COULD AUSTRALIA HAVE A CAPE TOWN DAY ZERO?

Background Report
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Date: 14 February 2018
Could Australia have a Cape Town Day Zero?

EXECUTIVE SUMMARY

Could an Australian city run out of water? In fact Australia has already had its own Day Zero, which occurred almost without warning on Christmas day 1974. Darwin’s Cyclone Tracy decimated the city, but it critically impacted the city’s power system with rainwater and saltwater “drenching” the power station - damage that left the city with no fresh water or sanitation. \(^1\) As a result, a mass vaccination program was commenced almost immediately to avoid outbreaks of Typhoid and Cholera, and within days almost the entire population of the city was evacuated.

Are our cities safe from future collapse?

Is Australia Safe Today from a Future Day Zero?

Currently, the answer is probably ‘No’ for several reasons:

1. Droughts much worse than Cape Town have already hit Australia in the last few decades, and much more severe droughts could happen in the future.

2. Not all of our cities have adequate or even minimal drought proof water supplies.

3. Climate change increases the probability of severe droughts in Australia.

4. Most important of all is that drought is not our biggest threat. The evidence suggests that extreme weather disruption to critical infrastructure is the most significant risk to urban water supplies. It is Day Zero with little or no warning.

Cape Town’s Day Zero is currently scheduled for May 2018. Unless Australia moves to adapt critical infrastructure to climate change, our own Day Zero is not an ‘if’ but a ‘when’.

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How much water would people currently get in exceptional drought?

<table>
<thead>
<tr>
<th>City</th>
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<th>Population</th>
<th>Daily Litres Per Capita</th>
<th>With Advanced Recycling</th>
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<tbody>
<tr>
<td>Perth</td>
<td>145</td>
<td>2,000,000</td>
<td>199</td>
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<td>100</td>
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<td>166,000</td>
<td>0</td>
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</table>

During a serious long-lasting drought, such as the 40-year drought in 1174AD, all coastal capital cities in Australia with desalination plants could meet basic consumption and hygiene levels. However, only Adelaide and Perth could meet anything approximating household demand. And although there would be enough drinkable water for household use, businesses and farming would not be serviced.

The Perfect Storm of Extreme Weather
The more pressing vulnerability for Australian cities is not drought, but the probability of extreme weather events – such as flooding, wind storm or a bushfire - damaging the supply chain services that keep our water systems running. As essential services have become more cross-dependent the risk of cascading failure has increased.

Australian cities are walking into a perfect storm of (a) climate change, (b) continued development of settlements and infrastructure in highly exposed locations, and (c) a failure to manage critical infrastructure cross-dependence.

What can we do to avoid an Australian Day Zero?
Australian cities have avoided a drought Day Zero because they are adapting to long term reductions in rainfall in Australia caused by climate change through reducing water consumption and introducing desalination plants and recycled water. The same focus on adaptation needs to occur across all connected infrastructure.

Immediate assessment of and investment in resilient telecommunications, power, transport and water infrastructure is needed to ensure all major cities can withstand climate enhanced extreme weather events.

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2 In 2017 Sydney has seen a collaboration of critical infrastructure providers to identify their cross dependencies and identify collaborative adaptation priorities.
What if we don’t?
If governments don’t act, the financial sector will. Under the new Taskforce for Climate Financial Disclosure (TCFD) requirements, global financial markets are including the potential impacts of climate change when they consider the financial viability of governments and companies. For example, Moody’s Investor Services recently announced they will be including an assessment of a government’s performance on climate change preparedness when setting credit ratings.

Therefore, the impact of inadequate adaptation may well hit state credit ratings, such that inward investment runs dry long before the reservoirs.

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INTRODUCTION

This report has been produced to respond to a number of important questions raised by the imminent termination of reticulated tap water in Cape Town, South Africa (currently scheduled for May 2018) including:

- Could Australian cities suffer a similar fate?
- If so, which ones are most vulnerable?
- Is this due to climate change?
- Can we avoid an Australian Day Zero?

We seek to answer these questions and highlight some of the important lessons that can be learned.

