A Comparative Analysis of Aspects related to Water and Sanitation in South Africa (Cape Town) and Australia (Melbourne)

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Of

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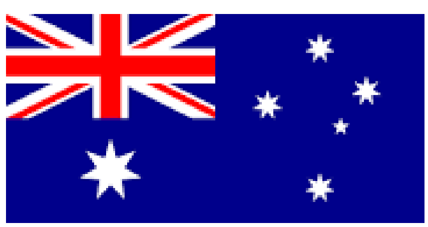

Executive Summary

The most essential thing on earth is water yet some countries and communities are struggling to access quality and quantity water for drinking, washing, cooking, bathing and irrigating crops. Two of the regions that faced water crisis is Melbourne and Cape Town. The current report will explore on the innovations, strategies and challenges used in Melbourne state in dealing with water and sanitation. This is compared with the challenges and strategies of water and sanitation in Cape Town.

The practicability of the approaches was attained by exploring on the case studies of two coastal urban cities where out of the projected problem in Melbourne, they have come up with strategies to tackle the current issue. These strategies and innovations will be compared to their effectiveness on the challenges of water and sanitation in Cape Town of drought, inadequate education of professionals and the public, and pressure on sanitation and drinking water.

The first objective for the study is to compare and examine the current strategies and innovations both in Melbourne and Cape Town. In response to Millennium Drought between 1997 and 2010, Melbourne undertook drastic cuts on the consumption rate by 50%. The water consumption rate in Melbourne in 1997 was 167,000 liters per person per year to 86,000 by 2011 (Hemati et al., 2016). The report illustrates that even after the drought, Melbourne did not bounce back to a high water consumption rate but maintained. Some of the strategies employed by Melbourne included voluntary and mandatory changes in water use where residents were fined by city officials for day time car washing and lawn watering. In contrast to Melbourne strategies, Cape Town which is a poorer city cannot campaign and enforce for water efficient dishwashers and washing machines as their issues is more on the system, plumbers and leaks.

The second objective for the study was to compare the prevailing strategies against indicators of new regionalism. The new regionalism-based approach to drinking water was applied to identify myriad of manipulating factors using varying mechanisms to encourage and support portable water systems. The approach comprises of integration, place, multi-level governance, and innovation. In Melbourne, an integration approach was applied where by all residents were involved. Similarly, Cape Town adapted the same strategy to deal with Day Zero crisis by ensuring each resident used 50 liters per day.

The third objective is to seek feedback from the case study on the practicability of proposed strategies implemented in Melbourne and how the challenges may or may not solve the issues of water and sanitation in Cape Town. Majority of actions and strategies applied by Melbourne to solve the issue of Millennium Drought may be used as a road map by Cape Town. This includes water recycling, use of grey water for non-potable purposes, desalination plants and investment on water infrastructure. However, due to the financial situation in South Africa, Cape Town may not be in a position to set billions and millions on water infrastructure.

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A Comparative Analysis of Water Supply between Cape Town in South Africa and Melbourne in Australia

Introduction

Approximately 40% of the world population suffers from water scarcity and the situation is projected to worsen due to global warming. According to World Water Council (2018), one in four people by 2050 is expected to face recurring or chronic water shortages. The current report will explore on Melbourne and Cape Town. Melbourne in Australia suffered the 'Millennium drought' between 1997 and 2009 which has led to the city slashing its per capita water use by 50% to install recycling plants and desalination.

A comparative analysis between Cape Town in South Africa and Melbourne in Australia will be conducted as both countries are facing threats in water crisis. Some of the aspects to be examined in both cities include the influx of people in to the cities and its effect on the ability of the cities to offer the residents with adequate water supply and sanitation. The study will also explore the reticulation of portable water as well as the infrastructure of waste water which will include the plumbing system in the cities. In addition, the case study will compare the projected guidelines and frameworks put in place to sustain the supply of water in regions stricken by drought. The study will also explore the implementation processes for the projects that are geared in improving the sanitations and plumbing systems in impoverished rural communities in the two cities.

1. Location of Cape Town and Melbourne

The author chose two case studies for the current report. They include Melbourne in Australian and Cape Town in South Africa. The global location of the two regions is illustrated in the figure below:

Figure 1: Illustrates the global location of Cape Town, South Africa and Melbourne Australia

Figure 2: An illustration of the comparison of availability and use of water between Melbourne and Cape Town. In the chart, it is clear that Melbourne is better in providing water to its population in comparison to Cape Town.

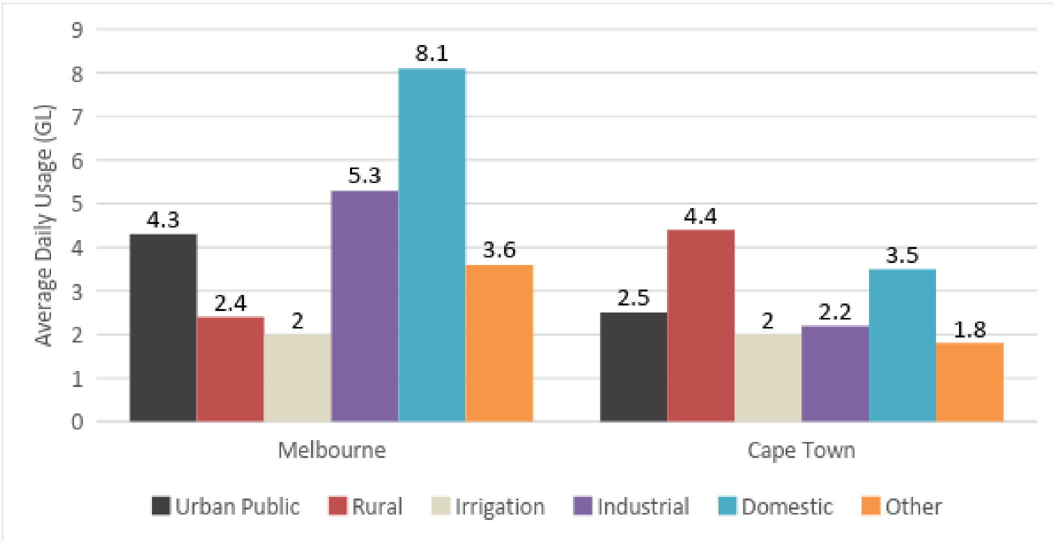
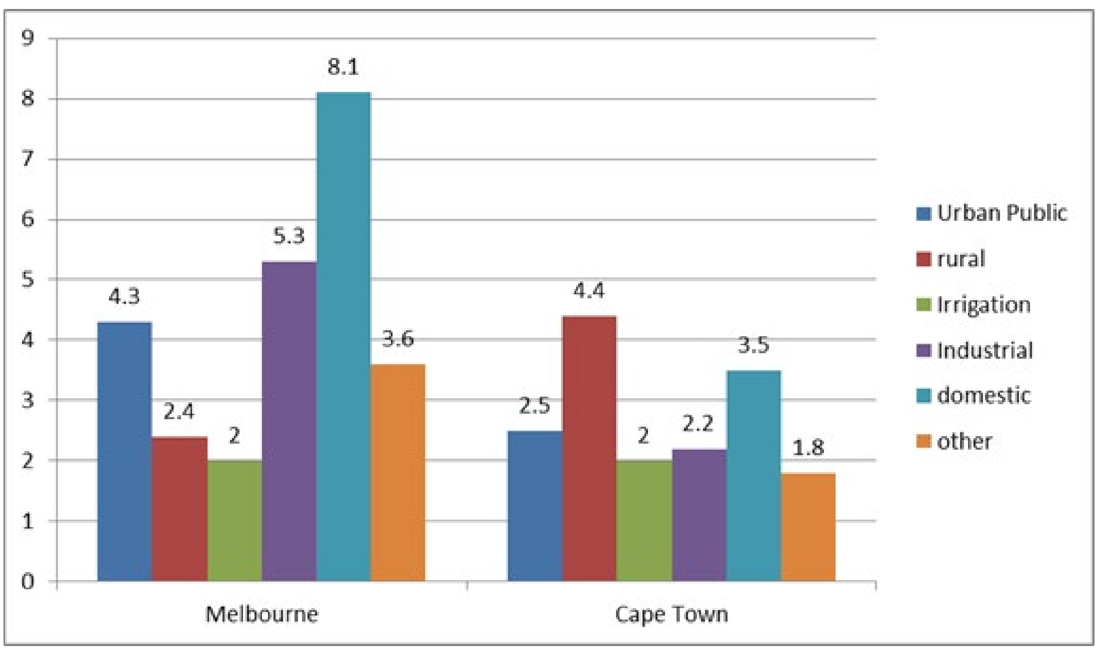


Figure 3: Average (2000-2015) comparison of water availability in Cape Town and Melbourne



