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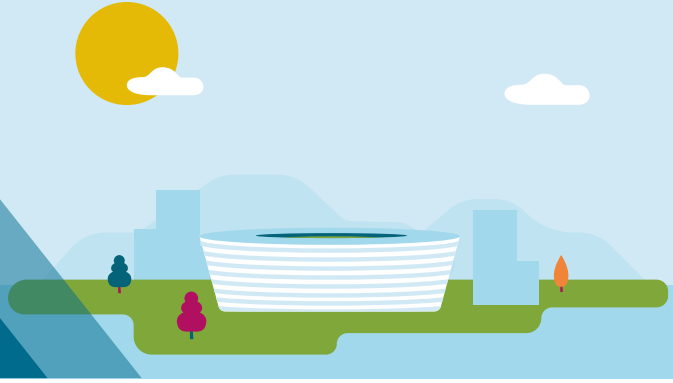


# WATER SECURITY THE CASE OF CAPE TOWN'S SEVERE WATER SHORTAGE

## OUR CHALLENGE

It seems counter-intuitive: Earth, our blue planet with 70% water, but only 2.5% of which constitutes fresh drinking water. Worse still, most of this is locked up in glaciers, ice and snow[1].

A 2018 report by a high-level panel convened by the United Nation Secretary General and the World Bank president investigated how the world manages water. Entitled "Making every drop count: An Agenda for Water Action", the report notes: "About 2.5 billion people (36% of the world's population) live in water-scarce regions.[2]" It further notes that:

### BY 2050, MORE THAN HALF OF THE WORLD'S POPULATION – AND ABOUT HALF OF GLOBAL GRAIN PRODUCTION – WILL BE AT RISK DUE TO WATER STRESS.

The International Resource Panel (IRP) mirrored these concerns in a report released in 2012 where it warned that by 2030 global demand for fresh water could outstrip supply by more than 40% if no changes are made to how we manage water.

Climate change, through its disruption of the Earth's water cycle, introduces additional complexity by changing when, where and how much rain falls. Extreme changes in rainfall (whether attributed to human-induced climate change or natural/internal variability) put strain on water management systems as these systems were designed based on a more stable climate.

Socio-economic factors, too, play a significant role. In many parts of the world economic growth, population growth,

better living standards and deteriorating water quality are responsible for the levels of water stress observed. An OECD report entitled "OECD Environmental Outlook for 2050" notes that:

### WATER DEMAND IS PROJECTED TO INCREASE BY 55% GLOBALLY BETWEEN 2000 AND 2050

with significant increases for manufacturing (+400%), electricity (+140%) and domestic use (+130%). Significant improvements in irrigation and limitations on irrigated Land use is driving reductions in the use of water in the agriculture sector[3].

1. https://water.usgs.gov/edu/earthwherewater.html
2. http://pubdocs.worldbank.org/en/623971522268005372/17825HLPW-Outcome.pdf
3. https://read.oecd-ilibrary.org/environment/oecd-environmental-outlook-to-2050_9789264122246-en#page1

# CAPE TOWN – THE "DAY ZERO" SCENARIO

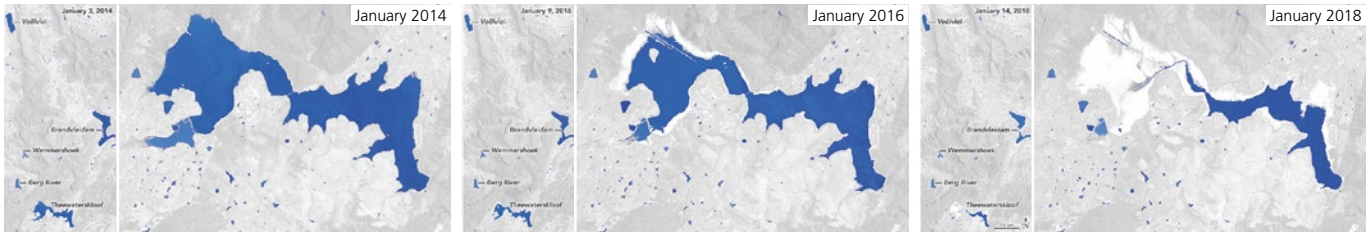
Cape Town's recent water crisis provides useful insights to help understand the interplay between climate change, socio-economic factors and water supply when assessing resilience of cities to natural disasters.

