A. Veronica Lewis
Academy of the Holy Names - Albany
Clifton Park, New York
Cape Town, South Africa - Water Scarcity

The Crisis in Cape Town: Avoiding Day Zero

Areas like Cape Town, South Africa are accustomed to surviving dry years. In response to drought, water restrictions are established and dams refill during subsequent wet years. The most recent drought to strike Cape Town has been different. Never in recorded history has Cape Town encountered a dry spell of such severity across three consecutive years. This water shortage is due to a combination of environmental factors, like a lack of rainfall and an abundance of alien plant species, and has been amplified by issues with infrastructure, such as leaky pipes and insufficient dam storage. These elements call for an amalgamation of solutions headed by the government of South Africa, its citizens, and private companies. The South African government has an obligation to create and fund projects which would ease the crisis, while citizens must work to conserve and recycle their water supply. The most promising short term solutions include desalination of nearby seawater and the imposition of extreme conservation measures, many of which the government of Cape Town has already put in place. Longer term solutions include the removal of alien plant species from existing water retention areas, improvements and repairs to existing delivery infrastructure, and the implementation of a set of smaller measures to more effectively capture and use grey water resources.

Cape Town is a port city on the southwest coast of South Africa. It is known for its pristine beaches, botanical gardens, and rich historical culture. However, a tourist's experience does not reveal the realities that many South African families face. Research of the country highlights patterns; one cannot understand South Africa without recognizing the significance that both water and economic status play in its society. The water story of this country impacts food production. About 10.3% of South Africa's land can be used for crop production. However, only around 20% of that land is high-potential arable land (Arable Land (% of Land Area)). The greatest limitation to agriculture is the availability of water, due to uneven and unreliable rainfall (Arable Land (hectares)).

Nationally, satisfaction with available water quality has been declining steadily since 2005. In 2017, 3.7% of households still had to fetch water from rivers, streams, and stagnant water sources (Statistics South Africa). South Africa is documented as having one of the most clean water systems in the world. Nevertheless, a lack of sanitation and access for rural communities has increased the threat of water borne diseases (Water in Crisis). Water is inexorably tied to other health issues like nutrition. Over 45% of South Africans are not consuming meals that have nutritional diversity. 28.3% of South Africans live in hunger, and an additional 26% are at risk of food insecurity ("This is what the typical diet looks like in South Africa.").

Statistical data show a steady decrease in annual rainfall in the Western Cape province; 2017 was the year with the lowest rainfall since 1933 (Chutel). In addition, Cape Town's population has grown from 2.4 million residents in 1995 to an estimated 4.3 million in 2018 (Chutel). This growth in population has not been matched by a sufficient increase in dam storage capacity (Chutel). Cape Town's main urban area covers 154 square miles and is part of the larger municipality of Cape Town, a region of about 400 square miles. Cape Town has the largest population density in South Africa, even greater than that of Johannesburg, South Africa's largest city ("South Africa - Population Density"). Cape Town is also a magnet for tourism in the region, bringing more than one million tourists per year to the city ("Cape Town Tourism 2017 Annual Report"). All of this puts tremendous stress on the existing infrastructure for the delivery of clean, potable water. Cape Town has been able to defer an imminent "Day Zero," a term

used to describe the foreboding day when the whole city's water supply will be gone, by limiting each citizen's water intake to 50 liters a day (Chutel). Comparing this limit to the 300 liters that the average American uses shows the gravity of the situation. The people of Cape Town have showered over buckets to catch and reuse water, limited how much they flush their toilets, and used hand sanitizer instead of washing their hands (Chutel). Staggered tariffs on water consumption have also been imposed. Unfortunately, even such extreme preservation is not a long-term solution.

Building a dam along one of the rivers in the area, such as the Breede River, could mitigate the problem. However, it would cost about $20 billion to build a dam with sufficient capacity to support Cape Town's dwindling water supply, and South Africa already has 500 government owned dams. (Water Research Commision). In its current financial condition, Cape Town would likely be unable to fund such a large project on its own, and a shortage of federal government resources makes the undertaking of such an expensive project infeasible (Vecchiatto). In addition, though dams can generally be a good source of clean energy, they also have a profound impact on the people and wildlife surrounding them. According to a 2017 report by the Internal Displacement Monitoring Center, the construction of dams is responsible for displacing 80 million people worldwide, as well as diminishing the world's freshwater wildlife population by 80% (Parshley). Therefore, a new mass storage dam may be only marginally preferable to other less expensive measures from an environmental perspective.