MELBOURNE

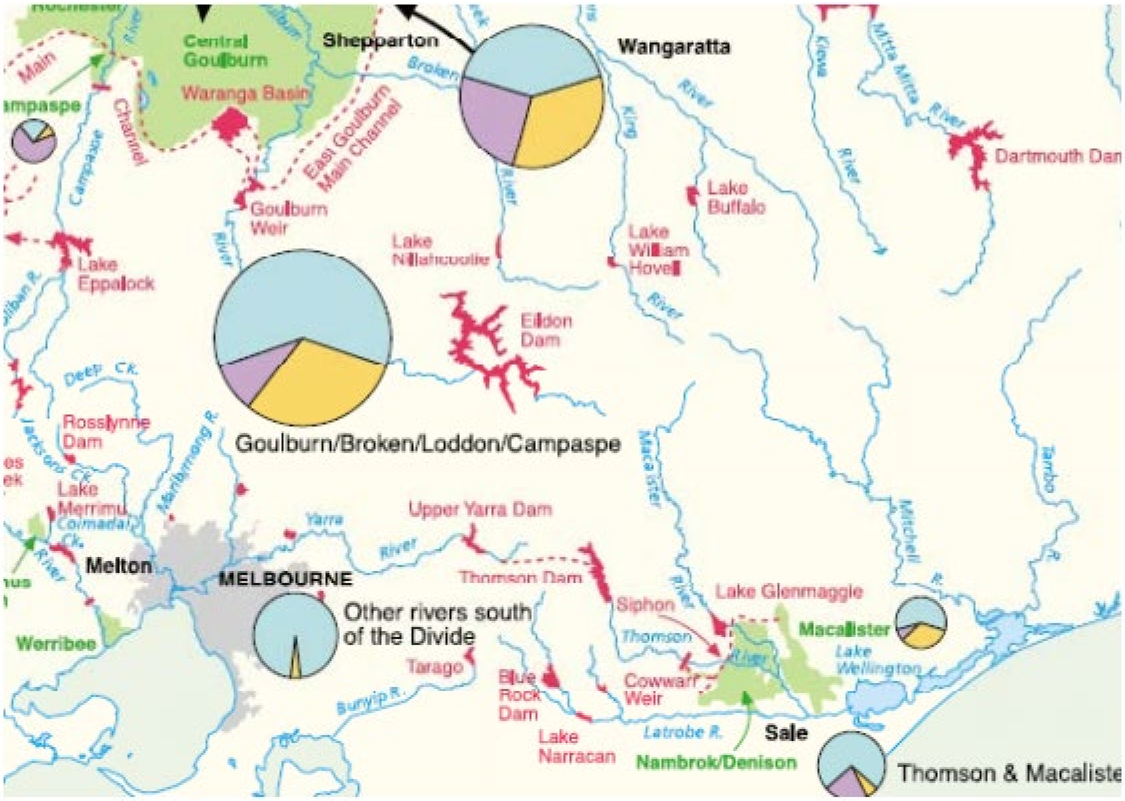
Melbourne's water supply system

According to Melbourne Water (2018), Melbourne is one of the cities with water of highest quality. The water industry in Australia is now in a mature phase of its evolution (Mercer and Lloyd, 1986). This phase is characterized by more emphasis on water recycling, conservation, demand management, and realistic pricing instead of construction of supply projects, capital-intensive, and large-scale, as in the past.

Figure 4: Waterway in Melbourne

The Melbourne water system according to Mercer and Lloyd (1986) uses the concepts of circular and; linear water systems. The Melbourne city has started on a complex water system strategy due to the challenges it's facing. The challenges include a growing and changing region as well as a changing and variable climate.

Figure 5: Main sources of water in Melbourne



According to Melbourne Water Corporation (2017) the population in Melbourne in the coming 50 years is projected to continuously grow. The population growth is not only on the metropolitan Melbourne but also around the edges. Due to this, there is need for the water company to produce safe, adequate and affordable water for home and commercial use requiring the wetland and the waterways to receive water they require in thriving. In addition, a thriving and variable climate is significant in the planning and managing of the water system. This is especially due to the regular droughts in Australia.

The Melbourne water systems have set their attention to economic regulations where they check the capital investments and its effect on the charges and the prices to consumers. Previously, little attention was paid on the economies, public acceptance and technological resilience of water desalination and recycling after drought subsided.

Melbourne water systems

i. **Collection of Water**

The sponge-like soils in Melbourne catchment areas help in filtering and holding rain water. The tapped water is then released to the rivers slowly to feed the storage reservoirs for the city. Majority of water catchment sites in Melbourne produces clean water that requires minimal treatment due to limited access by the public. Other sources of water collection especially during crisis include: North–South Pipeline and Victorian Desalination Plant.

ii. **Storage of Water**

The storage reservoirs in the city have the capacity of holding water for about five years. This long duration is important in water purification as it helps to remove impurities due to the breakdown of materials over time. The system is interlinked which helps the transportation of water if need arises. For example, Melbourne water system may help in directing less water to their treatment plants that are more expensive to run or remove water from a reservoir during heavy rains.

iii. Water Treatment

For safe drinking water, water from the reservoirs is treated in water treatment plants. Majority of Melbourne water requires little treatment as it is from less contaminated areas. However, water sourced from open catchment areas requires full treatment.

iv. Transfer of Water

The treated water is then transported throughout the suburban Melbourne through large pipes referred as water mains to reservoirs that are smaller. The small reservoirs distributed in different localities in the city are used to store water for a few days to make sure consistent distribution of water even during high demand. By use of small pipes, water is distributed throughout the city to regional and metropolitan retail water companies. In addition, smaller pipes are used to transport water to businesses, schools, hospitals and homes across Melbourne. As illustrated in figure 6, the water supply of Melbourne is interconnected and complex where the water system of Melbourne is made up of:

- 38 service reservoirs
- 12 minor treatment plants
- 2 major treatment plants
- 10 storage reservoirs
- 156,700 hectares of catchments and
- many kilometers of pipes

The working principle of Melbourne water system is that it is vital to start with a highest quality source than treating the water to the appropriate standards. This has made Melbourne to be among the systems producing the highest quality water and among the five cities globally with well protected catchments. The reservoirs receive water from the forests through the streams which ensures enough water during droughts. For example, along Thomson River there is Thomson Dam which is about 130 km in Grippsland at the east of Melbourne. This dam, has a 19 km long underpass inflowing Great Dividing Range into the Upper Yarra Reservoir and then onto Silvan where it is dispersed for drinking (Melbourne Water, 2018).

Figure 6: Melbourne’s Water System

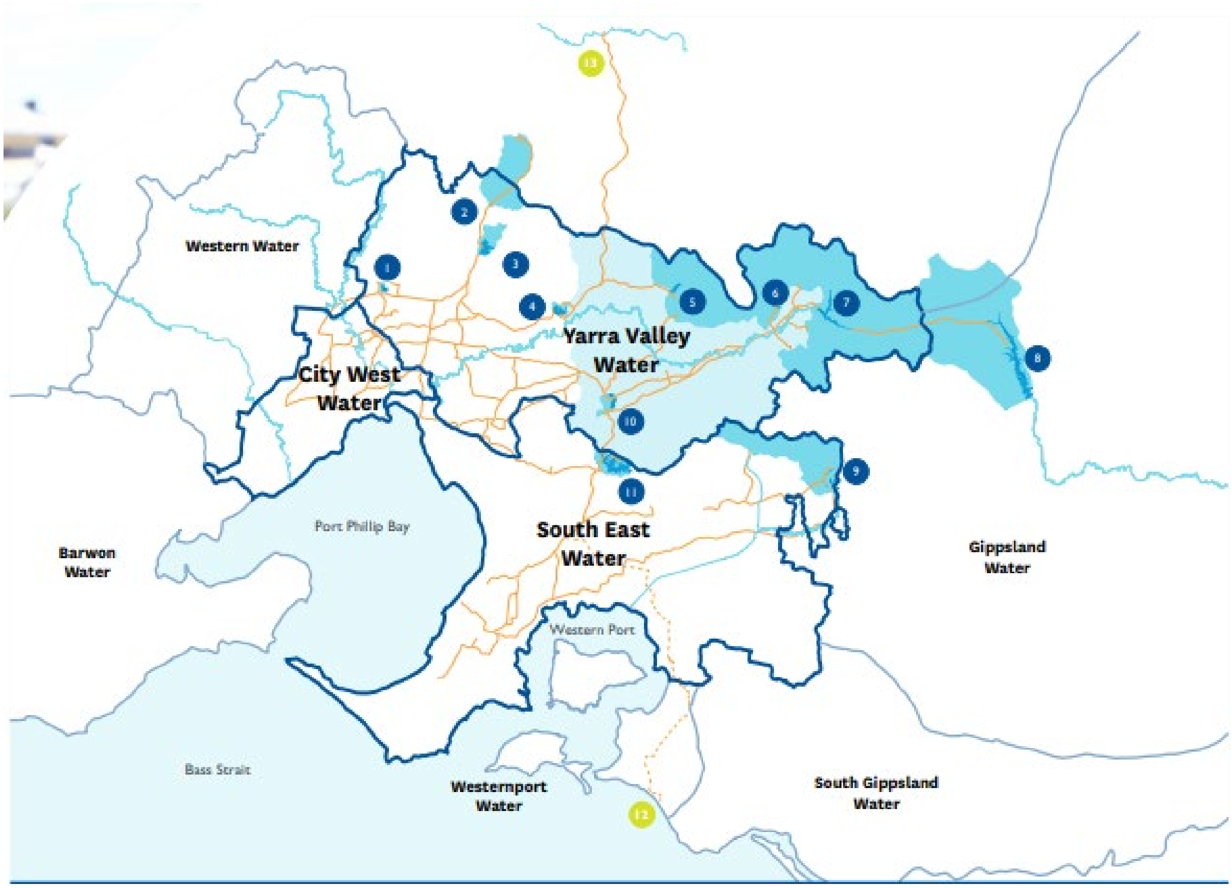
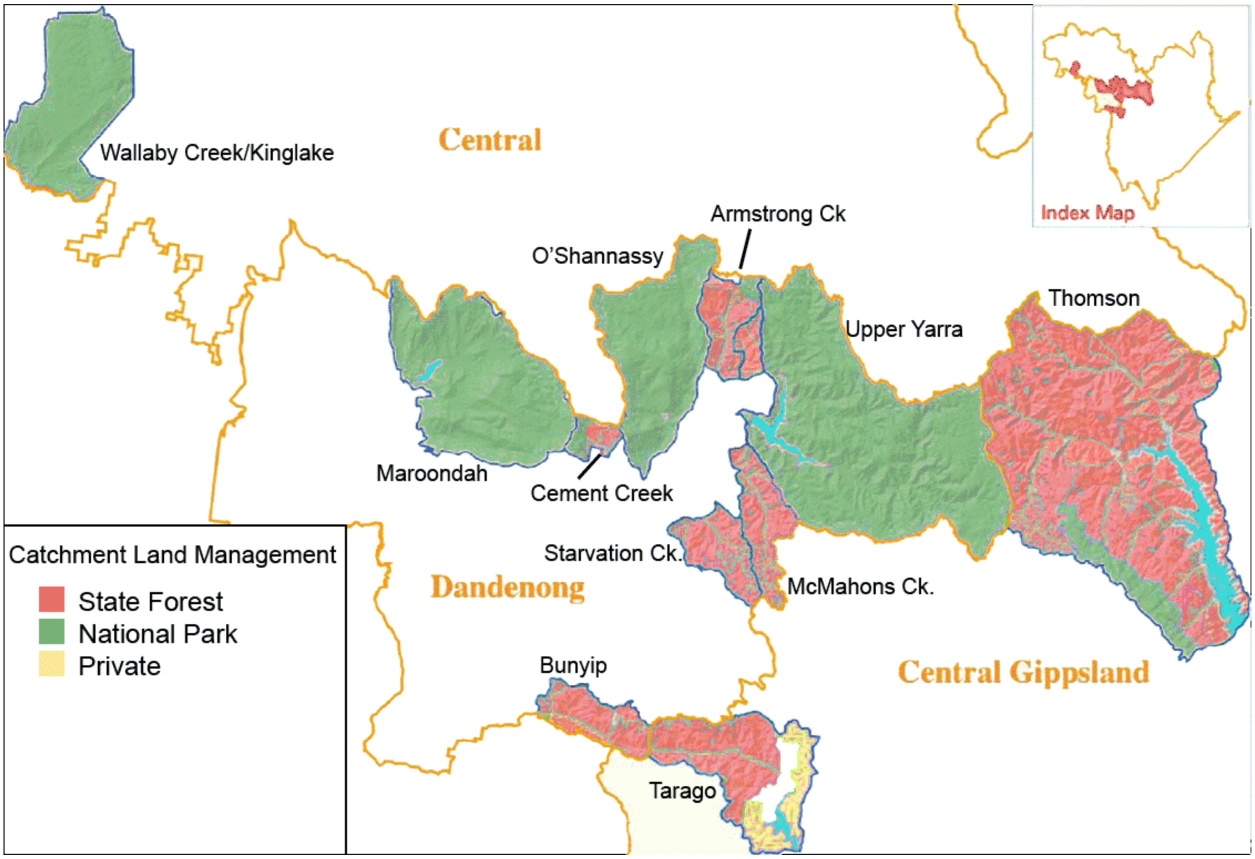