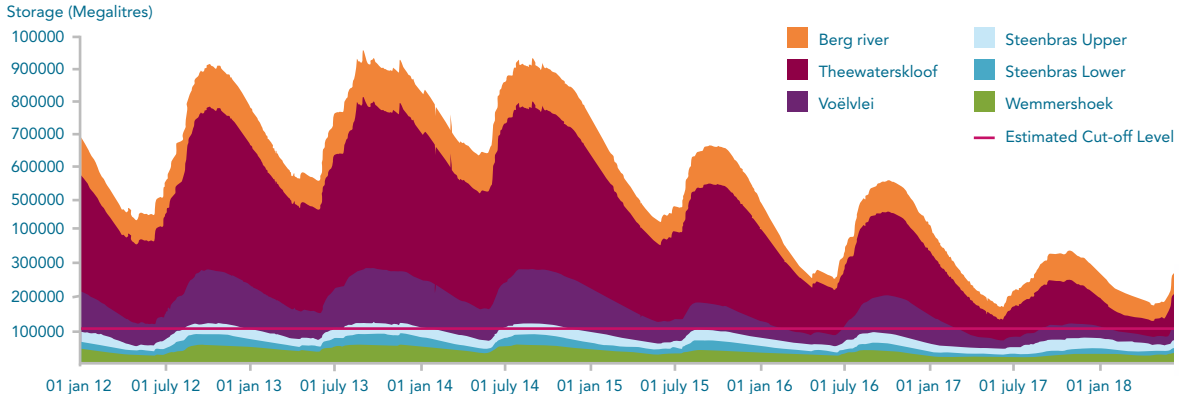
Cape Town, South Africa's second biggest city, is home to almost four million residents. As winter rains failed for the third consecutive year (2015-2017), water levels in Cape Town's six major reservoirs dropped to just over a quarter of its 900,000 megalitre[4] capacity – effectively only 15%, as the last 10% is not usable.

The six major dams make up the majority of the Western Cape Water Supply System (WCWSS) that supplies residents and commercial industries including agriculture, construction and retail businesses. More than half of the total capacity at the major dams come from the 480,000 megalitre Theewaterskloof dam. Before the 2015 drought, capacity stood at 75%. After three consecutive drought years, capacity dropped to 22% in March 2018, with Theewaterskloof falling from 76.7% in March 2014 to 10.6% in March 2018. Almost all Cape Town's water supply comes from rain-fed sources, with a clear dependency on the Theewaterskloof dam.