A combination of approaches could comprise a four-point plan to balance Cape Town's water accessibility and use. The plan would provide a buffer against future periods of drought, during which its legacy collection systems would not be sufficient to sustain the basic water usage needs of its population and visitors. The elements of the plan would be:

1. Large capacity desalination plants to supply near and mid-term water needs
2. Increased capacity of natural and mechanical mass storage systems to increase water reserves for sustained periods of drought
3. Long term infrastructure improvements that would allow the city to wean off of desalination after an initial period
4. Grey water capture systems and other technologies introduced into building codes

While this plan is ambitious, the cost of failing to address the water shortage in Cape Town with significant changes could be a cascading financial crisis amplifying the impact of the natural resource shortage. This is a real threat as tourists begin to avoid the area due to the water shortage. The four elements of the proposed plan are discussed in further detail below.

Desalination

Cape Town's coastal location offers the opportunity for the construction of desalination plants along its waterfront. It costs about $658 million to build a large desalination plant, using traditional designs, which would purify about 380,000,000 liters of water per day ("Desalination FAQ"). However, Israel Desalination Enterprises (IDE) has developed an innovative type of megascale desalination plant that produces 627,000,000 liters of water per day for an initial investment of about $500 million (Talbot). If this type of plant were used in South Africa, it would provide 150 extra liters of water per day to each citizen of Cape Town. These plants use reverse osmosis to produce clean, potable water from saltwater. Traditional desalination uses more energy than other water-purifying techniques, but new engineering by IDE has cut energy and building costs significantly. These plants utilize larger tubing than that which was used in previous plants, reducing the cost of piping and hardware (Jacobsen). They also employ energy recovery devices to capture hydraulic energy otherwise lost from the stream of ejected seawater (Biche). This energy is transferred with 98% efficiency, dramatically improving on the energy consumption usually associated with reverse osmosis systems ("The Leading Energy Recovery Solutions in

Desalination"). Large scale desalination could serve Cape Town as one element of a comprehensive plan to bring the city into long term equilibrium with its water resources. Desalination plants could run year-round, even during non-dry seasons. That potential, coupled with a plan for creating additional mass storage of clean potable water, could create a reserve for the inevitable periods of drought that Cape Town so often experiences.

Effective Storage Capacity

While Capetown's system of dams can theoretically hold a supply of water that would be sufficient to survive a very dry season, its main storage challenge comes from a single environmental condition:

The population of invasive plant and tree species within and around the 44 dams that currently store most of Cape Town's water supply are very thirsty. These species consume enough water each year to refill the 44 storage dams to full capacity (Wild). One estimate has the current level of invasive species growth in the areas of Cape Town's dams reducing the water supply by more than 100 million liters per day (Qukula). Because these alien plant species tend to use more water than native species, and also crowd out the native species, the problem is multiplied as the alien species proliferate and expand their footprints.

The solution to this condition, while potentially costly, has three advantages to its implementation. First, there is an existing model for returning the land in and around the dams to its native state by eradicating the invasive fauna. Vergelegen Wine Estate, a private venture, has successfully cleared 2200 hectares (about 5,400 acres) of storage dam areas of most of the invasive plant species that soak up massive amounts of water (Qukula). This project could serve as a model for a large scale operation that addresses a significant portion of the acreage in and around Cape Town's 44 dams. Second, the Vergelegen project created many jobs for local workers whose earnings contributed to the regional economy (Godard). This type of investment reverberates through the economic system in addition to its directly measurable benefit to the water supply. Third, the successful project proved that reducing the presence of alien plant species also reduced the need for toxic insecticides. This reduced the runoff contamination of adjacent dams and groundwater. This ancillary benefit of such a project would have additional positive economic and health impacts. Overall, the implementation of an alien species eradication plan would take significant pressure off of the current supply system, and provide a pathway to potable water stability with the addition of other supporting measures.

Infrastructure

Capetown's main infrastructure challenges come from two critical conditions:

1. The water delivery infrastructure in Cape Town is in a serious state of disrepair. This condition causes both a loss of water due to leakage from the system, and access problems for a significant portion of the population. This is true even in years when the overall supply of water is adequate.
2. Wastewater treatment capacity and operations are both inefficient and insufficient.