Figure 7: Illustrating the water catchment in Melbourne



Water Treatment

Melbourne produces safe drinking water through treatment and disinfection of the water before entering the water system. The type of treatment varies depending with the source of water where some only requires disinfection while other

sources need complex treatment. The water system in Melbourne applies full treatment process which in inclusive of filtration before disinfection takes place. The first stage in treating the water is coagulation chemicals (liquid aluminum sulphate (alum)) are introduced to water to help the small particles and bacteria to stick together and form large particles (Melbourne Water, 2018). The large particles are then introduced to the second stage of floatation or clarification which involves floating or sinking particles where they are separated from the water for easy removal. The type of plant determines if they will apply diffusers, which create fine bubbles which stick with particles making them float or mechanical settling basins, called clarifiers.

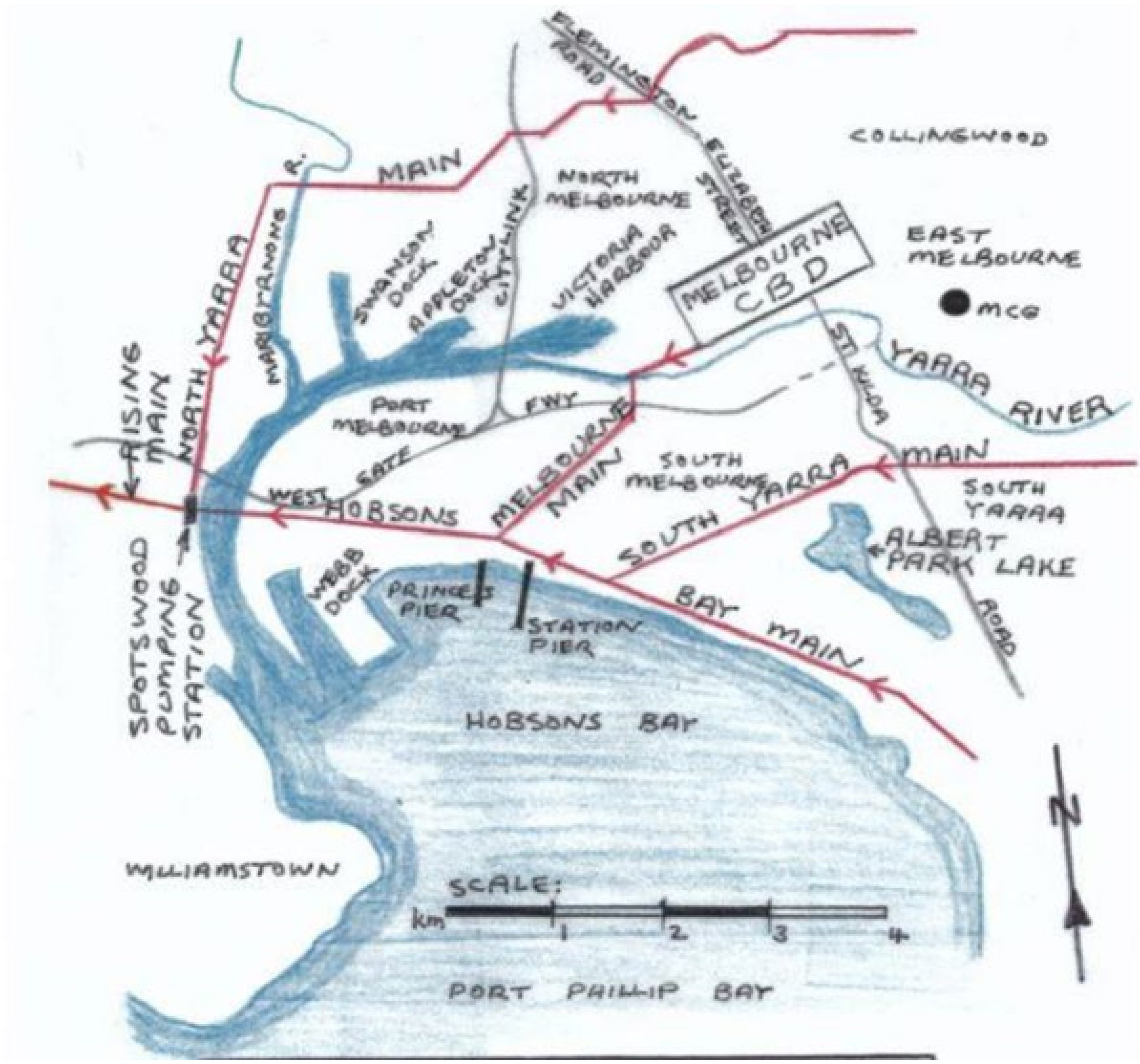
The remaining particles are eliminated through filtration. These particles are removed by membranes or filters after water passes through them. Some of the filters include: membrane filters with billions of microscopic poresand gravity media filters with layers of coal and sand. Infiltration is followed by disinfection either through the addition of ultraviolet light, chloramine (chlorine and ammonia), or Chlorine to destroy any disease-causing bacteria. Although the amount of Chlorine added in water varies from one plant to another, the amount does not exceed one milligram per liter (0.0001%). Other process includes the addition of fluoride to prevent tooth decay. The recommended amount of Fluoride according to Health (Fluoridation) Act 1973 is less than one milligram per liter (Melbourne Water, 2018). To neutralize the PH of the water, soda ash, caustic soda or lime is used due to their low PH in comparison to the Fluoride and Chlorine previously added. Addition of lime is also beneficial in preventing household fittings and pipes from corrosion.

Sewerage System

All waste waters in Melbourne go to either Easter Treatment Plant or Western Treatment Plant in Victoria. Melbourne's Sewerage System is involved in the collection, transportation, treatment and disposal of sewage produced in a large part of the Melbourne metropolitan area. The sewerage system produces bulk sewage which is charged to three retail water business: Yarra Valley Water, South East Water, and City

West Water (Melbourne Water, 2018). The waste water in the plants is treated by use of one among the three lagoon systems. One lagoon system comprises of ten lagoons where sewage enters allowing the bacteria present to break to down the organic matter. In the first lagoon, the sewage has a lot of sediments but as it flows through each lagoon, the water becomes clear and cleaner. The systems contain two types of lagoons, aerobic and anaerobic due to the differing environment for each form of bacteria. However, the two forms of bacteria are beneficial as they aid in breaking down the organic matter in sewage treatment Brown, Jackson, and Khalifé (2010). Figure 6 illustrates the main features of Melbourne sewerage system. Different sewerage systems are used in the eastern treatment plant from the western treatment plant. The effluents from the eastern system are released at Boags Rocks to the environment while the South East Water's treatment plants releases their treated effluents to Hastings, Mornington, and Rosebud (Engineers Australia, 2014).