THEEWATERSKLOOF DAM

Source: AdobeStock

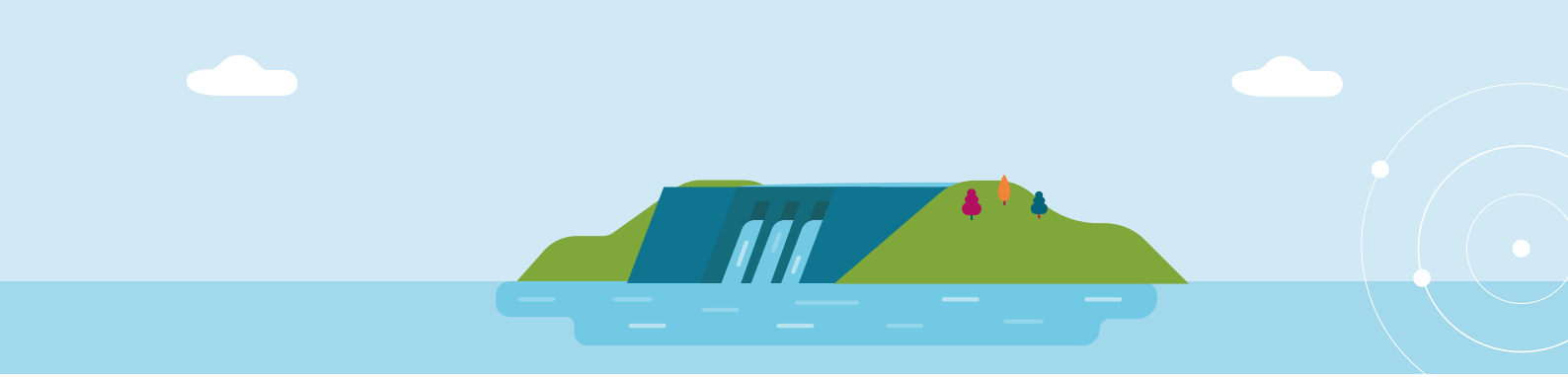



DWINDLING SUPPLY ACROSS THE SIX WCWSS DAMS THAT FEED CAPE TOWN

Source: http://www.capetowndrought.com/ (bottom panel), Nasa Earth Observatory (top panel)

4. A megalitre is equivalent to a million litres

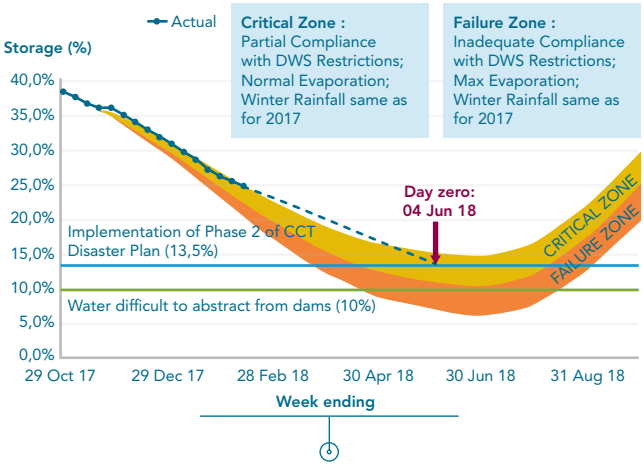


# EMERGENCY RESPONSE

The sharp reduction in available water prompted officials to initiate a range of mitigation measures with the national government declaring the drought a national disaster. Most alarming however was the ominously named "Day Zero", which represents the date when officials estimate capacity in the six main dams would drop to 13.5%. At this point the city would turn off piped water supply to 75% of the city's homes – over a million households. Residents would be forced to queue for water at 200 water collection points around the city to ensure a guaranteed minimum of 25 litres per person per day. South African National Defence Force and police personnel would be deployed to oversee water distribution.

Day Zero moved in relation to the city's adherence to the daily target of 450m litres. Preventative measures included per person limits of 50 litres per day – implemented from 1 February 2018. For perspective, an average American uses over 300 litres of water per day, according to a report by U.S. Geological Survey.

Water tariffs increased and were structured to disincentivise excessive consumption[5]. Water restriction devices were installed for non-complying residents. Water pressure was reduced. A water map[6] was published showing green lights over homes that were conserving water, exposing those that didn't. Water intensive activities such as filling pools, washing cars, watering lawns, were banned. These initiatives serve as an important reminder of the capacity of a city to preserve its scarce resources.




CAPE TOWN CITY'S WATER DASHBOARD SHOWING THE TREND IN WCWSS ACTUAL AND PROJECTED CAPACITY, AND THE INFERRED DAY ZERO, WHEN TAPS WOULD BE TURNED OFF.

Source: capetown.gov.za (published weekly, accessed 13 February 2018)

# RESILIENT CAPE TOWN

Perhaps most inspiring was the capacity of most Cape Townians to adapt as local communities galvanised to avert the impending disaster. A comprehensive public awareness campaign covering social media, television, radio and print media provided detailed advice on how to carry out household activities within the 50 litres per person limit[7]. Residents recycled water, harvested rainwater (when the occasional shower came) and installed boreholes. Hotel guests were encouraged to take shorter showers and flush toilets only "when necessary". New habits were learnt. Agriculture industry reduced usage and some farms even released water from private dams to increase levels in reservoirs serving the public.

