‘Water Banking’ for times of drought: Moving from idea to implementation in Windhoek, Namibia

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KEY FINDINGS

1. Windhoek, like many other cities in southern Africa, is increasingly running up against the limits of water supply to meet the needs of a growing city.
2. Windhoek has a long history of innovating to increase and secure water supply that other cities can learn from, including water reclamation and now water banking.
3. To artificially recharge an urban aquifer to store water for times of drought requires considerable investment in land use management, pollution controls and water treatment to yield water of sufficient quality to inject underground and to protect groundwater stores.
4. Technical capacity, while critical, is not enough to bring a city-scale water innovation of this kind to fruition. Political commitment, sustained resourcing and collaboration between public, private, local, national and international agencies are required.

Introduction and aim

Many cities across southern Africa, and globally, are battling with not having enough (clean) water to meet the domestic needs of all residents, supply hospitals, schools and the like, and to meet the needs of commercial and industrial businesses. This is a massive constraint on health, well-being, economic growth, job creation, food security and reducing poverty in cities. While water scarcity is a daily experience for many, it is particularly pronounced in times of drought, when seasonal rainfall is very low and/or evaporation is especially high. This is when the supplies of surface water provided to cities from rivers and dams run dangerously low. This brief explores an innovative approach to reducing the risk of urban water scarcity being developed in Windhoek, Namibia – referred to as ‘water banking’ or managed aquifer recharge – which entails pumping water into underground aquifers in times of good rains to store it for times of scarcity.

Based on research undertaken in the Future Resilience of African Cities and Lands (FRACTAL) project, this brief focusses on the decision-making processes involved in moving from the idea of water banking to implementation, highlighting enablers of progress, challenges faced and what lessons these yield for other cities facing water scarcity.

City context and issue

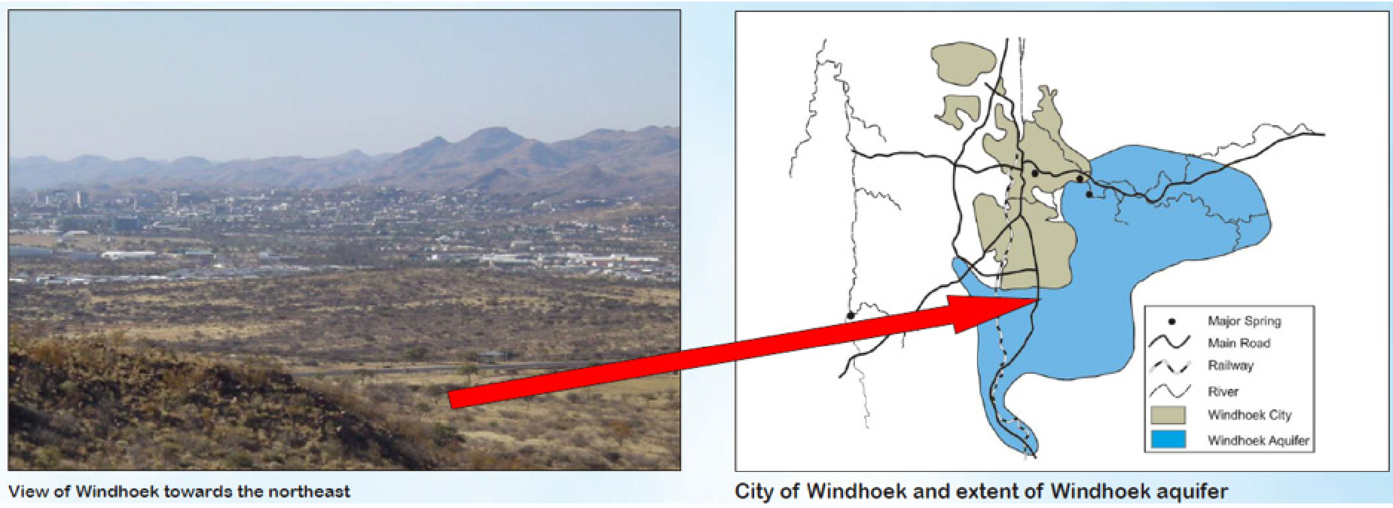
Windhoek, in Namibia, is a small but fast-growing capital city situated in an extremely dry region. For many decades the national and local governments have been working to secure a reliable supply of water to Windhoek, to accommodate a growing population and economy. Large-scale abstraction of groundwater from the Windhoek aquifer began in the 1950s[i] (see Figure 2 for timeline). The first large dam feeding surface water to Windhoek, the Goreangab Dam, was completed in 1959. Windhoek was the first city to implement a direct potable water reuse system with the construction of the Goreangab Reclamation Plant completed in 1969, cleaning wastewater to the quality needed for consumption[ii]. A system of three interconnected dams was built between 1969 and 1982, greatly expanding the amount of surface water available to the city[iii].