Figure 8: Main features of Melbourne sewerage system within the city



Recycled Water

Melbourne is highly recognized for recycled water highly treated sewage applicable for varying non-drinking purposes. According to Melbourne Water (2018) the system produces the largest Class A in Australia of recycled water. Class A is the highest grade of recycled water in victoria. In Victoria, recycled waste water is used in: doing the laundry, washing cars, flushing toilets, watering parks, gardens and sports grounds, irrigating crops, and firefighting. The recycled water is produced both in the Western and the Eastern treatment plants where they are later supplied to retail water companies supplying to businesses and homes. Some of the areas that are accessing Melbourne recycled water include: Cranbourne housing estates, Eastern Irrigation Scheme, Cranbourne, Werribee Employment Precinct and Werribee Tourist Precinct (Water, 2005).

CAPE TOWN

Figure 9: Residents negotiating their way through a dried-up section of the Theewaterskloof dam near Cape Town

The Water Supply Network of Cape Town

The City of Cape Town (CCT) is one of the Western Cape Water Supply System (WCWSS) which sources water from a system of dams supplying water for agriculture and surrounding urban. The system entirely depends on rainfall. The system comprises of the three largest dams which are managed and controlled by National Department of Water and Sanitation (DWS) (Muller, 2017). The DWS is responsible for implementing and managing the schemes for water resources in attempts of meeting the water demand for agriculture, mining, industries, and cities. The plan for the system by the DWS indicates a 1 in 50 year's level of assurance meaning that during drought with 1:50 year's severity or more, there is need for restrictions to cut the amount of use (Blersch and Plessis 2017).

The Guardian (2018) explains that South Africa is facing threats of physical water scarcity by 2025 where the recent drought in the country is an illustration of its socio-economic development. This is due to the great impact that the drought specifically hit the agricultural sector broadening the trade deficit after the country incurred loss from maize exportation. The agricultural sector was greatly hit where they lost approximately 370,000 jobs in the fourth quarter of 2015. The drought led to increased food prices resulting to consumer inflation in the country and pushed approximately 50,000 persons below the poverty line. A long-term impact of the drought was great effect on the economic growth by having a decrease in 0.2% in 2015 (The Lancet Planetary Health, 2018). It is crucial to note that Cape Town and the

South Africa water situation is not an issue of the future but a current issue requiring urgent resolutions.

Globally, freshwater are sourced by rainfall./ however, in Cape Town and South Africa at large, there is low rainfall and low per capita water of ~500 mm average annual rainfall, in comparison to other countries with 843 m3 water per capita per annum. According to World Water Council (2018) water supply for a country should be equal to 30% of the runoff particularly the waste water. Majority of water in South Africa is sourced by dams where only 10% of the water is sourced from underground which is unavailable especially during famine and drought (Winter, 2010). Another potential water source in Cape Town is desalination which is mostly disadvantageous as it is an energy-intensive process and highly expensive. The demand of water in Cape Town is rapidly increasing with agricultural activities topping up with 63%, seconded by municipal at 26% and industrial with 11% (The Lancet Planetary Health, 2018).

Water Governance in Cape Town

In Cape Town, water is regulated by the municipal council and the national council in a given area. Some of the institutions regulating and protecting water supply and resources include: Water User Associations, Catchment Management Agencies, and Dept. of Water and Sanitation. The Lancet Planetary Health (2018) identifies the importance of having good governance of water at the root which is the process of water from the source, to the pipes, the taps, and the sewers.

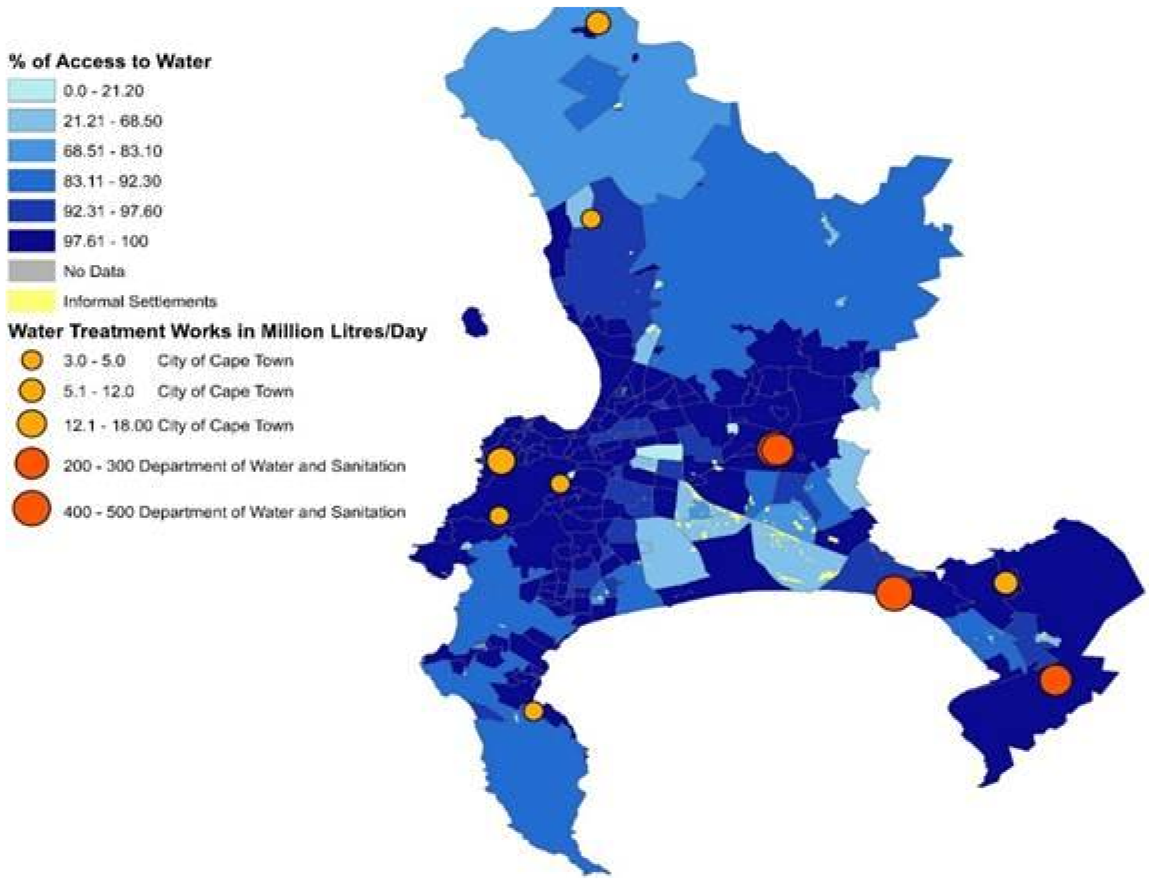
In contrast to Melbourne water crisis which was caused solely by drought, the water crisis in Cape Town is more political than as a result of drought. The local government has been questioned on their attempts of averting the water issue in Cape Town. The Western Cape according to The Conversation (2017) is the only province in South Africa headed by Democratic Alliance which is the opposition party. Due to this, there is a complicated association between Western Cape and national government. This resulted to challenges while preparing for drought like failure to respond or acknowledge the municipal and provincial calls for help which blocked timely interventions, erroneous water allocations to agriculture, and wasteful expenditure in the national Department of Water and Sanitation.

Water Treatment, Supply and Sanitation

The Water and Sanitation Department in Cape Town is fitted out with water assets worth R58 billion, inclusive of three major dams (Steenbras Upper, Steenbras lower and Wemmershoek) and eight smaller dams, 20 000 km of pipes in the water and sewer reticulation network, 38 maintenance depots, 3 marine outfalls, 23 wastewater treatment facilities, 400 pump stations, 25 bulk reservoirs, and 12 water treatment works (Appiah, 2011).

The water system supplies approximately 880 000 m3 of water to customers in one day. The water system in Cape Town in one year experience about 3 200 pipe bursts and 8 500 new water connections (Blersch, and Plessis, 2017). Some other roles for the water and sewerage system department in Cape Town include: preventing pollution to the water and storm water system, recycling and saving water and regulating water use, provision of water and sanitation to informal settlements, maintaining reticulation systems, ensuring excellent quality of our water and treating water. The figure below illustrates the amount of water treated in various plants

Figure 10: Amount of water treated in varying water treatment plants



The quality of water in Cape Town is monitored and controlled operationally by WTPS as well as Scientific Services Branch. This water according to Department of Water Affairs (2001) has a supply assurance of 97% in terms of the Department of Water & Sanitation and Raw Water Supply Agreement. The population of Cape Town is about 3.8 million and is supplied through approximately 1.1 million households. The table below illustrates a comparison of water supply in Cape Town and Melbourne

Table 1: Comparison of Cape Town and Melbourne

	CAPE TOWN	MELBOURNE
size	**948 mi²**	**3,858 mi²**
Population (2017)	**3.5 million**	**4.4 million**
Population density	**1400 people/km²**	**1560 people/km²**
ANNUAL POPULATION GROWTH	**0.8%**	**3.7%**
Average household Income	**1.7 k**	**26.9 k**
UNEmployment Rate	**19.4%**	**6.2%**
WATER TARIFFS	**R16,54 per kl**	**R22,16 per kl**
Investment in water systems	**≤ R60 billion in assets** **≤ R30 billion in projects**	**≤ R200 billion in assets** **≤ R300 billion in projects**
Education Facilities	**8 Higher Education**	**8 Higher Education**
GROSS DOMESTIC PRODUCT (GDP)	**103$ billion**	**356.2$ billion**
average temperature	**16.7°C**	**14.7°C**
Drought	**2015-Present**	**2000-2008**
Average Water Consumption	Average Water Consumption	**1.1 Billion liters per day**
Geography	**Semi-Arid**	**Semi-Arid**

Policies for Water in Cape Town

Globally, the water resource management legislation and policy in South Africa is one of the most progressive regulations. Although several progresses are seen globally in the act, there are questions on its impact and benefits to the residents at the ground. According to Appiah (2011), Cape Town is one of the cities affected by water scarcity in the world. By summer, it is reported that approximately four million residents queue guided by armed guards to collect water which is one of the most scarce commodity in Cape Town and surrounding cities (Department of Water Affairs, 2001). The dramatic urban crisis according to Appiah (2011) is influenced by climate change, a record drought, and population growth. There is several warning from leaders indicating that the residents are likely to face "Day Zero" of water. This day was at first indicated to be in mid-April but has been pushed further to beginning of August where the city will shut off all; taps at businesses and homes as a result of perilously low volumes at the reservoirs. This can be illustrated by the image below which is an illustration of the main water supply in Cape Town at Theewaterskloof Dam, which is running dry.