CAPE TOWN’S EQUIVALENT CITIES IN AUSTRALIA

A number of cities in Australia – including Perth, Melbourne and Adelaide - have similar weather and water cycles to Cape Town, as they are located at similar latitudes. They are subject to the same global weather cycles as Cape Town, albeit with local variations due to the combination of nearby land and ocean influences.

Cities at these latitudes get most of their rain during winter. If Adelaide does get rainfall during summer, it is usually from strong tropical storms that blow all the way from the Kimberley and across the continent.

Rainfall at these latitudes is heavily influenced by a weather feature called the subtropical ridge. The subtropical ridge is formed when the air that is heated at the equator, moves southward, cools and descends into the lower atmosphere. The area of descent tends to block weather from one side of the ridge moving to the other. The effect is that if you are on the northern side of the ridge, rainfall tends to come from tropical storms from the north. If you are on the southern side of the ridge, rainfall tends to come off of the Southern Ocean."\(^3\)

The Effects of Climate Change on Cape Town Type Cities

Australians understand how variable our climate is. In a drought year the subtropical ridge may not move as far north as normal, and therefore it acts as a mass of hot air that sits over southern Australia, blocking the critical winter rainfall from the Southern Ocean. We see these instances described in weather reports as a “blocking high pressure system”.

\(^3\) Adapted from Grose et al, 2015
Incidents of blocking high pressure systems have been increasing in the last few decades and the vast majority of climate change models project that this effect will worsen in future (Grose et al, 2015). The consequence is that autumn/winter rainfall in southern cities will become increasingly unreliable as climate change becomes more severe.

Cities like Adelaide are already starting to feel the effects of these large climate influences, and will need to prepare for more droughts in future. It seems that Perth is also an early victim of this change. According to the Water Corporation, since the 1970’s Perth’s rainfall has decreased by 19%.

illustrates that Perth has probably entered a ‘new normal’ in which it has less than half of its long-term average in water flows in local streams.

![Stream flow south west Western Australia](image)

Figure 1 Stream flow for the Perth Region showing a decline in the average amount of water in the local catchments. The figure shows the 20 year moving average (line), 20 year mean (black bar), 10 year mean (red bar) (adapted from Willis, 2018).
SO WHY HASN'T AUSTRALIA HAD A DAY ZERO?

Australia does have cities that could probably be affected by similar circumstances to Cape Town. However, in response to the recent in droughts in Australia, our cities have started to adapt to long-term reductions in rainfall. The graph below illustrates what was achieved in Sydney when efforts were made to reduce water consumption.

Figure 2 The decrease in water usage in Sydney due to staged interventions (adapted from AHSCA, 2018)

Figure 2 demonstrates a more than 25% reduction in water consumption per person, just through improved practices and more water efficient houses and appliances.

Other cities have also acted. For example, in the last decade Perth has implemented new, more climate-resilient sources of water, including desalination and groundwater replenishment. Western Australia has also introduced a commitment to waste water recycling of 13-30% by 2030 state-wide (water corporation of WA, 2018b). Businesses and households in WA were educated to use less water and make use of recycled water. Similar activities are underway in many major Australian cities that now have desalination plants and are implementing water efficiency practices.

With some climate projections suggesting a potential worsening of water yield in tandem with rising global and local temperatures, it is essential that all states make future plans to include expanding groundwater replenishment schemes, recycling and increasing the capacity of new and existing desalination plants.
IS AUSTRALIA SAFE FROM A FUTURE DAY ZERO?

Currently the answer is probably ‘No’ for several reasons:

1. Droughts much worse than Cape Town have already hit Australia in the last few decades, and much more severe droughts occurred before European settlement and could happen again in the future.

2. Not all of our cities have adequate or even minimal drought proof supplies.

3. Climate change only increases the probability of severe droughts in Australia.

4. Drought may not be the most likely hazard to interrupt drinkable water supplies.

Australia’s 40 Year Drought

In the decade long “millennium drought” which finished in 2010, storages in Brisbane went below 15% (SEQ Water, 2018), Melbourne as low as 38.8% (Melbourne Water, 2018), Sydney as low as 33.9% in February 2007 (Carter, 2014).

Australia has suffered much worse droughts, including the 40-year drought from 1174 to 1212AD (Vance et al, 2015) which would likely leave storages exhausted with traditional inflows. Even ground water sources would likely be drawn down beyond acceptable use levels.

