CT WATER CRISIS: HEADING FOR ECOLOGICAL SUICIDE?

By Anthony Turton October 23, 2017

I recently tried to explain the current dire situation in Cape Town in a non-technical manner. That piece was written with the intention of generating an informed public debate, because all things being equal, Cape Town is potentially the first city in South Africa to experience total system failure in 2018.

To take this debate to the next level, I hope to crystalize out some very clear cause-effect linkage, because this is needed when making the correct decision about future strategy going forward. In my view there are three distinct "things" that need to be profoundly understood for adequate policy-reform. I will try to explain them in non-technical terms so that the layperson can understand their relevance.

The first of these "things" is that the core problem confronting the Western Cape in general, and Cape Town in particular, is what is known in the technical literature as "hydraulic density of population" (HDP). Developed by highly acclaimed Swedish scientist Prof Malin Falkenmark, this is now accepted globally as a key indicator of sustainability.

It is widely used by various intelligence agencies as an indicator of social stability / cohesion in a given country. Stated simplistically, there is a direct relationship between human population, water availability and social cohesion. Seen through this conceptual lens, the WC problem is the interplay between population dynamics and water resource availability, with social cohesion being the result of this interplay.

I recently did a confidential peer review for an investment portfolio that had flagged Cape Town as a high risk for incoming capital, citing the HDP, but not using these exact words. While I am unable to share details because of professional confidentiality, this specific risk report highlighted what I believe an informed policy reform process should be centred on. Let me build this argument further.

HDP has two components to it – population dynamics and water availability – with different implications arising from a range of relationships between variables.

On the population dynamics side, there has been massive urbanization since the transition to democracy in 1994, with little by way of infrastructure upgrade to cope with these demands. The outcome is that Cape Town simply has too many people dependent on its current water resource-base. If a government response is to curtail water use per capita, as it currently is, then the unintended consequence is that the Western Cape (WC) economy will be increasingly unable to attract capital and existing assets will be increasingly at risk.

This triggers a vicious cycle, because lower economic activity results in more unemployment, less taxes to the fiscus, and therefore less money available for infrastructure upgrades. It also drives the loss of social cohesion – something we need to guard against.

On the water availability side, there is a long-term trend in climate variability at work. Whether this is human-induced climate change or not is irrelevant, because all that needs to be known is that current datasets show that cold fronts are becoming weaker, and therefore less able to penetrate inland, to provide water as rainfall.

More importantly, higher ambient air temperatures also mean increased loss to evapo-transpiration (ET). More water is lost off open dams (E) and plants transpire more water through the stomata of their leaves (T) under such conditions. Climate is important to grasp, because the response by the Mayor is predicated on an assumption that the current drought is temporary, so the policy response is only on temporary solutions, most notably with groundwater becoming more important and desalination as a stop-gap.

Seen through the lens of HDP, this is clearly an inappropriate policy response. A growing population needs to survive off a dwindling water resource base, so to merely shift emphasis from surface to groundwater, ignores the simple fact that groundwater needs to be recharged in order to be sustainable. More importantly, to consider desalination as only a short-term stop-gap measure, means that the cost per unit of water generated will always be prohibitively high.

This leads logically onto the second core concept needed for any informed policy reform debate. Any coastal aquifer is governed by known physics. In a nutshell, any aquifer along the coast has a balance of forces defined simplistically as recharge (water percolating into the aquifer from the surface), abstraction (water withdrawn artificially to sustain human needs) and the pressure of sea water exerted laterally.

So, there are three critical elements – volume in, volume out and balance between fresh and salt water along the coastal margins. The physics of water are specific. Fresh water is less dense than saline water, so the two never mix. Along the coastal margins, this means that a saline wedge lies beneath a lens of fresh water. If more water is abstracted than is recharged into the aquifer over time, then the angle of this interface changes, and the saline wedge penetrates deeper inland. This is catastrophic, because once an aquifer is salinized, it takes decades (if not centuries) to once again become fresh.

This is known in the scientific literature as the Ghyben-Herzberg Principle. The physics of water flowing through an aquifer is known in the scientific literature as Darcy's Law. Both of these are fundamental to any evidence-based policy response being developed if it is to be sustainable over time.

This means that an unintended consequence of failing to grasp the core driver of the problem – HDP – results in an inappropriate policy response by merely replacing surface water with groundwater resources. This is dangerous, and can be likened to what the same Swedish scientist called "Ecocide" – suicide committed by a society when they destroy the ecological foundation of their daily well-being. Excessive groundwater abstraction will certainly result in ecocide, because of the salinization of the coastal aquifers in the absence of increased recharge.

This logically leads us to the third "thing" that is relevant. Managed Aquifer Recharge (MAR) is a rapidly growing solution driven by the convergence of science, engineering and technology in advanced societies.

Called by different names, including Aquifer Storage and Recovery (ASR), it simply means that water is cleaned up to a level that makes it safe for use, but then instead of storing it in an open dam where evaporative losses (E) reduce the volume over time, it is pumped underground into a confined aquifer. This is happening all over the world and is a viable technology with an increasingly predictable set of pros and cons.

The Stockholm Industry Water Prize was awarded to a MAR project in California, where a series of injection wells had been engineered to prevent the movement of the saline wedge defined by the Ghyben-Herzberg Principle. This solution made use of recovered grey water, treated to a safe standard, and then used as a curtain to prevent salt water intrusion along the lateral fringes of a coastal aquifer.

