Madi Lund
Central High School
La Crosse, Wisconsin
Cape Town, Water Scarcity

The Price for Water: Water Scarcity in Cape Town

Water is the most precious commodity in the world, especially for countries in the southern hemisphere, but due to the fact of increasingly extreme weather conditions, many often find it hard to find enough water just to drink. There are people suffering all over the world from dehydration and the plethora of issues that can arise from droughts. One city in particular is experiencing these burdens on a dangerous level. Cape Town, located on the western tip of South Africa is one of the largest and most tourist attractive cities in South Africa. Cape Town was even coined as the best place to visit by the *New York Times* in 2014 ("*Fun"*). It is home to the City Bowl, a large peninsula jutting out into the Atlantic Ocean which creates a large port surrounded by mountainous features. Over the past few decades however, Cape Town has been experiencing a substantial jump in population every year. Cape Town's population reached nearly four million in 2011, jumping up 2.6% from the previous decade, and has a proposed population of 4,300,000 by the year 2030. However, because of the large rate of growth, about 1.05% every year, issues of properly and effectively distributing resources has become an issue pushed to the forefront of everyday life. Two-thirds of South Africa's population now lives in urban areas, according to the most recent survey of the country released by the South African Institute of Race Relations (SAIRR), a trend seen clearly in Cape Town. The city's high annual increase in population has led to the creation of large and dense neighborhoods. According to World Population Review, the average population density is 1,530 people per square kilometer, which creates very compact and dangerous conditions, especially during these dry times. These dense areas are typically occupied by non-white citizens who have been forced into these neighborhoods because of old apartheid rules that have not died out in the growing nation. Apartheid was the policy introduced in South Africa in 1948 that legally segregated and discriminated, economically and politically, based solely on race. Because of this harsh system, poorer South Africans are statistically non-white, putting them at a huge disadvantage in the fast coming fight for water. In addition, with most of the wealth and power held by white citizens, possible corruption in water distribution is not uncommon, although the country works diligently to evenly distribute resources to try and create a sense of unification, it is often ineffective.

Cape Town has had a dwindling water reserve for the past few years due to its high and steady population growth and its record droughts. As of 2018, however, they reached a critical state where the city would have needed to shut down public taps and wells, and begin forcing their 4 million residents to line up under military watch to collect water starting mid-April, 2018 (*Welch*). However, because of a recently successful rainy season and diligent human effort, the so called Day Zero, the day water would truly run out, has been pushed back. This may sound like a crisis averted, but the aforementioned Day Zero lies just over the horizon in 2019. The rainy season, while helpful, was not enough to replenish Cape Town's main dam which supplies water to the city. These 'human efforts' also came from the cost of people cutting water usage by over half, as well as the public shaming and fining of water wasters in the city, according to Quartz Media. As reported by James de Villiers with Business Insider "Capetonians use on average only 124 liters of water per person per day, compared to California where residents used 387 liters per day at the height of their drought in 2015." The cutting of water usage, while valiant, is incredibly dangerous for families in Cape Town. A paradigmatic South African family is large, typically including extended family with many children all living with or near each other (*Pier*). These families are also mostly made up of the non-white citizens and are already suffering the financial burden left from apartheid, so for these families to cut water usage, children in particular are being put at risk. White Capetonians, while still being put at risk, often are being put at a greater advantage. Families of European descent tend to follow the nuclear family model, so their homes are typically filled with less people, so

they are able to use less water and get by, so they are not put at as high a risk of being fined for using too much water. The detriments of not having access to clean water are not only dehydration, the primary cause of death for children in Africa, and the second leading cause of death for adults, is diarrheal diseases. These diseases cannot be prevented or treated without access to clean water and proper forms of sanitation (*"Global Water"*). Other possible deadly symptoms include organ failure and the sudden drop of blood pressure, resulting in vertigo. This is especially dangerous considering the large amount of dense and poor neighborhoods scattered throughout the city. This also presents a clear issue besides the looming lack of water. The race issue in South Africa is coming to the forefront of society again. The majority, about 42%, of Cape Town's populations is described as "colored," a term used during apartheid to group together large amounts of non-white citizens. This old-style apartheid and class geographies has maintained disparity for access to clean water for decades and is becoming an increasingly dangerous situation during the current water crisis. It has even been reported that some farmers and even citizens have had to resort to stealing water from their neighbors in order to survive. "The question that dominates my waking hours now is: When Day Zero arrives, how do we make water accessible and prevent anarchy?" says Helen Zille, former Cape Town mayor. There are 'water wars' breaking out all over the city, making the situation faced by citizens even more dangerous, especially since Cape Town is reported to already be one of South Africa's most crime riddled cities. The push for urbanization in Cape Town as its population grows rapidly is continuing to create a vast gap in access to potable water, and the poor urban neighborhoods will be the first to feel it when public taps are eventually shut off, with no true end to the crisis in sight.