Several questions are underway on ways in which the city will make water accessible in the wake of Day Zero to prevent anarchy. For several years there have been no reports of a shutdown of such a size in a cosmopolitan city. However, urban cities from South America to North America, from Asia to Australia are facing severe drinking-water shortages as a result of climate change, population growth, and overdevelopment.

The water situation in Cape Town has led to installation of 200 emergency water stations at gathering spots like grocery stores. Each emergency water stations are supposed to serve about 20,000 residents (Carden, 2008). Other strategies identified for implementation by authorities in Cape Town include storing water at emergency water at military installations and has made it illegal to use taps to water gardens, wash cars or fill pools

Figure 11: Barren reservoir in Cape Town

Figure 12: Effluent treatment plants in Cape Town

Figure 13: Water System in Cape Town

Water Crisis in Cape Town South Africa

Cape Town according to Muller (2017) has pushed Day Zero to 2019 as dams fill up in the country. The Day Zero was supposed to be August 2018 where taps in the city would run dry prompting people to queue for water. Two years ago, a drought hit Cape Town that was triggered by El Niño which greatly affected the economic growth and agricultural production in South Africa (Department of Water and Sanitation City of Cape Town, 2018). One of the cities that were greatly hit is Cape Town particularly due to lack of good subsequent rains in the region worsening the water shortage situation. The residents of Cape Town have been surviving with a stringent water use restriction which currently is at 50 liters per day per person (GIBSON, 2018). There have been reports of improvement of the water situation in Cape Town.

Department of Water and Sanitation City of Cape Town (2018) explains that Day Zero for August 2018 was announced by the government in 2017 by taking unprecedented gamble due to the shortage of water in the country. The announcement of Day Zero in Cape Town led to panic and water stockpiling which in turn increased the specter of civil unrest and a reduction in tourism bookings. Gibson (2018) explains that Cape Town started the campaigns for conserving water through restrictions at point of use, a strategy that has worked were the residents are restricted to 50 liters of water per person. This is in contrast to the daily water usage per person per day in Melbourne of 161 litres per person per day in 2016/17 (The Guardian, 2018). The government has regulated this through hefty fines for a household exceeding this limit or installation of meters which shuts after a household attains their limit.

The situation in Cape Town has resulted to residents showering standing over buckets to recycle or reuse the water. Other ways are by limiting toilet flashing to one time a day and recycling washing machine water. Water restriction in Cape Town led to a reduction in consumption in mid-2017 of 600m liters per day to 507m liters per day by April 2018 (Brooks, 2018).

According to Brooke (2018) Day Zero was calculated by calculating the maximum evaporation (based on wind and temperature) and current agricultural practices and urban use. This equation deliberated both man-made and natural conditions. According to PWC (2017), Cape Town was able to avoid or delay Day Zero to 2019 by combining the efforts by the residents and good rainfall. These factors are the reason why the city is still having Day Zero threats as change in new adopted behaviors on water rain and reduction in rainfall may result to drought and hasten Day Zero situation.

In Cape Town, the residents were restricted to two minutes shower, no watering gardens and swimming pools were viewed as a disgrace (Gibson, 2018). The government went to the extent of a former mayor (Dan Plato) making house calls and shaming water offenders where he introduces the list of 100 top water offenders. However, these restrictions bore fruit as they were able to reduce water usage by half. Nevertheless, the government warns that if they fail to be stricter on water usage, Day Zero may approach sooner (The Guardian, 2018).

The Day Zero in August 2018 was averted not singly by the winter rainfall but as a result of incredible co-operation of the inhabitants as well as human and technological interventions initiated by the Cape Town municipality to reduce the consumption rate. One strategy was the extensive and dedicated awareness, communication and behavioral change campaigns which encouraged the behavior changes among residents. For the persons contravening the restrictions, the city installed water demand management devices. In addition, ongoing roll-out of pressure management which has led the city to at least save 62 million liters in a day due to the constructed pressure zones (The Guardian, 2018). Also, Cape Town used a holistic approach to maximize all water resources alternatives within a short time like increased extraction from springs and temporary desalination.

One proposed way of regulating water use is the increase in water usage tariff from 27% by tiring the water prices in relation to average water use. Such measured will result to double the price of water from $2.10 to $3.20 (26 rand per kiloliter to 40 rand) (The Guardian, 2018). However, increasing the tariffs has been voted against both by the residents and the businesses (The Guardian, 2018). There are continuing debates on the real cause of the water crisis in the city. According to analysts, the water situation in Cape Town is as a result of a combination of factors including: politicking in a contested region, poor infrastructure planning and climate change.

One of the profound causes is that the storage system was not comparatively operating with the current population growth in the city. According to Chutel (2018) there has been a rapid population growth in Cape Town from 2.4 million in 1995 to 4.3 million people in 2018. In the same duration of rapid population growth, Cape Town has only built one major dam the Berg River Dam in 2009 which only increased storage by 15%. This is an indication of lack of focus on the water management system and the governments as a result of personality politics and politicking blames. However, critics argue that the problem in the Cape Town is not as a result of storage facilities but the rainfall regimes and strategies and innovations of managing water (The Guardian, 2018).

Water Reticulation in South Africa

South Africa has embarked on a massive infrastructure development in the water system. However, the country still has a long way to go as they need strategies to control the quality of water through the water system designs that require putting in water supply projects. The need for effective designing is because of the water scarcity situation in South Africa which requires effective utilization of water. Therefore, the water system design should be aimed at supplying water to a vast number of users in a location where there is a reliable source. Page, Abu-Mahfouz, and Mothetha (2017) highlights varying documents that are significant in designing water systems in South Africa:

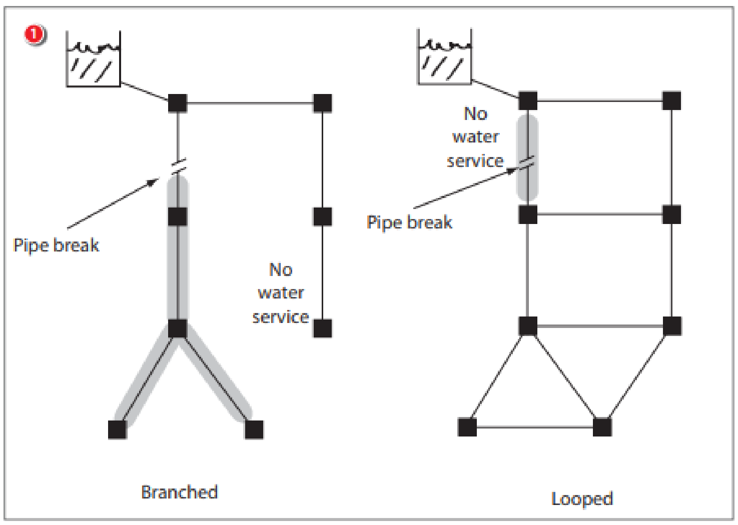
- SANS 1200: Code of Practice for the Design of Civil Engineering Services available at www.sabs.co.za
- Technical Guidelines for the Development of Water & Sanitation Infrastructure freely available at (www.dwa.gov.za)
- Guidelines for Human Settlement Planning and Design which is freely available at website (www.csir.co.za) of the Council for Scientific and Industrial Research

The reticulation system in South Africa has first tackled the issue of regional scheme which supplies water to a large-scale area has been redesigned to branched network configuration. This system comprises of a long bulk pipeline supplying water to a series of reservoirs which via reticulation supplies water to villages through public standpipes to homesteads. Therefore, the reticulation process in Cape Town comprises of only one path from source to standpipe. One advantage of this type of system is that it is less expensive to start. However, Chutel (2018) argues that such a reticulation system has several challenges like:

- Fluctuations in water demand resulting to high pressure oscillations.

- Future extensions may result to pressure issues
- Taste and odor issues may result from stagnation or accumulation of sediments for long duration in the pipes
- Potential danger of contamination as a result of some pipes staying for long without water due to irregular situations as illustrated in the figure below
- Low reliability

Figure 14: sources of contamination in the reticulation system in South Africa



However, these issues can be rectified to ensure that the problem is rectified through a looped network

- Fluctuations of water demand are not in position to provide great effect on the fluctuations of pressure
- The system receives water from different water systems to reduce long stagnation on the pipe

- In case of system maintenance, they are concerned receives water from, other directions
- Looped system will ensure easier extensions to developing or new regions as well as ensuring adequate pressures in the system

Plumbing System in South Africa

It is illegal in South Africa under Water Services Act to install any plumbing components that fail to comply with specific components highlighted in SANS 10254 and 10252. However, this law does not prohibit the sale and import of non-compliant products just their installation (Chutel, 2018). The compliance of the plumbing by laws is maintained by the local authorities who ensure all plumbers are registered, performs in-site visits, and maintains schedules of approved products. However, Ziervogel, Shale and Du (2010) argue that Cape Town does not fully enforce the plumbing related laws. Some of the reasons for lack of enforcement include: a severe shortage of technical staff at local government level, lack of commitment to this aim, and inadequate understanding of the need for maintaining high technical standards.