The best local example of this is found in Botswana and Namibia, where water is temporarily stored in surface ponds designed to recharge local aquifers. The most sophisticated example that I am aware of is currently being run by the Water Utility Corporation in Perth, West Australia. They will eventually be recovering 120 mL/d (mega litres or million litres per day) from the sewage effluent stream at the Beenyup Waste Water Treatment Works.

This is treated by reverse osmosis followed by UV disinfection before being recharged back into the Leaderville Aquifer more than 100 metres below surface. In my professional opinion, the only way that the Table Mountain Aquifer, and other local sub-surface water resources, will be viable over the long term, will be if they are serviced with active MAR technologies. If this is not done, then Ghyben-Herzberg tells us exactly what will happen as the saline wedge moves into the aquifer, destroying the resource for decades into the future.

These three "things" need to be inserted into the public debate as elected officials decide on strategy for what is probably the single biggest existential threat to the future of the people of Cape Town.

To summarise then, these three things are:

1) Hydraulic density of population (HDP) as the core driver of the problem with two distinct sides being active – population dynamics and water resource availability over time – with social cohesion being the resulting outcome of this dynamic interaction. Get it wrong, then we will logically see social decay into anarchy and chaos; but get it right and social cohesion will be restored, or even enhanced.

2) Long-term climate cycles that are reducing the volume of water in the overall WC system, irrespective of whether climate change is human-induced (or not).

3) The physics of coastal aquifers is defined by the Ghyben-Herzberg Principle that defines the angle of the interface between fresh and salt water in response to changes in the

balance between abstraction and recharge over time. These are the key variables to understand.

We are now able to have a more informed and hopefully constructive discussion in the policy arena.

To inform this discussion further, I believe that three critical elements of any policy reform will be required, if we are to reverse the system collapse now seen to be more-or-less inevitable in March 2018. These three critical policy elements are:

1) Desalination of seawater.

2) Recovery of water from waste streams

3) Managed aquifer recharge (MAR).

Let me explain why these three elements are needed:

Firstly, it has been known since the first National Water Resource Strategy (NWRS) was launched in 2004 that the Berg River Water Management Area (WMA) would be in deficit by 508 million cubic metres (mcm) per annum by 2025.

The same NWRS told us that at national level we would have a deficit of 2,044 mcm by 2025, with major areas of risk being the Upper Vaal (with a projected deficit of 764 mcm) and the Mvoti-Mzimkulu WMA (with a projected deficit of 788 mcm).

Government decision-makers have therefore known of this for more than two decades, but have simply failed to act accordingly for reasons beyond the scope of this think piece. Therefore, for all coastal areas sustaining significant economic activity and human populations, the most logical solution is to desalinate seawater. The technology is mature and the cost per unit of water treated is declining significantly as refinements take place.

Personally, I am unable to see a future for KZN, the Eastern Cape and the Western Cape without desalination being a core component – not as a short-term drought response, but rather as a deliberate long-term strategy that recognizes the harsh implications of HDP. South African companies have lots of experience, with examples being the AMD desalination at eMalahleni, the Trekopje desalination plant in Namibia, and a plethora of smaller plant dotted around the country. We already have the technology, so we have no need to import it from anywhere.

Now the question arises, what of the desalination plants when there is sufficient rainfall to sustain surface water resources? I will answer this key question below. It’s an important issue to grasp for any informed policy reform.

Secondly, water recovery from waste is a growing phenomenon globally. The UN has recognized waste water as one of the critical resources for future sustainability. We already have successful waste water recovery systems in South Africa, but for some reason they are not placed on a pedestal as successful solutions. These include, but are not limited to, various desalination plants in the Mpumalanga coalfields (such as eMalahleni and Tweefontien), the Durban South Sewage Works where industrial process water is generated for the petrochemical industry and adjacent paper and pulp mill, and the Potsdam works in the Cape where grey water is harvested for irrigation of public spaces.

We simply need more of these – in fact we could conceivably generate around 50 billion litres of water daily if we do this across the entire country – but central to this is the fact that the technology used for recovering water from waste is similar to the desalination of seawater.

We therefore get back to this central issue – this is a permanent and not a short-term policy trajectory.

Finally, we get to Managed Aquifer Recharge (MAR). Now we can deal with the issue raised above – what of the desalination plants when there is sufficient rainfall to sustain surface water resources? The answer is simple – that surplus water is used for MAR. It is banked in a safe place for use in the future. This enables surface water to be optimized for agriculture and other major job creation drivers in our economy, BUT at the same time it increases the assurance of supply (stated conversely it reduces the risk that arises when rains fail sequentially for a few years). Correct sizing of plant means that one does not have to build a massive desalination facility for drought relief only, but rather a few smaller plants, strategically located where they can contribute to MAR. There are many complexities in this process, so for the purpose of an enlightened policy discussion, let us merely raise the issue and ignore the nuanced detail for the time being.

In conclusion, if these three elements of policy reform are incorporated – desalination of sea water, recovery of water from waste streams, and MAR – then Cape Town will emerge from this crisis invigorated, socially cohesive and a safe destination for the capital needed to grow jobs and create general wellbeing across the entire population, irrespective of race or wealth status.

If you care about this policy reform process, please reflect on what I have said above, and consider sharing it with your respective networks. It is important that an enlightened citizenry engage with their elected officials with a clear set of ideas in their heads. I have offered a few of these ideas for consideration by the broader population. Please educate yourself by becoming familiar with the key concepts mention above. Google them at leisure and educate yourself so that you can ask appropriate questions of your elected representatives. After all they are making decisions over complex issues with highly embedded risk that will directly impact your future wellbeing. Water is far too important to be left solely in the hands of politicians who only have a short-term election cycle in mind when making major decisions.

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