Under such circumstances cities would likely be reliant on desalination of ocean water as a new drought proof source, coupled with recycling to capture useable water that would otherwise be lost to the ocean.

However, not all of Australia’s cities are coastal – and only coastal cities can have desalination plants.

Figure 3 Image: The Perth Seawater Desalination Plant (from SUEZ, 2018)
Desalination Yields in Australia

- Perth has two desalination plants one in Kwinana producing 45 Gigalitres (GL) of fresh water every year, and one in Binningup producing 100 GL of fresh water\(^4\).
- Adelaide’s largest desalination plant is at Lonsdale and is capable of producing 100GL per year\(^5\).
- The Victorian Desalination Plant in Wonthaggi can produce 160GL per year\(^6\).
- The Sydney Desalination plant is capable of producing 91GL a year\(^7\).
- Brisbane’s Desalination plant can provide 48GL a year\(^8\).
- There are no desalination plants in Darwin, Hobart or Canberra.

![Desalination Water Capacity (GL/annum)](image)

Figure 4 Total desalination capacity by Australian city.

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Considering where water is used, the Bureau of Meteorology lists that the estimated total volume of water extractions for consumptive use across Australia was 15,900 GL in 2015–16. This is 5 per cent lower than in 2014–15. Of this 71% was used for agriculture, 21% urban use and 9% for other industries. This report also noted a per household water use of around 400 litres per day. Given that the average household size is currently 2.6, this equates to a daily use of around 150 litres per person.

In practice, in the event of a disastrous drought, many commercial, industrial and agricultural water-consuming processes might be taken offline in order to preserve water levels to households for consumption and adequate sanitation.

The World Health Organisation suggests, “a minimum of 7.5 litres per capita per day will meet the requirements of most people under most conditions. This water needs to be of a quality that represents a tolerable level of risk. However, in an emergency situation, a minimum of 15 litres is required. A higher quantity of about 20 litres per capita per day should be assured to take care of basic hygiene needs and basic food hygiene.”

Keeping the above minima in mind and looking at Table below, with no recycling, all capital cities with desalination plants could meet basic consumption and hygiene levels – but only Adelaide and Perth could meet anything approximating drought level household demand.

Using Recycling to Extend Water Supplies

In California the potential for water reuse has been estimated to be 23-25% of available wastewater. This would therefore reduce the need for as much potable water, and would have water saving and environmental benefits.

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Singapore currently meets 30% of its water needs – including potable quality water – through advanced recycling technologies.\(^\text{14}\)

Obviously, water can be recycled several times, but assuming widespread application of up to 50% recycling capability, this could double the effective yield from desalination.

Recycling is a relatively established technology and can be brought on line quickly and so it should be considered a critical technology for Australian cities to mitigate against a deep drought.

Water recycling could be used to effectively double the amount of production, which would bring Melbourne to an acceptable household allocation, but would still leave Sydney and Brisbane falling short.

It should be noted, however, that these production levels do not make any allowance for commercial, industrial or agricultural water needs. That means, to maintain enough drinkable and sanitation water for household use, businesses and farming would have to go without.

Table 1 The potential water availability per capita using desalination capacity with and without recycling. The population data comes from the relevant providers websites\(^\text{15}\).

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Figure 5 Comparison of water available through existing desalination and desalination coupled with the significant recycling.
EXTREME WEATHER EVENTS AND CRITICAL INFRASTRUCTURE

The most immediate risk to Australian urban water supplies is that of extreme weather events damaging the supply chain services that keep our water systems running. Droughts unfold slowly and can be managed with timely action - extreme events occur with little more that a few days notice.

Essential services have become increasingly cross-dependent in recent years:

- Communications systems are used to monitor and control water distribution networks;
- Electricity supplies pumps and valves and move water and waste water around our cities;
- Roads and transport networks provide critical access lines for staff, engineers and critical consumables like disinfection chemicals.

Disrupting any of these undermines the security of the water and sanitation system of every modern Australian city.

A Day Zero in Australia could occur through a lack of timely investment in resilient telecommunications, power, transport and water infrastructure.