Solving the first critical infrastructure condition would decrease the overall demand on Cape Town's water supply systems, complementing other measures discussed above. A recent study (Crookes et al, 8) estimated that more than 1 cubic kilometer of water is lost in the supply system due to physical infrastructure deficiencies (leakage). This amount, if recovered, would represent about 7% of current demand levels, and would dramatically narrow the gap between the current supply and the current demand for potable water. The same study indicated that addressing this problem could create thousands of jobs in the plumbing and infrastructure sector. These would be relatively high paying jobs and would have a positive economic impact.

A related infrastructure issue involves the treatment of wastewater in South Africa. Currently only about 54% of municipal wastewater is treated (Crookes et al, 11). Treated wastewater can be used as grey water in a number of agricultural and industrial applications, reducing the demand for potable water by these high demand activities. Treating additional wastewater would have a more modest impact on the overall supply, improving it by about 10% of the amount provided through delivery infrastructure repairs. While this is relatively small, it still represents a large amount of water. It is potentially a complementary measure to close the water demand/supply gap in Cape Town. As nearly a quarter of South Africa's wastewater treatment facilities are in a "critical state" needing "urgent intervention" (Crookes et al, 11) an increase in waste water treatment capacity could be accomplished through repair of the current facilities, rather than the capital investment that would be required for new facilities.

As an additional infrastructure measure, Cape Town might also consider the adoption of local building codes that mandate the addition of grey water capture systems in new construction or major renovations. Such systems would make greater use of rainfall captures during wet seasons to reduce the use of potable water for such purposes as flushing toilets, maintaining landscaping and other irrigation needs (Curry). The cost for materials used in such systems start at about $200.

Recent Developments

The South African government funded Quality Filter Systems (QFS) after the company won a tender in 2018 to provide an emergency desalination plant to delay Day Zero. However, this plant has not been in use since February of 2019, due to the company's concern about the turbidity of the water (Liao). QFS has contacted the City of Cape Town to see whether the water is safe for injection, but the City has made no response. The City also has not made a monthly payment to QFS since August 2018, and currently owes the contractor R21.5m (Liao). Two other desalination plants, also commissioned by the government of Cape Town and run by private enterprises, are still in operation. The combined output of the two operating plants is more than 15 million liters of potable water per day (Veolia Water Technologies). The South African government has also pledged to enact a campaign to update infrastructure, with the objective of reducing water waste. Designated the "War on Leaks," the campaign's goal is to create a reduction in non-revenue water in South Africa. The project will employ 15,000 South Africans as plumbers and artisans, boosting the struggling economy while also addressing the water shortage (Johnson). Mother Nature has also intervened with a most recent season of normal rainfall. While this has been a welcome condition, it does little to reassure the population of Cape Town that its water resources are sufficient and prepared to withstand another inevitable dry season.

The present return to more normal levels of rainfall has given a reprieve of unknown duration to the area of Cape Town, South Africa. While its most recent bout with severe drought conditions has passed, the region remains at risk for additional water shortages should dry conditions return. Without significant progress on several of the measures discussed above, Cape Town could face another day zero water crisis in the very near future. By implementing a coherent and comprehensive plan for its water resources and infrastructure, Cape Town has the opportunity to avoid a repeat of its latest water crisis. Cape Town's water program, if properly conceived and executed, could serve as a model for other communities and regions facing similar pressures due to shifting climates and weather extremes.

Works Cited

Africa, Statistics South. "The latest household statistics and more." Statistics South Africa. 19 Mar. 2019 <http://www.statssa.gov.za/?p=11241>.

"Arable land (hectares)." Data. 19 Mar. 2019 <https://data.worldbank.org/indicator/AG.LND.ARBL.HA?locations=ZA&view=map>.

“Arable Land (% of Land Area).” *Data*, World Bank Group, Feb. 2019, data.worldbank.org/indicator/AG.LND.ARBL.ZS?view=map.

Biche, Bart. “Highly Efficient Energy Recovery Devices”. Sept. 2011. *Energy Recovery*, www.energyrecovery.com/resource/highly-efficient-energy-recovery-devices/. Accessed 24 Feb. 2019.