According to Ziervogel, Shale and Du (2010) the local government of Cape Town in average has three civil engineering professionals (technicians, technologists and engineers) per 100,000 populations. This is in contrast to the number of civil engineering professionals of approximately 22 engineers per 100,000 populations in Melbourne. Due to this inadequacy of civil engineers in the Cape Town authority, the local government cannot be in a position to provide even the basic infrastructure services. Due to this, management and enforcement of plumbing legislation is not one of their priorities. There is need for dramatic changes in the enforcement of legislation in South Africa to ensure improvement in future.

There is a high level of site leakages where according to a study conducted in Cape Town among 189 randomly selected properties indicated that at least 59% of the properties had on-site leaks. The average level of leakage in Cape Town was identified as 30 kl/month or 40.7 l/h. The average rate of leaks for all properties was 17 kl/month or 24.2 l/h. flats laid at blocks showed a large frequency of leakages (Jacobs & StrijdomII, 2009).

Cape Town requires installing high quality plumbing system that will minimize the rate of spillage and effective water use (SANS 10400-P, 2010). The Civil engineers in South Africa should be equipped with qualified personnel to control and monitor responsibilities as well as enforcing regulations.

Strategies

There is need for transparent processes through coördinated actions as well as shared decision-making allowing all stakeholders to be actively involved in the formulation of the plan and the implementation of water management activities, innovations to eliminate the impact of droughts or climatic changes and improvement on all efforts of water management.

Use of Dual Water Reticulation System

In 2009, several civil engineers in South Africa including JE van Zyl, JR Adewumi and AA Ilemobade from the universities of Johannesburg and Witwatersrand prepared a report entitled “Assessment of the feasibility of using a dual water reticulation system in South Africa” (Ilemobade, Adewumi & van Zyl, 2009). However, after sending the report to Water Research Commission, it was questioned if the system would be feasible for the country by question why high quality portable water to be used for landscape irrigation and toilet flushing which has caused questioning on its sustainability in South Africa.

Although a dual system is feasible for South Africa, Watercare Services (2013) argues that the environment is not materialized and the misuse of water in the country. The advantage of a dual system is that it allows recycling of non-potable water and allows consumers to enjoy 60% discount. According to a report by Ilemobade, Adewumi and van Zyl (2009) the water crisis in Cape Town has forced the country to enhance sparingly water usage among residents of potable water. To avert Day Zero, the residents in South Africa should adopt a dual system whereby they will not use potable water to flush their toilets.

Desalination

The process of desalination helps in separating dissolved salts as well as other minerals from water. There are three methods of desalination pressure, electrical and thermal. The Victorian desalination is the only source of water not requiring rainfall which makes it significant in meeting the needs of Melbourne residents. The Victorian Desalination

Project which is the biggest desalination plant in Australia cost AUD 4.8 billion and supplies 450,000 m^3 of drinking water per day (SUEZ's Degremont Water, 2018). The plant receives its power from renewable energy

The water desalination plant in Melbourne was announced in 2007 after Millennium Drought due to low levels of water storage which was at its lowest of 16.5%. The plant delivers up to 150 billion liters of high potable water every year which is about 65% of what is needed by the residents (van Zyl, Lobanga, Lugoma & Ilemobade, 2008). The desalination water system is crucial in meeting the demand of the growing population in Melbourne as well as the extreme effect of changing climates. During droughts, the municipal of Melbourne have tackled the issue of solely relying on water restrictions by using other water sources like: recycled water, storm water, and desalination.

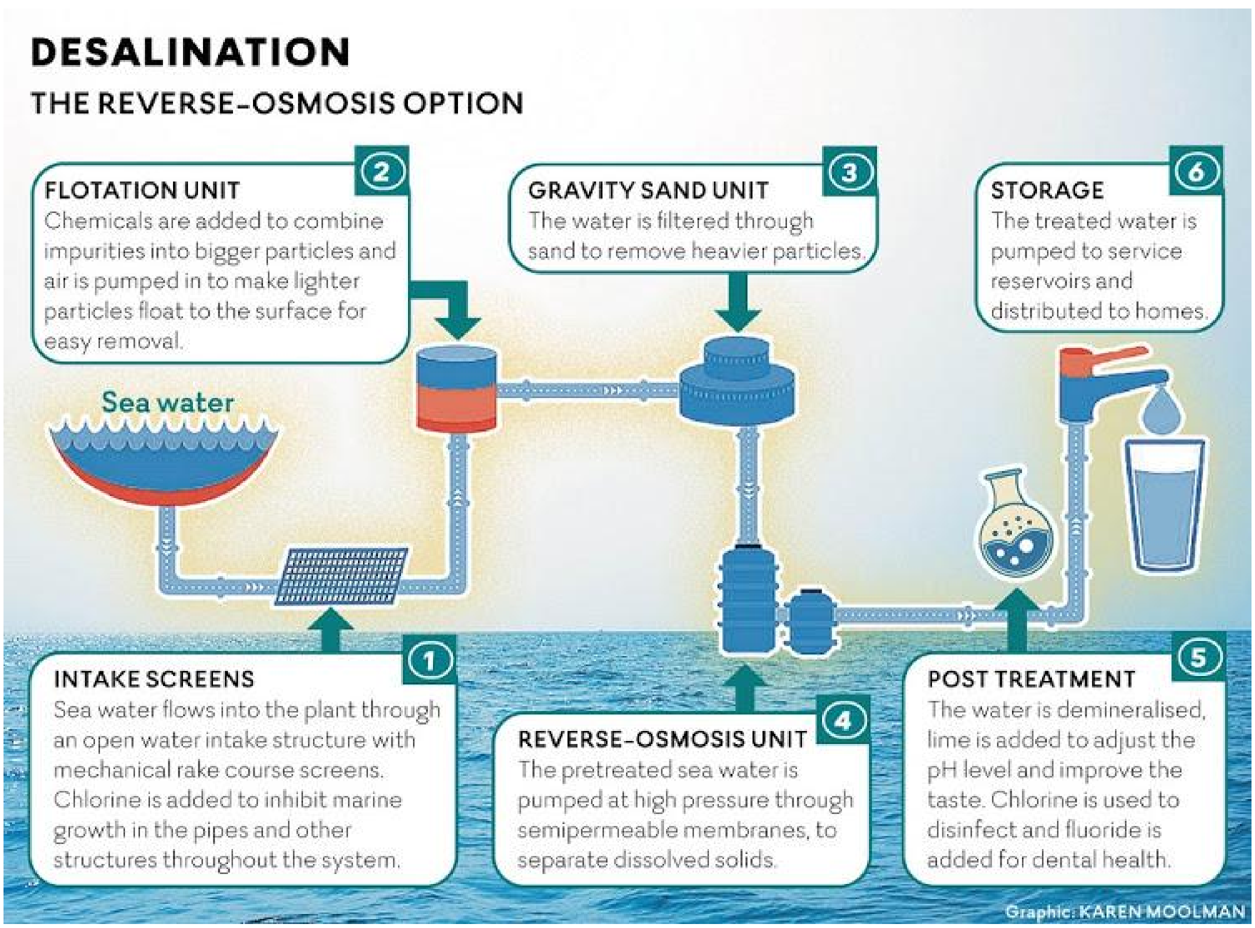
The plans that were put into action in the years 2010 to 2012 include the construction of a new desalination plant to provide water for Melbourne and its surrounding cities and towns. The plant generates up to 150 billion liters of water. In addition, Victoria's Water Grid was expanded by constructing the Sugarloaf Pipeline which transfers 75 billion litres of water. Melbourne's Eastern Treatment Plant was upgraded to produce up to 100 billion liters of tertiary treated recycled water suitable for non-potable residential, industrial, agricultural and environmental uses. Water conservation measures such as the Water Smart Gardens and Homes Rebate Scheme which contribute to Melbourne households using water more wisely and efficiently by providing a range of rebates for rainwater tanks, greywater systems and dual flush toilets were also intensified to ensure sustained water management by the public (Edokpayi, Odiyo, and Durowoju, 2017).

The process of desalination is one of the strategies that South Africa requires to adapt to ensure water supply during droughts and not relying singly on water restrictions. The Government of South Africa publicized that it would invest in the greater use of recycled water, water desalination and storm water through an A$1 billion (R10.3 billion) urban water infrastructure fund (Jacobs & StrijdomII, 2009). A temporary desalination is illustrated in the figure below

Figure 15: Temporary desalination in Cape Town

South Africa built two desalination plants Strandfontein and Monwabisi's desalination plant. Each of the plant has been producing 2 ML/d from April 2018. However, Cape Town cancelled the proposal of building Cape Town Harbor desalination plant but there are ongoing plans on strategies to increase water production this plant was projected to produce approximately 50ML/day. These augmented sources are projected to supply approximately 40% of the current daily fresh water needs in Cape Town (Paarl, 2018). The projected desalination supply is comparatively similar to Melbourne's which is one-third of Melbourne's needs (33.33%)(Melbourne, 2018).