By the 1990s the groundwater levels in the Windhoek aquifer had dropped dangerously low from abstracting more water than naturally recharges. In 1994, the city began implementing water management strategies to reduce use and slow down growth in water demand[iv]. The government began assessing various options for adding new water to the city’s supply system and conserving the water that was available. One of the options put on the table was to artificially recharge the Windhoek aquifer, injecting ‘excess’ water from dams and reclamation plants during high rainfall periods underground, and thereby have more groundwater available to abstract in periods when dam levels are very low. Hence the name ‘water banking’, in the sense of saving and storing water for when it is most needed. This seemed like an attractive option because it dealt with the problem of extremely high evaporative losses from dams and because it posed a more local solution than other new sources of either surface water or groundwater. These would entail securing new sources from much further away from the city, requiring many agreements to be in place, and high costs and water losses associated with transporting water long distances.

The Windhoek Managed Aquifer Recharge Scheme (WMARS)

Prompted by a water crisis in the wider Windhoek region, the government in 1996 began investing in detailed technical, financial and economic feasibility studies of the Windhoek Managed Aquifer Recharge Scheme (WMARS). This included detailed studies of the aquifer to establish flow characteristics and boundaries, drilling and testing four injection boreholes, and assessing the costs and phasing of a large-scale scheme to deliver up to 8 million m^3 per year[v]. The feasibility phase was completed in 2004 after eight years of testing and assessments.

Figure 1: View of City of Windhoek and extent of aquifer. Source: Mapani, Schreiber and Kamona, no date, URL: http://www.mme.gov.na/files/publications/b7e_windhoek_aquifer.pdf (accessed 27 September 2019)



View of Windhoek towards the northeast

City of Windhoek and extent of Windhoek aquifer

After a two-year planning phase, preparing an implementation plan for the recharge scheme, establishing water quality requirements for the water to be injected into the aquifer, and passing new land use and urban development regulations to protect the recharge areas, a six-year production phase followed. The production phase saw 2.83 million m^3 of water injected via six boreholes.

Getting water of sufficient quality to inject into the aquifer and arriving at an agreement between the City of Windhoek and NamWater on the cost and payment model for the water to be injected have proven to be two large stumbling blocks for the scheme. The water quality problems stem from industrial and domestic waste contaminating surface waters, requiring more stringent pollution controls, land use controls, and increasing water treatment capacities.

An expansion phase was planned for 2013 to 2016 to drill ten more injection boreholes and increase the volume of water being recharged to 8 million m^3 per year. But, a drought and impending water crisis brought implementation to a halt in 2015. Attention shifted from recharge to increasing abstraction of groundwater to meet demand during the drought[vi]. In effect both the water and the funds to expand the recharge scheme dried up. Vandalism of the injection boreholes has also proved problematic. So, in 2019, with the national and city governments having recently declared another drought crisis, the managed aquifer recharge scheme is not halfway to where the City had wanted it to be by this point in time. There are eight recharge points, but two are defunct due to vandalism, with the capacity to recharge 2 million m^3 of water per year, instead of the 8 million as planned.

Recent efforts have been made to get back on track with the expansion plans. In 2016 and 2017, the City of Windhoek, with the support of the German Federal Ministry for Economic Cooperation and Development and the United Nations Development Agency, applied for international climate financing from the Green Climate Fund, but with limited success.

To complete the full WMARS was estimated to cost N$565 million. Completing the scheme requires another 30 borehole installations with power supply, 57km of additional pipelines, three pump stations, seven booster pump stations, and the installation of granular activated carbon filters to treat water from the Von Bach Dam.

Additional capital investment projects are also required for the operational success of the full scheme, including improving the water quality of Swakoppoort Dam, upgrading of the Gammams Waste Water Treatment plant, and developing a new Gammams Advanced Water Reclamation Plant – altogether estimated to cost in the region of N$855 million.