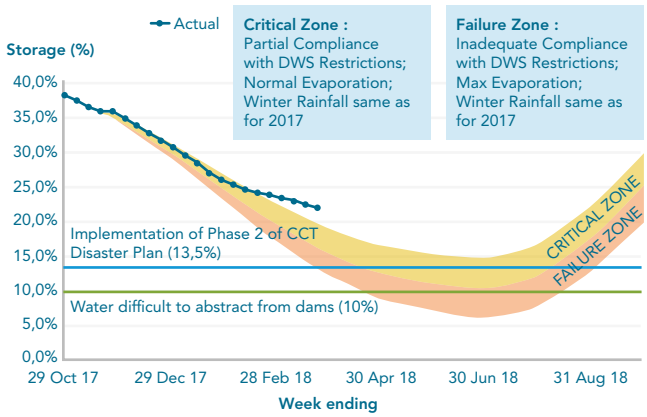

PUBLIC AWARENESS INFOGRAPHICS AND SLOGANS

Source: Eye Witness News (top panel), Capetown.gov.za (bottom panel)

5. https://www.news24.com/SouthAfrica/News/city-of-cape-town-ups-price-of-water-to-reduce-consumption-20180206
6. https://citymaps.capetown.gov.za/waterviewer/
7. http://resource.capetown.gov.za/documentcentre/Documents/Graphics%20and%20educational%20material/Water%20Saving%20Checklist%20to%20Avoid%20Day%20Zero.pdf

# DISASTER AVERTED

The range of conservation efforts reduced consumption from ~1.2 billion litres per day in February 2015 to levels just over 500 million litres per day in mid-September 2018 and Day Zero was pushed out to 2019.





DISASTER POTENTIALLY AVERTED AS PROJECTED CONSUMPTION NOT EXPECTED TO ENTER THE CRITICAL ZONE

Source: left panel: capetown.gov.za (published weekly, accessed 29 March 2018). Right panel: @CityofCT

# COSTS (AND GAINS)

According to media reports, the drought and adaptation measures came at a significant cost, affecting a range of businesses reliant on water. Reduced consumption meant reduced revenue to the City of Cape Town, which contributed 10% of Cape Town's operating income in 2017. Less easy to quantify is the potential reputational cost to officials responsible for water management. Water restrictions and tariff increases affected revenue, costs and jobs across tourism, food and wine industries, construction companies (who rely on water for cement), and retail businesses such as hairdressers and car wash companies[8]. Construction project delays had a knock-on effect on delivery of schools and road repairs.

Increased costs and impacts of the water crisis on commerce prompted Moody's, the rating agency, to issue a credit rating report[9], highlighting the potential impacts of the crisis on the city's ability to service its debts.

Impact on food prices (fruits, vegetables, but also beef) was reported to be mitigated by supply from neighbouring areas unaffected by water restrictions. However, a sustained period of drought would increase food prices, with disproportionate impacts on the poor.

Adaptation measures also raised concerns about their potential environmental impacts including risk of over-utilised groundwater aquifers (which can also accelerate sea level rises as coastal cities sink) and threats to biological diversity[10].

The increased threat of water-borne diseases is also cause for concern. The South African Medical Association (SAMA) warned in 2015 already that "the direct and indirect consequences of climate change – with five South African provinces already declared drought disaster areas – would see increases in malaria, dysentery, cholera and dengue, compromised drinking water, a loss in production and food security and an increase in extreme weather events."

