projects will place enormous pressure on water resources.

Of the 15 million people in the Limpopo basin, more than two-thirds live in rural areas. Most of them are dependent on agriculture. Since most of these households' livelihoods are relatively undiversified, it is hard for them to buffer the impacts of climate.

Moreover, HIV prevalence in the basin ranges between 11 and 26 percent. The impacts of environmental change are often felt more acutely by those living with HIV and AIDS, since they need to focus their resources on health care and thus are less able to deal with climate shocks.

A Vulnerability and Risk Assessment (VRA) process conducted in the Bobirwa district of Botswana offers some insights into what these stresses mean

at the household level. The VRA process, led by Oxfam with input from other researchers, entailed a series of interviews and workshops aimed at understanding how vulnerability to climate and other stresses is experienced at both the household and district level.

This research was carried out as part of the Adaptation at Scale in Semi-Arid Regions project, led by the University of Cape Town with partners from other African universities and international and local aid groups. The project, which focuses on semiarid areas across Africa and India, explores climate impacts at the local level and how adaptation can be supported and scaled up from the village to the district and national levels.

During the VRA process, a few herders talked about how their livestock, which are central to the livelihoods of many households in the basin, have been threatened by foot-and-mouth disease. In 2012, a few areas in Botswana reported an outbreak of the disease. Respondents at the VRA workshop said market restrictions imposed to address the problem significantly reduced the incomes of households reliant on livestock.

Farmers in Bobirwa also reported that lack of rainfall has resulted in a scarcity of drinking water for livestock, which leads to weight loss and lower profits when the animals are sold. But they said they were unable to migrate with their animals in search of water because of the threat of livestock theft.

DROUGHT AND FLOODS

The impacts of climate variability on agriculture and food security were clear during the 2011–12 rainy season, which started later than expected in the Limpopo basin, leading to a reduction in the area planted. In 2012, high rates of malnutrition leading to stunting revealed chronic food and nutrition insecurity in a number of countries. An estimated 5.5 million food-insecure people live in the SADC region; poor rainy seasons have been the main contributing factor.

The impacts of climate on agriculture have both direct and indirect effects on employment. Since the irrigation agriculture sector is the second-largest employer in the basin, drought years and other reductions in water availability result in fewer employment opportunities and higher food prices.

The VRA process in Bobirwa showed what drought has meant for the everyday lives of people in the basin. Participants said that the elderly use their social security grants for food instead of other vital supplies and services. They mentioned other far-reaching social consequences as well. When crops and livestock are afflicted by drought, household incomes decline, which in turn makes it hard to pay bills and school fees. This leads to other risky behavior when children drop out of school, and it also results in increased outmigration. All of these impacts in turn add stress to household relations.

As one woman said, “No rain, no grass, no grazing, no *mokolwane* palm [*Hyphaene petersiana*] to use for basketry and so no income.” A male participant added, “We rear livestock for both consumption and income. We can’t sleep if we lose our livestock. We have no income for school fees, hence school dropouts, poor school attendance, and no payment of daily bills.”

Flooding is also a significant climate risk in the basin, especially from cyclonic activity in the Mozambican Floodplains Zone. Floods have had severe impacts on infrastructure and the economy, causing both temporary and permanent damage and disrupting communications, business, and public services.

The worst of these storms was Cyclone Eline in February 2000, which brought heavy rain throughout the Limpopo basin. Rain gauges in Botswana recorded over 40 inches of precipitation, more than half the average annual total. In Mozambique, the Limpopo River overflowed its banks and spread more than 20 kilometers wide, inundating farmland, killing 800 people, and drowning more than 20,000 cattle.

FROM COPING TO ADAPTATING

Given such wide-ranging impacts, it is critical to explore how individuals, organizations, and nations in the region are adapting and how they might adapt to climate variability and change. Some adaptation responses can be implemented by individuals with few resources, while others require large-scale institutional support.

Much depends on the available capacity for adaptation. Researchers have found low adaptive capacity among individuals as well as at the regional

Climate change is already having an impact on rural livelihoods and the economy in the Limpopo River Basin.

level because of weak institutions and inadequate planning and infrastructure. As Opha Pauline Dube and M.B.M. Sekhwela of the University of Botswana have suggested, indigenously developed livelihoods and knowledge bases used to be sufficient to cope with drought in the Limpopo basin. Unfortunately, adaptive capacity has weakened with a decline in traditional institutions.