Due to the fact of Cape Town's geographical location, on the Atlantic coast, desalination plants are the first obvious idea to provide a fix. However, Cape Town has already built temporary desalination plants which provide seven million liters daily to the city, but since these plants are not permanent, mistakes are often made, and sea water will slip through to people's homes. The city does have plans to build a permanent desalination plant, but construction would not be completed for another 2-4 years, well past the expected Day Zero (*Shelley*). Other issues which could arise from the plants is their environmental impact. Desalination plants require an immense amount of energy to run, the process of which contributes to climate change. However the only issues that can arise from using desalinations plants are not only towards the environment. As stated, Cape Town is a heavy tourist location, and as more and more temporary desalination plants are raised, currently three, sadly the attractiveness of the city decreases. This may seem like a necessary price to pay, but tourism has huge economic value, and often is the source for citizens' main incomes. Shop owners or other tourism attraction owners already are suffering as less people are coming in to visit the city, so as Cape Town continues to struggle, economic burdens will only continue to rise, even if the water burden goes down. Other issues are the fact that desalination plants cannot be put anywhere, finding the right areas which can produce the quality and quantity of water required is difficult enough, then construction begins which can take varied amounts of time. These plants, while reducing the burden, will not last forever, so the technology Cape Town needs is something which can be implemented quickly and will be easily sustainable.

The most precious commodity to the region is disappearing, and as long as the droughts do not end there is no natural way to replenish the resource. However, as technology advances, a possible fix to this problem has been developed in the labs of UC Berkeley and the Massachusetts Institute of Technology. In the field of reticular chemistry, metal-organic framework (MOF) technology in recent years has been developed to harness solar power to pull water from the air and condense it into clean, unpolluted drinking water. The technology combines different materials, organic and inorganic, together to create a specific molecular matrix with particular pocket sizes able to absorb different gases or vapors dependent on their size. Developed by chemist Omar Yaghi in 2017, this device uses highly porous and absorbent substances (MOF), condenser plates, and solar power to take in water at night and condense it during the day into pure drinking water, even in stark desert air. The technology is also incredibly sustainable, as the MOF has strong bonds which give it a crystalline, definitive structure which will not collapse as gases

and vapor moves in and out of it. This technology is a huge advancement and has created a completely new family of materials. Omar Yaghi stated in an interview done by the BBVA Foundation after he was awarded the tenth edition Frontiers of Knowledge Award in the category of Basic Sciences, that this new technology can be used for the purpose of watering dry regions or even purifying contaminated water, since only potable water would be absorbed by the MOF, and harmful chemicals would be left behind. This revolutionary breakthrough would be the perfect technology to provide relief for Cape Town.

Each device uses about one kilogram of the MOF substance placed between a solar panel and a condenser plate. The first substance tested to use in the MOF was zirconium, and it successfully created the correct molecular pocket size able to absorb water; but because of its steep price it would only serve to increase the price of each condensing unit, so a cheaper metal was sought out. Aluminum was later tested as it is one hundred times cheaper than zirconium, and Professor Yaghi was successful in creating a new matrix with the correct structure to take in water and it was effective in early testing in 2017 (*Service*). The MOF, now using aluminum, is placed inside a chamber that is left open during the night so that it may absorb water in cooler weather. During the day, the solar power will heat the MOF so that the water will evaporate and go through the process of condensation at the bottom of the chamber, where the water is then collected in a separate container below. This would be the ideal technology for Cape Town, as they would need many of the devices to produce enough water to help sustain their citizens, and since they take water directly out of the air, the devices could be placed anywhere in the city, instead of just on the coast. The prototype of the condenser was able to pull 2.8 liters of water in 20-30% humidity over a twelve hour period (Sanders). "A person needs about a Coke can of water per day. That is something one could collect in less than an hour with this system," (*Omar Yaghi*). Implementing this technology in Cape Town, a city on the coast of South Africa, with an average relative humidity of 70-80% (*"World"*) would have results unprecedented during early testing. Another benefit to using this technology is long term price. Since the technology is still very new, the price of the device itself is not certain, however, the price of aluminum in South Africa fluctuates between 7.5 and 20 rand per kilogram, equivalent to .63 to 1.69 USD. Even if the device itself is initially highly priced, to sustain its use would cost very little, especially since the MOF does not deteriorate with extended use, and one of its main components is so cheap. But with limited released information with reference to the device, it cannot be determined whether or not the MOF would ever even need to be replaced.