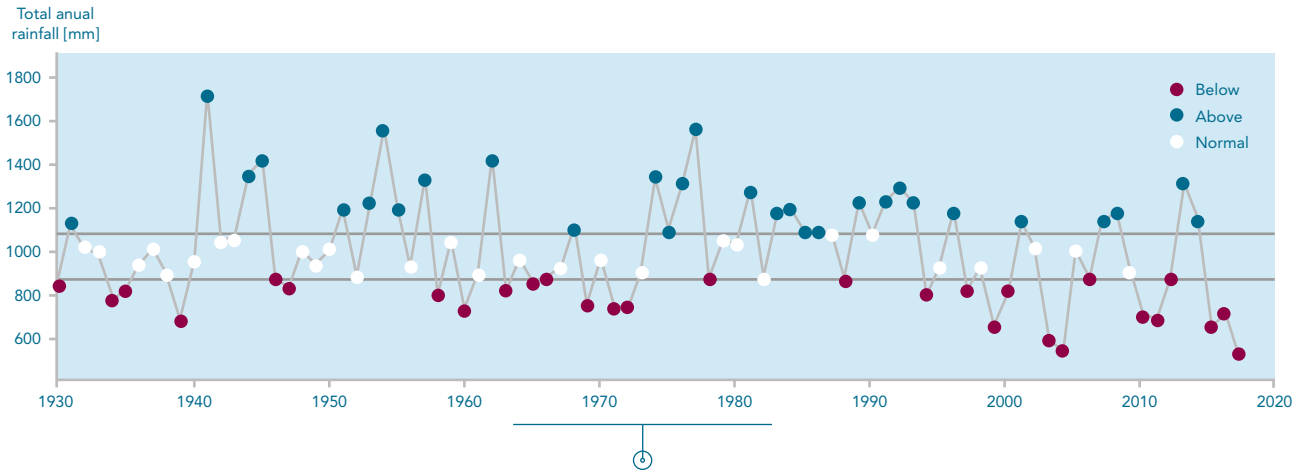
A report in Reuters in 2016 mirrors these comments on the link to disease when it noted "residents hoarding rain water in canisters spurred an outbreak of mosquito-borne dengue and possibly the more recent scare of Zika.[11]"

8. https://www.cnbc.com/2018/03/06/south-africa-cape-town-drought-economic-impact.html
9. https://www.bloomberg.com/news/articles/2018-01-29/moody-s-says-water-crisis-credit-negative-for-city-of-cape-town
10. http://www.sciencemag.org/news/2018/02/ecologists-arms-over-cape-town-s-plans-ease-water-crisis-drilling-aquifer
11. https://uk.reuters.com/article/us-brazil-water/drought-ends-in-brazils-sao-paulo-but-future-still-uncertain-idUKKCN0VR1YJ

While dwarfed by consequential costs, the water crisis has provided some gains. Large contractors won Government tenders for exploration and drilling contracts to tap underground water and build temporary desalination plants.

Small businesses involved in water management have responded to the increased demand for boreholes, reverse osmosis water filtration systems, rainwater harvesting systems, compost toilets and water-restriction devices.

## HOW DID THIS HAPPEN?

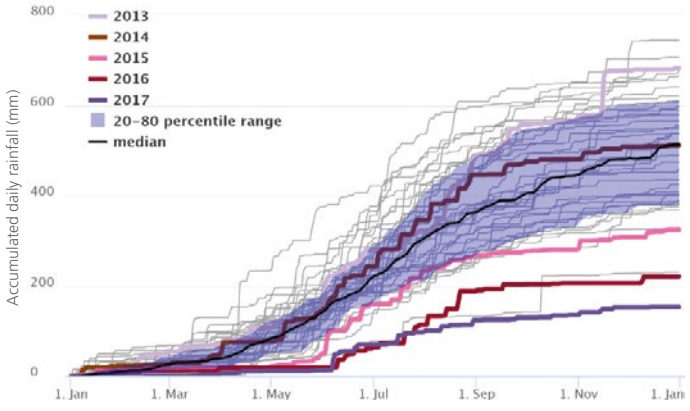



ANNUAL TOTAL RAINFALL (MM): SAWS' RAINFALL DISTRICT 4 (INCLUDING CAPE TOWN)

Source: South African Weather Service (SAWS)

Rainfall data from the South African Weather Service (SAWS) reveal that 2017 was the driest year on record (with 2015 the second driest). While the meteorological drought is rare, dry clusters have occurred before. Note the long dry spells in the exhibit above from mid 1920s to 1939, the early 70s and late 90s.