Many households rely on shorter-term coping strategies that include reducing the number and size of meals, switching to less-preferred foods, increasing reliance on casual labor and self-employment, selling assets (particularly livestock), and stopping children from going to school. These coping strategies were common in the past during food crises, but many households across the basin are now resorting to them every year. Adaptation programs should help households find better ways to deal with climate risks in the future.

Some smallholder farmers have managed to rely less on rain-fed agriculture by practicing water harvesting (collecting rainwater) and using water-efficient drip irrigation. Interventions like these need institutional support from extension officers or agricultural suppliers to ensure that the technology is properly used.

Research in the Limpopo basin in South Africa shows that smallholder farmers have improved their ability to cope with climate variability and use seasonal climate information, but their lack of access to both local and international markets has inhibited their ability to sell their produce. Considering the climate changes already being felt and the difficulties of maintaining a livelihood based on rain-fed agriculture, alternative income sources also need to be explored. In order to get traction, these alternatives should build on local skills and markets; they could include developing trades, crafts, and the service industry.

Another example of adaptation at the regional scale is the use of early warning systems and disaster preparedness in general. This is particularly important in the Limpopo basin, since the seasonal droughts it is currently experiencing are expected to become more intense and frequent. Improved river flow monitoring can lead to fairer arrangements for sharing limited water resources.

Recognizing the lack of a sufficiently integrated monitoring network across all of the countries in the basin, the World Meteorological Organization developed a proposal for a transboundary flood forecasting and early warning system. This would include improved real-time monitoring of flood

and related data. Hydrometeorological conditions would be measured by telemetry equipment, radar, and satellites. The data must be transmitted in real time to a range of stakeholders that can share the information widely. A regional center could issue advisory statements.

Climate change adaptation requires considering a range of options—from technical interventions that reduce direct climate risk, such as efficient irrigation, to institutional responses such as supporting new livelihood strategies that help people reduce their risk exposure, or developing networks with better access to climate information. Technical interventions have received higher priority in the past. Less attention has been given to institutional interventions and the governance mechanisms needed to scale up responses.

Such institutional responses, which require developing new networks and new ways of thinking about supporting vulnerable households, deserve more attention. This calls for a focus on building capacity for learning, flexibility, and innovation in the context of climate change.

CAPE TOWN CRISIS

Cape Town, a city of 4 million people at the southern tip of the African continent, is a prime example of drought's impact on the region's urban areas. Cape Town attracts millions of tourists a year as well as migrants hoping to find work. It has a diverse population with high levels of inequality.

The city has historically relied on six large dams for its water supply. In 2017, the city experienced a third straight year of below-normal rainfall. The reservoirs did not fill up; the water levels behind the dams were at their lowest ever. Research has shown that there was a 1-in-400-year chance of having such low rainfall three years in a row, and that climate change made this drought more likely. While the drought afflicting Cape Town cannot be blamed entirely on climate change, more of these extreme events are likely to occur in the future.

Supplying water to residents under such conditions is a complex challenge that requires technical, political, and economic expertise and ingenuity. In South Africa, water belongs to the state. The national Department of Water and Sanitation is responsible for bulk water and thus for the large dams.

The city government had been asking the national department to increase the bulk water supply for a few years. Unfortunately, this was not done for a number of reasons, including the de-

partment's resource and staffing constraints. Politics also may have played a part, since Cape Town is run by the Democratic Alliance, a rival of the African National Congress, which has long been in power at the national level. In any case, the city chose to take matters into its own hands to try to avoid a water crisis.

In early 2018, Cape Town faced a real threat of running out of water. If dam levels dropped to 13.5 percent of capacity, Day Zero would arrive: the taps would be turned off. Residents would have to go to one of many water distribution points in the city to fill up their containers with the daily ration of 25 liters per person.

A Critical Water Shortages Disaster Risk Plan had been introduced in October 2017, outlining three response phases. Phase 1, including water rationing, was implemented in the same month. In Phase 2, essential services would continue to receive water supplies, as would the central business district, but households and individual businesses would be cut off. In Phase 3, only drinking water would be available, at secured distribution points.

One of the major concerns was about Cape Town's high number of low-income households in informal settlements and how they might be affected if the city moved to Phase 2 or 3. Another was about the health and infrastructure implications of shutting down the sewage system.

Luckily, only Phase 1 of the disaster plan had to be implemented. It involved reducing water pressure in the system and imposing restrictions that limited individuals to using only 50 liters (about 13 gallons) of water per day. Businesses were also required to reduce their usage, agricultural water supplies were cut, and punitive tariffs were introduced for those who exceeded their allowances. Devices that limit water flow were installed in households with high consumption rates, capping their supply at 350 liters per day.