This device is still in very early development and there are still many improvements that could be made before implementation in Cape Town. The condenser could be made larger so it could collect more water at one time and the device still needs to be tested in a non-arid location, but there is no suspecting that this would be unsuccessful. Perhaps it could even result in the yielding of more water, as there is a much larger abundance of water vapor in the atmosphere over Cape Town. There still is the issue that no certain price has been set, so the overall cost cannot be predicted without this, but there is no denying that this technology could be life changing. "At any moment, the atmosphere contains an astounding 37.5 million billion gallons of water, in the invisible vapor phase. This is enough water to cover the entire surface of the Earth (land and ocean) with one inch of rain." ("*How Much"*). There is no reason why the potable water in the atmosphere should not be harnessed in small amounts to reduce the burden on people struggling all over the world with water scarcity.

Even if the MOF technology was not executed on a large scale, individual devices could go into effect in places like farms and schools. *The Sunday Times* reported in February of 2018 that farmers on the Western Coast of South Africa are feeling the recurring drought especially hard, even with the recent rain. "Agriculture is an important part of the province's socioeconomic fabric. The sector contributes 2% to South Africa's national GDP [gross domestic product], more than a fifth of which comes from the Western Cape," (*Johnston*). If farmers continue to be cut off from water, there is no doubt that their products will continue to die and have a substantial negative effect on the South African economy, but also if farmers are losing their crops season after season, it could lead them to abandon the profession

altogether. Cape Town's agricultural scene, mainly horticulture and livestock, could be completely decimated in a matter of a few years. That is why the implementation of the solar power devices would be so beneficial, the farms would no longer have to rely on the city to allocate water to them, but they could set up their own systems in their own backyards. This would lift the burden on not only the farmers, but on citizens as well. When there is a shortage of water, a shortage of food always follows, so even if there is still a direct encumbrance of water scarcity on people excluding farmers, at least there will be a sufficient supply of food and healthy livestock. Ultimately, the MOF device could serve as either a replacement for the public taps while working in unison with the current desalination plants, since the amount of devices it would take to supply enough water to be 100% efficient is simply unrealistic. It could also be used as a small scale solution to serve individual needs for people like farmers or those living in poor overstressed neighborhoods. Both of these tasks would be relatively simple given the devices mobility and accessibility. The only issue that blatantly arises is cost. Again, no set price has been released for the device; the logistics cannot be completely set in stone.

The devices implementation would have to be funded by either the South African government or possibly the United Nations. In a quote from the South African UN's website, "The United Nations is a universal organization whose purposes are to maintain international peace and security… to cooperate in solving international economic, social, cultural and humanitarian problems and in promoting respect for human rights and fundamental freedoms; and to be a center for harmonizing the actions of nations in attaining these ends." The drought is clearly a humanitarian crisis which has the possibility of affecting all South African citizens, so this would fall under the UN's jurisdiction of interference. So even if the devices in total will cost more than the construction of desalination plants, their long term sustainability will make up for the cost and the financial burden would not be high directly on individuals. The true glory of this device is that it is not specific to Cape Town's geographical location. The condenser can be used virtually anywhere, so this device can be used in almost any situation where water is scarce. Water scarcity has a direct impact on food security and overall health. It is such a complex and dangerous issue many people are already suffering from. "Around 700 million people in 43 countries suffer today from water scarcity. By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stressed conditions." (*"Scarcity"*). This crisis is not particular; in the future any person no matter their wealth or status can be affected. The issue is growing exponentially, and action which does not burden citizens, risk environmental destruction, or relies on specific geographical locations is required.

This solution needs to be implemented quickly as the water crisis in Cape Town continues to move towards the critical Day Zero. Although there is no set date where water will be shut off as of now, it will always be a looming threat if no solution is actualized quickly. Millions of people will lose their access to clean water, and with no natural fix to the scarcity, since the current rainy season has not been enough to replenish the dam, which used to supply the city with its water needs, the issue will only continue to worsen. The dry season will also only continue as climate change continues to rage on all around the world. Serious action on a grand scale to offset the effects of climate change simply has not been taken yet, and conditions are only worsening. "Day Zero is looming for Cape Town and a dedicated and efficient long-term solution to South Africa's water woes must be found. The weather can't be controlled and drought patterns for the region are set to worsen. It's time to stop relying solely on rainfall and dam levels for clean water as a critical resource" (*Zyl*). It is now humanities job to pool their resources and collective intelligence to find ways to effectively and safely implement environmentally friendly technology to bring water back into people's homes before it's too late. So many people already suffer the detriments of water scarcity and do not have the luxury of being located on the coast, so this technology has the potential to eventually serve millions of people no matter where they are.

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