The remoteness of the recent drought was the subject of analysis conducted by the Climate System Analysis Group (CSAG). Their analysis suggests the three-year observed rainfall has a recurrence of ~1:300 years[12].




CUMULATIVE DAILY RAINFALL FOR CAPE TOWN INTERNATIONAL AIRPORT TELLS A SIMILAR STORY ABOUT THE RARITY OF THE LAST THREE YEARS

Source: DATA: SAWS through GSOD,
Figure: © Climate System Analysis Group, University of Cape Town

12. http://www.csag.uct.ac.za/2018/01/22/facts-are-few-opinions-plenty-on-drought-severity-again/

## THE ROLE OF CLIMATE CHANGE

Why were the droughts so extreme? Was it bad luck or is there a climate signal beyond natural variability? The Intergovernmental Panel on Climate Change (IPCC) notes that "precipitation projections are more uncertain than temperature projections[13]". Climate models predict that it's "very likely" we will see decreases in mean annual precipitation over Southern Africa beginning in the 2050s.

The IPCC findings for Africa focus on average annual rainfall. While studies[14] suggest a higher chance of drought years as we approach the end of the 21st century, further research is needed to understand how global warming may change the likelihood of having clusters of drought years, as was observed in 2015-2017[15].

## THE ROLE OF NATURAL VARIABILITY

Most rain in the Western Cape Province falls during winter months (April to September), and very little rainfall is received during summer months, which is modulated by El Niño Southern Oscillation (ENSO). ENSO therefore has a relatively minor influence on rainfall in the Western Cape. As the South Africa Weather Service notes "rainfall in the Western Cape Province is often modulated by the passage of cold fronts, that develops over the Southern Ocean, and the cross-continental passage of these fronts are important for Cape Town's rainfall." The Southern Ocean circulation, and critically, the frequency of these cross-continental passage of cold fronts across the Western Cape is difficult to predict at a seasonal time range (one to three months in advance). This complicates disaster response efforts.

## THE ROLE OF POPULATION GROWTH, INCREASING LIVING STANDARDS AND FARMING

Population growth brings increases in water demand, with further increases as living standards improve. Cape Town has seen significant increases in living conditions post-Apartheid including formal housing with piped water.

In analysis conducted by the South African Environmental Observation Network, population and dam capacity data since 1841 was analysed[16]. They found that dam capacity *per capita* has halved since the construction of the Theewaterskloof Dam in 1980. Demand increases (74%), as measured by population growth outstripped supply increases (15%) for the period 1996-2016.

WHILE CONSUMPTION INCREASES WITH IMPROVING LIVING STANDARDS, CAPE TOWN'S RAPID ADAPTATION ILLUSTRATES HOW QUICKLY COMMUNITIES CAN LEARN NEW WATER-CONSCIOUS HABITS.

City officials too have learnt how to keep *per capita* consumption under control through metering, tariff structures that dissuade excessive use and public awareness campaigns.

There are also indirect effects as improving living standards influence purchasing patterns. Increased demand for meat has led to a growing cattle and poultry farming industry. These operations generate significant waste thus requiring substantial quantities of water for cleaning. Similarly, the introduction of alien, water-intensive crops require artificial irrigation, which is a big drain on water supply.

These demands on water supply will only increase as cities such as Cape Town become bigger and its people become wealthier.

13. https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap22_FINAL.pdf
14. http://www.csag.uct.ac.za/2017/11/01/is-cape-towns-drought-the-new-normal-piotr-wolskis-article-for-groundup/
15. https://www.worldweatherattribution.org/the-role-of-climate-change-in-the-2015-2017-drought-in-the-western-cape-of-south-africa/
16. http://www.saeon.ac.za/enewsletter/archives/2017/october2017/doc01

# LESSONS LEARNT AND THE ROLE OF (RE)INSURANCE

Here are a few lessons drawn and opportunities for collaboration with (re)insurers:

**1. A strong dependence on a single water source tests water supply in drought years and could cause significant strain during consecutive drought years.**
A strong dependence on a single dam (Theewaterskloof in the Cape Town example) tests supply when rainfall in the dam's catchment is low for long periods. Cities need to diversify their water supply by introducing additional water sources such as groundwater aquifers, desalination plants, natural springs and wastewater recycling.