All-in-all water banking is a costly venture, but in a dry, drought-prone and expanding city region like Windhoek, the economic valuation suggests that the losses to industry, property values, and the job losses associated with water shortfalls greatly exceed these costs. Despite considerable technical work showing the feasibility of the scheme, the financial investment, political will and organizational agreements are not yet at a level required to make full implementation possible. With each successive drought, renewed commitment is expressed to implement the scheme to increase the water security, climate resilience and economic prospects of Windhoek, but the necessary resources are allocated to other priorities, making progress impossible.

Figure 2: Timeline showing the use of the Windhoek aquifer 1950-2020, from abstraction and natural recharge to increasing efforts at artifical recharge

CONTEXT	DATE	WINDHOEK AQUIFER
	1950	Large-scale abstraction from the Windhoek Aquifer began in the 1950s
Goreangab Dam completed	1959	
	1960	Windhoek relied almost solely on groundwater until 1960 (some augmentation from Avis Dam)
Goreangab Reclamation plant established, first direct potable water reuse system in the world	1968/69	
Three dams system building began	***1970***	
	1975	1970 to 1975: five-year rest period to enable groundwater levels to recover
	1980	
Three dams system completed	1982	
National independence	***1990***	
Began implementing water demand management strategies	1994	
Severe drought, Central Areas water crisis, Berg Aukas Mine added as emergency groundwater supply	1996	First injection testing of secondary aquifer as proof of concept for artificial recharge of Windhoek Aquifer
NamWater established	1997	Feasibility study testing first recharge points commenced
	2000	
New water reclamation plant commissioned	2002	Results of feasibility study and pilot scheme published (injection trials of 0.5 Mm^3; estimated annual natural recharge rate of 1.73 Mm^3)
	2003	Economic Feasibility Study on the Artificial Recharge of the Windhoek Aquifer
	2004	Phase 1 / feasibility phase completed - four boreholes were equipped to recharge 3.1 million m^3 per annum
CoW decision to protect aquifer recharge areas by restricting development in southern parts of Windhoek	2005	Implementation Strategy for Artificial Recharge and drilling of deep boreholes in the Windhoek Aquifer completed, including water quality parameters
Good rainy season: first year since 1976 when the sluices of Von Bach dam opened	2006	First stage of recharge scheme began: 6 injection boreholes with a combined recharge capacity of 10,000 m^3/day, injection water was fed under gravity from municipal water supplies
	2010	
	2012	First phase of borehole injection completed: targeted recharge area could not receive any more water (between 2006 and 2012 total of 2.83 Mm3 of water injected into the aquifer)
Low rainfall and little inflow into supply dams	2014	
CoW announces restrictions to avoid impending water crisis	2015	Groundwater abstraction resumed at rates higher than most previous years
State of emergency announced by President due to drought	2016	Drilled more abstraction boreholes, abstracted 11 million m^3 per annum; Green Climate Fund (GCF) Feasibility Study on WMARS developed through GCF Readiness Programme
	2017	Prepared GCF proposal for Strengthening Water Security in the Central Area of Namibia under the Climate Change, but unsuccessful
	2018	Eight recharge points but two defunct due to vandalism, capacity to recharge 2 million m^3
President announces state of emergency announced due to drought & CoW declares water crisis and increased water restrictions	2019	Large scale abstraction to cover shortfalls in surface water from three dam system
	2020	

Conclusion

What can other cities learn from this? To get a city-scale water innovation like this one operational, you need to get the technical requirements, political priorities and financial commitments all to align, which is very difficult. Ten to fifteen years of preparation time is required and even then, severe blockages and delays are experienced. There is no quick fix to water supply side 'solutions', as was also learnt by the City of Cape Town in their recent drought and water crisis experience. Much public focus is on the quantity of water supply, but this scheme highlights the complex interlinkages between water quantity and quality, and thereby the need to tackle climate risk and drought management through integrated strategies dealing with land use, public infrastructure investment, pollution monitoring and controls, and inter-agency collaboration. Designing and implementing such integrated strategies require strategic, knowledgeable and influential policy entrepreneurs or champions, who can work across domains, in addition to various technical specialists and financiers, and buy in from both the public and private sectors.

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