Taken from this perspective, Australia has already had its own Day Zero, which occurred with little warning on Christmas day 1974. Darwin's Cyclone Tracy decimated the city, but -critically- it impacted the cities power system with rainwater and saltwater "drenching" the power station. This and other damage left the city with no fresh water or sanitation. As a result, a mass vaccination program was commenced almost immediately to avoid an outbreak of Typhoid and Cholera, and within days almost the entire population of the city was evacuated. Without functioning water and sanitation systems, "Darwin had, for the time being, ceased to exist as a city."  

Extreme weather events damaging infrastructure are not restricted to cyclones. For example, on 16 December 2015 an East Coast Low storm in Sydney caused a localised 'mini-tornado', which hit the city's Desalination plant at Kurnell. It took off a number of the plant's roofs and caused significant wind and water damage to the control room.

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17 Ibid
This sets a concerning precedent of an extreme weather event rendering crucial resilience infrastructure defunct.\textsuperscript{19} If this had happened during a deep drought when the desalination plant was the only thing keeping the taps on, this would have had devastating consequences for water security.

There are many other recent examples of extreme weather rendering crucial infrastructure defunct:

- The South Australian wind storm in 2017 shut down power to the State;
- The Brisbane floods in 2011 reduced water treatment in important plants to 50% capacity, severely threatening Brisbane’s water supply\textsuperscript{20};
- Visitors to Mackay were evacuated due to floods in 2017 as it had 24 hours of safe drinking water remaining\textsuperscript{21}.

Worsening Extreme Weather Risk as Climate Change Progresses

Human induced climate change began over 100 years ago and continues to gather momentum in the absence of effective emission cuts. Most of the extreme events that can impact critical infrastructure are being exacerbated by climate change.

- Increasing Heatwaves: temperatures exceeding the tolerance of machinery, reducing the efficiency of electrical supply networks and overloading networks when air-conditioning demand surges.
- Wind Storms like cyclones are projected to have higher and more destructive wind-speeds and, due to climate change, are expected to reach further south – into parts of Western Australia and Queensland where infrastructure has not been designed to cope with such conditions.
- Sea Level Rise is leading to higher storm tides that can reach low-lying infrastructure such as waste water treatment plants.
- Days of ‘bushfire weather’ are increasing, which threatens power, communications and road networks (Lucas et al, 2007).

Assuming the infrastructure and the design standards stay the same, the only conclusion is that the risk of Extreme Event Day Zeros will increase.

CONCLUSIONS AND RECOMMENDATIONS

We have avoided a Cape Town-style Day Zero in Australia because we acted decisively in the millennium drought to improve the resilience of our water supplies. However, it is well within the realms of probability that we will again experience a sustained or even multi-decade drought that would mean that these initial investments will not be enough to ensure ongoing water supply to our cities. Australia needs further investment in future-proofing our water supplies.

However, our largest and most immediate risks are far more likely to arise from weather events that damage critical power, telecommunications and transport infrastructure that then lead to failures of our water supplies and other services. We see this play out every year in cyclones, bushfires, storms and floods.

These issues are getting worse, not only because of climate change, but also because we continue to develop settlements and infrastructure in highly exposed locations.

We now we have to act decisively to ensure resilience of our highly cross dependent infrastructure. Sydney is currently the only city in Australia that is taking this challenge seriously. Through the NSW Government, they have brought together all critical infrastructure providers to identify and co-invest in solutions to their cross dependent risks.

Australia is being left behind in ensuring resilience of our cross-dependent infrastructure. The C40 Cities network has started to promote cross dependent infrastructure to its network of 90 cities23. Last year, the Government of Canada called for proof of concepts to assess cross dependency in its major cities and regions24. In the UK, the regulator has given water utilities provisions to use part of their revenues to ensure supply chain resilience25.

It is therefore recommended that:

1. All Australian state governments implement cross-dependent infrastructure analysis for all their critical services.
2. The federal government regulates that all essential services must consider the risk of climate change and cross dependent supply chain services on their operation, and contain long term risks sufficiently to protect cities.
3. Government owned or regulated infrastructure must be allowed to factor the cost of adaptation and cross-dependency resilience into their pricing.

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REFERENCES