**2. Even with redundancy, water supply systems could fail when in extreme climate scenarios.**
Cities should quantify future expected growth in water consumption and given planned demand increases, estimate costs of interventions should the city experience a 200-year drought scenario, 500-year drought scenario or 1000-year drought scenario. This could include costs of /associated with:

- implementing water restrictions;
- importing drinking water, as Barcelona did in 2008 when water tankers were brought in from other cities;
- More extreme measures, such as towing an iceberg from Antarctica, as the UAE is considering[17] or
- Emergency water treatment.

**3. Demand will continue to outstrip supply unless significant interventions are implemented.**
Competing priorities such as education, unemployment, housing and HIV/AIDS in the case of South Africa, and fiscal tightening make this task challenging and can politicise planning around water supply. Should these water shortages continue, lack of intervention could prove politically costly.

**4. Water shortages can emerge due to several reasons.**
Water management departments need to conduct counterfactual studies of past water crises that have affected other large cities to better learn how to plan for these disasters. Water stressed countries like Australia have implemented major adaptation programmes to improve water security despite growing cities and erratic rainfall. Some countries/cities however face a growing risk of water security:

- Brazil: large cities in South East Brazil such as Sao Paolo and Rio de Janeiro, like Cape Town, are susceptible to dry years;
- Bangalore and Cairo due to its water pollution issues;
- Large cities in China, due to population growth, where 20% of the world's population accesses 7% of the world's fresh water; pollution and lack of diversification of its water supply;
- Jakarta, due to draining of aquifers and resulting sinking;
- Moscow, due to water pollution and high dependence on a single water source;
- London, due to its lower annual rainfall relative to other large European cities and high dependence on Thames;
- Tokyo, due to its short rainy season and;
- Miami, due to contamination of the Biscayne Aquifer, the city's main source to fresh water.

**5. When a crisis looms, demand can be managed efficiently.**
Cities should assess the tools employed by the City of Cape Town and local communities to cut demand.

**6. Droughts are challenging to predict.**
Uncertainty about climate risk influences investment decisions. Inaction due to lack of understanding is a poor outcome. Concise probabilistic forecasts communicated clearly in a way that aids understanding is essential in planning for adverse scenarios.

**7. Climate change is considered a threat multiplier[18].**
Cities need to invest in research to better understand the potential impacts of climate change on their future water supply systems.

17. http://gulfnews.com/news/uae/tourism/firm-to-tow-icebergs-from-antarctica-to-fujairah-1.2020868
18. https://www.un.org/press/en/2017/sgsm18470.doc.htm

# CONCLUSION

This case study presents opportunities for (re)insurers to partner with cities in developing resilient risk-based solutions. With deep expertise in modelling climate risks and designing financial structures, the (re)insurance industry is well placed to support cities improve resilience when water systems are stressed.

Indemnity-based risk transfer solutions can help to cover known additional / increased costs when emergency interventions are initiated. The loss of revenue to small business due to failure of the municipal water supply could also be included where there is low penetration in the private (re)insurance market.

Non-indemnity parametric solutions are an alternative to traditional (re)insurance solutions and would be more useful where immediate funding is needed. Apart from using pay-outs to offset costs incurred to manage a water crisis, they could also help treasury ease funding hurdles. For example, (re)insurers could work with national treasury to structure a climate-linked parametric funding solution that injects capital into large infrastructure projects following severe drought years. UNISDR Making Cities Resilient campaign provides a useful entry point for interested risk professionals.

Cape Town's experience presents some key insights about water security and the vulnerability of cities. Risk Officers in large or rapidly growing cities, especially in semi-arid regions should study the Cape Town example to better understand the vulnerabilities facing their cities and explore financial solutions to mitigate potential risks. SCOR stands ready to step up its engagement with Cities to develop resilience solutions.

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