INCONVENIENCE AND INEQUALITY

These restrictions, which will remain in place through 2018, have affected many aspects of city life. Like many other Cape Town residents, I had to watch my garden die since we could not water it at all during the dry summer months. My children have stopped using the bath daily and now wash themselves or just their feet in a bucket instead. We all know how much water one flush of the

toilet takes, and we use buckets underneath the shower to catch water that we then use to flush. This has become habit for many residents.

Many businesses that rely on access to water have suffered—but some have boomed, particularly those that sell water tanks that people install on their properties to catch rain. Drilling companies have also thrived, sinking boreholes across the city for residents, businesses, and public institutions trying to reduce their reliance on municipal water.

In certain suburbs, neighbors convened to discuss how to support more vulnerable households should Day Zero arrive—and how to monitor excessive users. Other civic groups took on a more adversarial role in criticizing the city's approach, organizing marches and presenting their views in the media. Some pointed out that many people living in shacks in the city's informal settlements, which lack water supply and other public services, have always had to walk to standpipes and wait in line for water. Yet there is now an outcry about how inconvenient it will be if everyone has

to wait in line. The crisis has thrown into sharp relief the inequalities that many in the city face daily.

In addition to the three-phase disaster plan, Cape Town's emergency response included a demand-management campaign and a scheme to increase the water supply in the future. So far, the city has added three temporary desalination plants, groundwater extraction from three aquifers, and a few water reuse plants. It also had some water transferred from an agricultural dam. This augmentation process has been fast-tracked with impressive speed, despite procurement challenges.

Along with the cut in agricultural water use, as well as the enforced reductions in usage by residents and businesses, these responses have helped stave off disaster for now. However, if the rains do not fall for a fourth year in a row in 2018, the prospect of Day Zero will loom once again next summer.

Despite initial challenges in getting households to reduce their water use, the campaign in Cape Town ultimately succeeded in achieving substantial water savings. But these responses have taken a toll on the city government, straining staff and resources. Funding for other basic services and development projects has been put on hold as money streams into managing the water crisis. Tourists

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have stayed away, worried that the city might close down. The ecosystem has suffered from depleted groundwater and river flow.

MORE TO COME

It looks as though Cape Town will pull through this time, but it was a narrow escape. The consequences of the city's water system shutting down would be so far-reaching that they are hard to imagine. How should large cities prepare for climatic extremes like this, which are likely to become only more frequent?

While the response to this crisis was dominated by technical and behavioral interventions, a more comprehensive approach will require negotiating new governance arrangements and rapidly forming new networks. Cape Town had the capacity to manage some of these tasks but officials did not communicate well with the public or undertake sufficient community engagement. The crisis highlighted the need to establish relationships and modes of engagement between city officials and other groups, since it is hard to activate new ones in haste during a crisis.

Civic groups popped up and neighborhood responses emerged in many places, a heartening illustration of the potential for bottom-up action. But how does a city ensure that this capacity is actively developed to support urban resilience? There is no easy answer. Input from experts and the engagement of the private sector as well as the cooperation of residents will be needed.

Meanwhile, how do river systems such as the Limpopo River Basin, which overlaps several

countries and supports a high number of rural households with limited capacity, prepare for future climate shocks? Many people have lost food security, their livelihoods, and even their lives during climate extremes, and national economies have suffered. Unfortunately, such impacts are likely to intensify in the future unless more resources are secured for improving the water supply and strengthening its governance.

In both urban and rural contexts, water resources are highly vulnerable to climate variability and have a direct impact on livelihoods and economies. For a holistic understanding of the problem that can lead to appropriate responses, we need more contributions by scholars from diverse disciplines, and from practitioners, officials, and experts in governance and cultural challenges as well as technical ones.

Adaptation is only going to get more challenging as changes in the climate intensify, combining with the effects of rapid urbanization and the persistently high levels of poverty and inequality in Africa. Good examples of civic organizations and innovative partnerships that have developed ways of living with less water must be shared and supported more widely. Instead of continuing to rely on the techno-managerial approaches that tend to be dominant at present, we should prioritize governance and equitable distribution of scarce resources in adaptation planning and policy. Adapting to climate change will be one of Southern Africa's greatest challenges; meeting it will require an effort that includes society as a whole, rural and urban, rich and poor. ■