"Cape Town Tourism 2017 Annual Report." *Cape Town Tourism*, www.capetown.travel/annualreport/2017/. Accessed 24 Feb. 2019

Chutel, Lynsey. "How Cape Town Delayed its Water-Shortage Disaster—At Least Until 2019." *Quartz Africa*, 9 May 2018. *Quartz Africa*, qz.com/africa/1272589/how-cape-town-delayed-its-water-disaster-at-least-until-2019/. Accessed 24 Feb. 2019.

Crookes, Courtney, et al. “A Delicate Balance: Water Scarcity in South Africa.” *Institute for Security Studies,* March 2018, issafrica.s3.amazonaws.com/site/uploads/sar13-2.pdf.

Curry, Pat. "Is a Passive Greywater System for You?" *HouseLogic*, www.houselogic.com/save-money-add-value/save-on-utilities/passive-greywater-system-you/. Accessed 24 Feb. 2019.

"Desalination FAQ." *Texas Water Development Board*, www.twdb.texas.gov/innovative water/desal/faq.asp. Accessed 24 Feb. 2019.

Godard, Paul. “Environmental Project.” *Vergelegen Estate - Environmental Project*, www.vergelegen.co.za/environmental_project.html.

Jacobsen, Rowan. "Israel Proves the Desalination Era Is Here." *Scientific American*, Ensia, 29 July 2016, www.scientificamerican.com/article/israel-proves-the-desalination-era-is-here/. Accessed 24 Feb. 2019.

Johnson, M. “Bucket Eradication & War on Leaks: DWS & Rand Water Inputs; with the Minister.” *PMG*, 13 Feb. 2019, pmg.org.za/committee-meeting/27884/. Accessed 20 July 2019.

Liao, Kristine. “Dirty Sea Water Brings Cape Town Desalination Plant to a Halt.” *News24*, 7 May 2019, m.news24.com/SouthAfrica/News/dirty-sea-water-brings-cape-town-desalination-plant-to-a-halt-20190506.

Parshley, Lois. “The Costs and Benefits of Hydropower.” *Smithsonian*, 5 January 2018, https://www.smithsonianmag.com/innovation/costs-and-benefits-hydropower-180967691/

Qukula, Qama. “Invasive Alien Vegetation a Major Threat to Cape dam Levels.” *CapeTalk,* 2 May 2018, http://www.capetalk.co.za/articles/301968/invasive-alien-vegetation-a-major-threat-to-cape-dam-levels-scientist

"South Africa - Population Density." *Trading Economics*, tradingeconomics.com/south-africa/population-density-people-per-sq-km-wb-data.html. Accessed 24 Feb. 2019.

“The Leading Energy Recovery Solutions in Desalination." *Energy Recovery*, www.energyrecovery.com/water/energy-recovery-desalination/. Accessed 24 Feb. 2019.

"This is what the typical diet looks like in South Africa." BusinessTech. 19 Mar. 2019 <https://businesstech.co.za/news/lifestyle/110325/thisis-what-the-typical-diet-looks-like-in-south-africa/>.

Talbot, David. "Megascale Desalination." *MIT Technology Review*, 2015, www.technologyreview.com/s/534996/megascale-desalination/. Accessed 24 Feb. 2019.

Vecchiatto, Paul. "South Africa Has No Immediate Plans for Cape Town Drought Relief." *Bloomberg*, 28 Jan. 2018, www.bloomberg.com/news/articles/2018-01-28/south-africa-has-no-immediate-plans-for-cape-town-drought-relief. Accessed 24 Feb. 2019.

Veolia Water Technologies . “Desalination Plant.” *Veolia*, 2017, www.veoliawatertechnologies.co.za/water-solutions/desalination/desalination-plant/.

"Water In Crisis - Spotlight South Africa." The Water Project. 19 Mar. 2019 thewaterproject.org/water-crisis/water-in-crisis-south-africa.

Water Research Commision. *Dams in South Africa*. Water Research Commision. wrcwebsite.azurewebsites.net/?mdocs-file=35409

Wild, Sarah. “Alien plants threaten to guzzle a third of the water in Cape Town and PE, according to a state report.” *Business Insider*, 4 November 2018, www.businessinsider.co.za/invasive-species-guzzle -cape-water-2018-11