Figure 16: Proposed Desalination Process for Cape Town

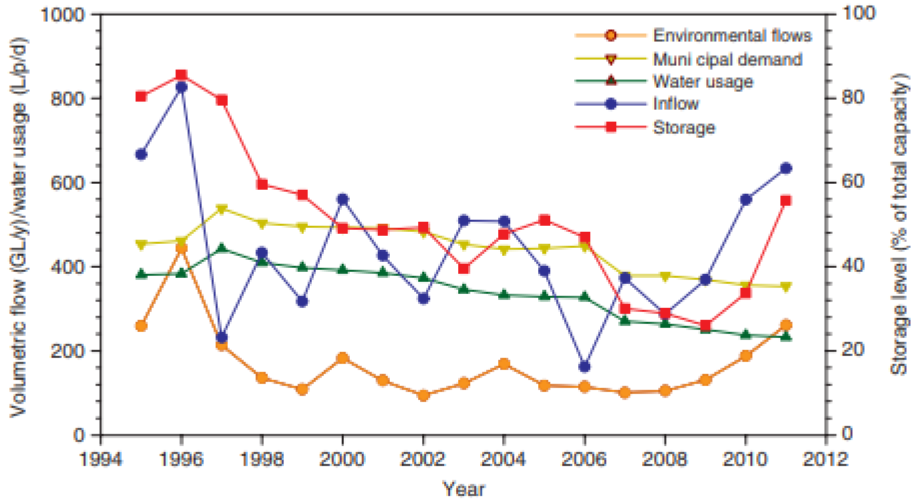


Drought Management in Cape Town

The current innovative strategies in Melbourne were influenced by the Millennium, Drought. The city that houses approximately 4.3 million persons is in a position to distribute enough and quality water to its residents. This section will explore on ways water engineers in Melbourne effectively responded to the Millennium Drought to formulate short-term and long-term strategies to boost the availability of water in the city (Baudoin, 2017). This will also include ways in which South Africa particularly Cape Town can borrow some of the strategies to ensure efficient water supply in the city.

The water demand in Melbourne have been reduced through a combination of strategies including restrictions, water conservation programs and emergency drops in the environmental release of water to streams. However, the water companies in Melbourne did not have independent price-setting powers thus did not apply water pricing as a tool for drought demand management. The figure below illustrates the water budget for Melbourne.

Figure 17: Melbourne's water budget illustrating water changes in regard to storage (percentage of total capacity as of June 30), inflow (GL/y), water usage (L/p/d), municipal demand (GL/y), and environmental flows (GL/y).



The adoption of technical innovations in Melbourne was facilitated by institution arrangements that allowed an integrated response from water authorities to millennium drought. The water sector in Melbourne is currently overseen by State Ministers of Water, Environment, and Health, and Treasury. The Water Act in Australia allows the minister of water to offer a clause in relation to how the system is operating through the adoption of Drought Response Plan (DRP).

The success of 2001 Water Demand Management/Water Conservation (WDM/WC) Strategy which was later revised in 2007 explains that the City of Cape Town (CCT) through its interventions postponed the crisis of water in the city. However, in 2014, economic growth and population increase increased the demand of water in the region. The national Department of Water and Sanitation and CCT relies heavily on Western Cape Water Reconciliation Strategy (2007), that recognized 4 water supply augmentation schemes as illustrated in the figure below

Among the four, two of the systems involves aquifer use and groundwater source but have rather not been used in South Africa but postponed severally as the country has been able to meet the demand. Nevertheless, the current crisis in Cape Town opens the needs for including the two schemes in the system. According to Baudoin (2017) the state of emergency in Cape Town has opened a reconsideration of developing groundwater from Table Mountain Group aquifers and Cape Flats. The Cape Town mayor, Patricia de Lille recently announced that the city is preparing a “Water Resilience plan” which will tackle all the issues related to water.

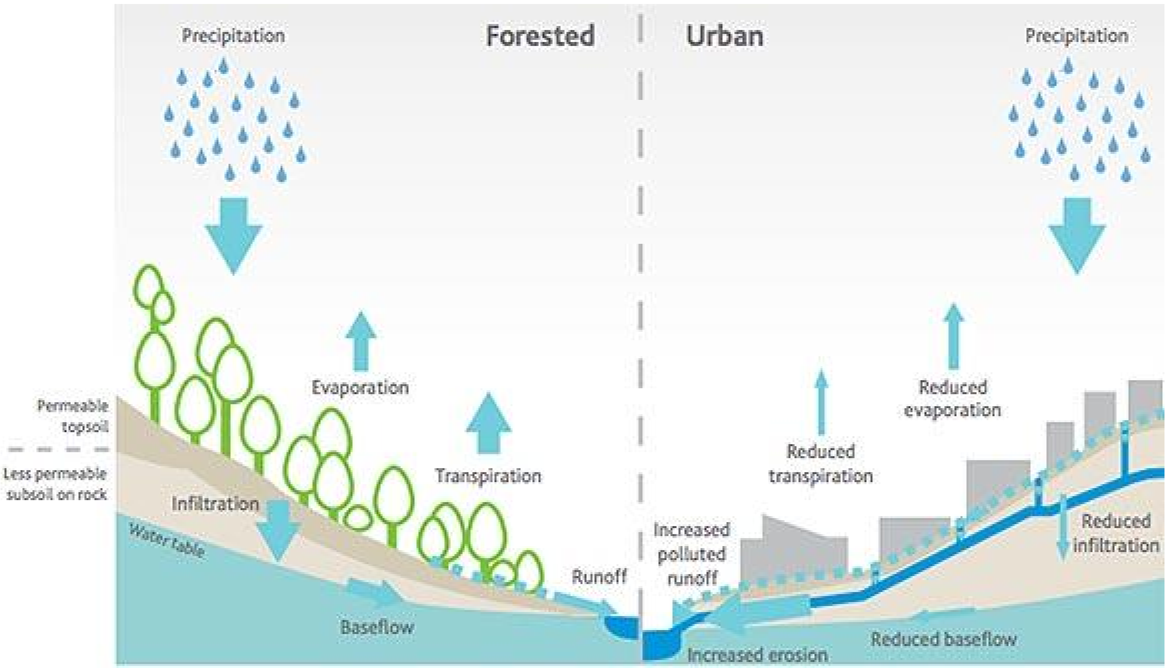
Nationally, South Africa has put strategies and policies to deal with the water crisis resulting from drought conditions. Some of these policies include: the Drought Management Plan of 2005, the National Disaster Risk Management framework of 2005, and the Disaster Management Act No. 57 of 2002. The day Zero was prevented by three things: the residents of Cape Town, highly skilled engineers and professional staff, and pre-existing water demand management program. The elements helped Cape Town to reach winter rainfall without running out of water. The risk of drought and famine in South Africa is tackled by the bulk water supply authorities. The current crisis in South Africa and particularly Cape Town is a sign that water restriction policies are not sufficient to solve water scarcity in the region (Brooks, 2018).

Similar to Melbourne, Cape Town installed water demand management devices for residents contravening water restrictions. Cape Town introduced a program for leaks repairs to reduce the loss of water particularly in water indigent areas. Another effective strategy that Cape Town borrowed from Melbourne is steep tariff hikes. Another borrowed strategy from Melbourne was the use of a holistic approach (The Executive Deputy Mayor, Alderman Ian Neilson, 2018).

As stated earlier by the mayor, the city is preparing a “Water Resilience plan” which will tackle all the issues facing the city and future strategies and policies of tackling the issue. Although the plan’s details are not yet on the system, the mayor has stipulated some of the goals of the plan including: managing all the urban water (treated water effluents, rivers, and groundwater and stormwater) through an integrated process. One long-term solution in the plan is groundwater storage and harvesting stormwater which will improve resilience and address the drought risk.

In order to build resilience in Cape Town, the city will require addressing drought, climate change and flooding during winter. This can be effectively attained through Water Sensitive Urban Design which will contain strategies that campaign for efficient water use like using storm water and putting more focus on sustainable development. This process is successful in Melbourne. The system for tapping storm water is figuratively illustrated below

Figure 18: System for tapping storm water in Melbourne



The Water sensitive urban design (WSUD) in Melbourne applies better urban design and planning of reusing stormwater to stop it from entering the waterways through mimics on natural water cycle.

Ways in Which Cape Town can built a Water Resilient City

1. Make use of green or natural infrastructure in the water system which serves as natural barrier against water related risk like drought and flooding
2. Break down of the silos isolating water related departments from government departments, like community organizations and civil society, and spatial planning and disaster risk management, to boost more informed and inclusive planning
3. Building a water-related resilience a city requires a more flexible institution that is able to respond proactively and quickly to changes

According to Gude (2017) treated water used for non-portable uses like flushing toilets and irrigation reduces the total amount of potable water used in residential by 20%. This strategy would thus be effective in saving water usage of portable water in the city. However, this system is criticized due to some challenges like limited institution capacity and water quality concerns.

SUPPLY-SIDE MEASURES

Greywater Systems

Greywater is water that is gently used in washing machines, tubs, showers and bathroom sinks. This water does not combine with fecal matter either from washed diapers or toilets. In Melbourne, grey water systems were installed in Inkerman Oasis (2.5 ML/year in 2009/2010) residential units. However, at households, the grey water system is not suitable for drinking as it is untreated and thus used for irrigation purposes.

Augmentation of Centralized Water Supply Systems

Some of the central systems used in augmenting water in Melbourne include

i. Construction of North–South Pipeline which holds r 75 GL of water a year from the Goulburn River and cost approximately AU $700 million
ii. Construction of the Wonthaggi Desalination Plant, which stores 150 GL of water an year and cost AU $6 billion

iii. Constructing Tarago Reservoir in 2009 which holds 21 GL/year and cost AU $97 million

The supply of water in Melbourne was increased between 2005 and 2009 by the use of recycled water after the launching of two major Class A recycled water schemes, the Eastern Irrigation Scheme and the Werribee Irrigation District (WID) Scheme. The reliance on recycled water was exacerbated by the frequently higher salinity of river water compared with recycled water during periods of low flow.

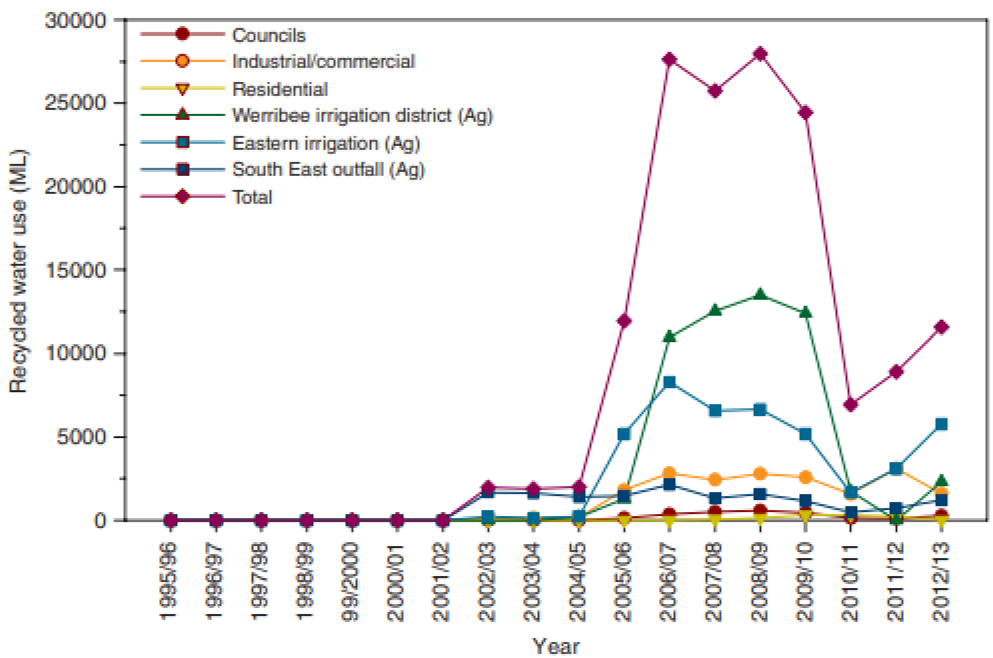
Because Melbourne's 4.4 million people consume about 376 GL (2017) of portable water annually, even modest efforts to substitute storm water runoff for portable supply. Bio-filters (also known as rain gardens and bio-infiltration systems) are one technology well suited for storm water use in Melbourne; in addition to reducing portable demand, such systems have many co-benefits for human and ecosystem health. While bio-filters are used for on-site retention and infiltration of stormwater, their product water was not typically used for potable substitution before 2009. However, after the drought, about a dozen stormwater harvesting projects have been completed mostly to irrigate gardens, sports fields, and golf courses.

In 2013/2014, the Office of Living Victoria allocated AU $50 million to alternative water projects, mostly to building systems to capture, treat, and use storm water runoff for portable substitution

Rainwater tanks

Following the millennium drought, Melbourne used rainwater tanks to capture and store rainwater from the roofs to tanks. This innovation increases the amount of water supply especially in drought stricken areas which receives high rainfall. The rain is trapped directly from the roof and is less contaminated in comparison to storm water hence requiring less complex treatment process. Estimating the volume of potable substitution achieved by the purchase and installation of rainwater tanks is complicated by their decentralized nature and the variability of demand across users. The percentage of households in the State of Victoria with rainwater tanks increased from 22.7% in 2015 to 34.6% in 2016 (Abedelkareem, 2017). Rainwater tanks are popular because they allow residents to support their ornamental plants and gardens despite water restrictions that curtailed the use of municipal water for irrigation. The figure below illustrates the amount of recycled water used in Melbourne

Figure 19: Amount of recycled water used per sector (agriculture, residential, industrial/commercial, and councils) and specific irrigation schemes (South East Outfall, Eastern Irrigation Scheme, and Werribee Irrigation District)



Melbourne's Living Victoria Water Rebate Program also provided rebates for rainwater tanks ranging from $850 to $1500, depending on their size and end uses. A 2013 survey found that rainwater tank use in Melbourne is divided primarily between residential users (68%) and industry, schools, and councils (32%).

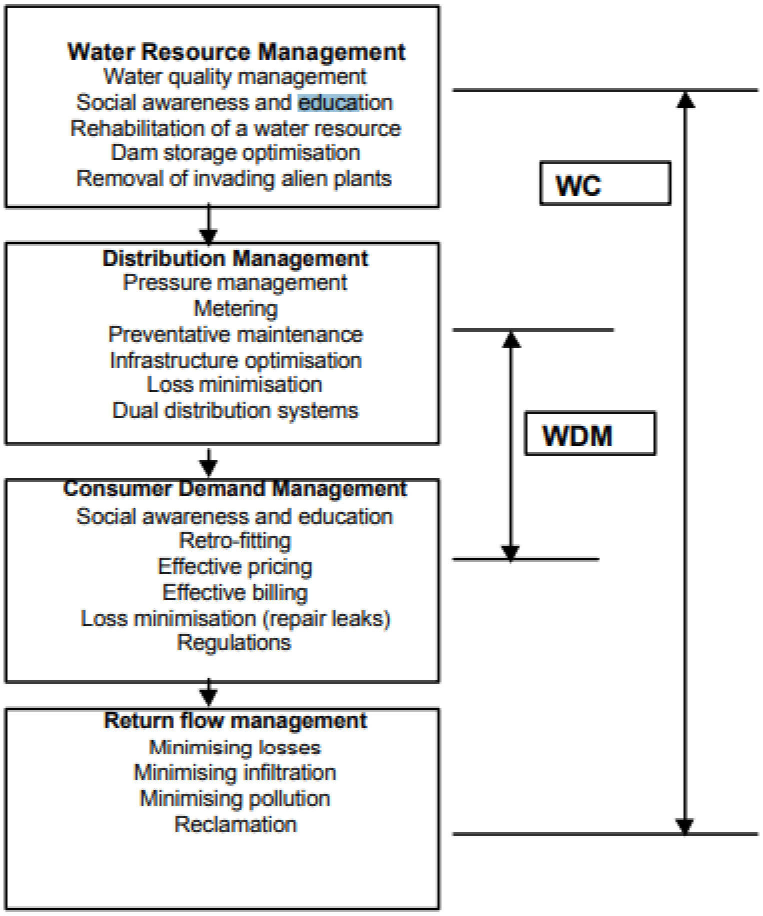
DEMAND-SIDE MEASURES

Millennium Drought in Melbourne reduced the rate of water consumption by half between 1997 and 2012. Some of the efforts applied by Melbourne to reduce water usage include:

i. Increasing funding for stormwater and rainwater harvesting
ii. Implementing water conservation measures comprising of rebate program for water efficient appliances
iii. Imposing water use restrictions
iv. Conducting television, radio, billboards, and print media advertising campaigns that promotes water conservation
v. Reducing environmental flows to rivers

According to Alkaisi, Mossad, and Sharifian-Barforoush (2017), if Melbourne did not embark on these measures, it would have drained by 2009. Although the city had in place pricing strategies, it did not apply the technique. The inclined block tariff which comprises of 3-tiers with ever-increasing unit price for example is used in Yarra Valley Water where persons using many units pay more. Setting of price in Melbourne is not based on drought for demand management purposes as Melbourne water companies do not have an independent price-setting power. In contrast, they set price in regard to adequate financial return for the water retailers.

Figure 20: Typical Water Conservation activities throughout the supply chain



Education Programs Targeting Schools and Homes

Both Cape Town and Melbourne have engaged in education programs which targets homes and schools. In 2006, the Victoria Government launched the School Water Efficiency Program (SWEP) to identify leaks and evaluate water use in public schools, and to promote water education. By 2009, 1737 schools joined the program. An estimated 269.1ML/year was saved from 2006 to 2009. The Learn It! Live It! The program was also established to promote water education and awareness in primary and secondary schools, which had 324 committed schools by 2011. The Water Smart Behavior Change Program developed in 2007, and by 2009, Melbourne water retailers worked directly with

140,000 households to show water saving habits in the home. Assessing the impact on water savings has been a challenge (Bourblanc, 2017).

Conclusion

Similar to majority of other municipalities, Cape Town is facing uncertain and variable hydrological regimens especially due to anticipated climatic changes. The recent water crisis that had almost resulted to Day Zero in Cape Town requires prompt and strategic innovation and water management. Cape Town can borrow some of the strategies from Melbourne a City with effective water innovations and technologies following the Millennium Drought. I believe that the situation in Cape Town can be rectified by adopting Melbourne strategies. Melbourne applies a more diversified water supply portfolio approach that works within the physical (built) infrastructure and sting natural (ecological) to increase the city's drought resilience both at short-term and long-term. Cape Town should adopt this process in opposition to costly large-scale bulk surface water supply schemes or exclusive reliance on WDM/WC.

This will comprise of scaling up sustainable urban drainage projects and groundwater abstraction while enhancing 'fit for purpose' water reuse solution, wastewater reuse, and groundwater recharge and protection. Currently, Cape Town has been extensively applying demand management to curb the rapid demand growth in the city which in turn has reduced the adoption of more diversified strategies. The systems have been impeded by general hesitation to integrate alternative sources into the water supply system and short planning horizons in drought management as a result of future uncertainties.

Another strategy that Cape Town should borrow from Melbourne is aquifer protection and sustainable groundwater development for urban recharge zones. Some of the strategies that Cape Town can adopt in protecting the aquifer include managing the quality of stormwater, land use changes, and identification of groundwater protection zones to be excluded from developments. Some other strategies that are effective in Melbourne that require adoption include the use of the dual water supply system whereby potable water will be supplied in one system while the other system will distribute non-potable water. Another issue that is prominent in Cape Town is lack of civil engineers as illustrated 4 engineers in Cape Town are in charge of 10,000 people while in Melbourne, 22 civil engineers are responsible for 10,000 residents. Additionally, the plumbing system in Cape Town is questionable as illustrated by the amount of water wasted through leaks in comparison to Melbourne. One of the effective strategies in Melbourne is that the city enforces all policies of water and sanitation unlike South Africa which although prohibits the installation of non-compliant products, it does not prohibit their import and sale in the country. Therefore, the comparative report of Melbourne and Cape Town illustrates the water management system and plumbing system in both cities and ways in which Cape Town can adopt some of the innovations to better their system and prevent water crisis in future through collaborative management.

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