**An overview of Managed Aquifer Recharge in Southern Africa**

Ricky (EC) Murray, Groundwater Africa, South Africa, 1 December 2016

MAR is not a new concept in Southern Africa. In the early-mid 1900s sand storage dams were constructed in stages in Namibia for the storage of water in artificial "aquifers" (Wipplinger, 1953), and in South Africa, the Atlantis scheme near Cape Town started infiltrating storm run-off and treated waste water in 1979 (DWAF, 2010a). In addition to these, farmers over the years have built numerous earth dams for the purpose of enhancing groundwater recharge. In recent times, there have been three major contributions to the advancement of MAR in the region. It started with a surge of research in the late 1990s and early 2000s (Murray and Tredoux, 1998 and Murray and Tredoux, 2002) which had two significant spin-offs: The construction of a major borehole injection scheme for the City of Windhoek, Namibia; and the South African government developed and rolled-out its national MAR strategy.

Southern Africa is dominated by hard-rock hydrogeology, so the research focussed primarily on assessing the feasibility of recharging these fractured aquifers. One of the identified test sites was in Windhoek, Namibia, where a successful MAR scheme could prevent the construction of a 700 km pipeline to the nearest perennial river and save the city the vast costs associated with major surface water transfer schemes.

Besides being the cheapest water supply option for the city, the Windhoek's MAR scheme is of particular interest because it involves large-scale borehole injection and recovery in a highly complex, fractured quartzite aquifer. Prior to this scheme, MAR had not been practiced anywhere in the world at a large scale in complex geological environments – the risk of losing water was generally considered too high. By undertaking a comprehensive feasibility study it was demonstrated that water losses would be negligible if designed and operated correctly (Murray, 2002). As a result the scheme was built and has been under permanent expansion since the first injection boreholes were commissioned in 2005. Its current injection capacity is 420 $m^3$/hr and with the new boreholes that have been drilled, this will increase to over 1 000 $m^3$/hr.

South Africa's MAR strategy (DWAF, 2007 and DWS, 2010b), like all comprehensive strategies, sets out objectives and tasks required to meet the objectives, and so far a number of the tasks have been completed. Examples of resources produced as part of South Africa's MAR strategy are:

- A check-list for implementing successful MAR projects (DWA, 2009a)
- A national map of potential MAR areas in South Africa (DWA, 2009b)

- Guidelines for planning and authorising MAR schemes (DWA, 2010c)
- Examples of MAR feasibility studies (DWA, 2010d).

Besides the larger schemes of Windhoek and Atlantis mentioned above, a few small-medium scale MAR schemes have been implemented in South Africa (mostly borehole injection), and a number of feasibility studies have been conducted with the intention of implementation in the near future. In addition to these a major feasibility study was undertaken for the Botswana government with the aim of assessing the value of MAR for the more industrious eastern part of the country (Murray, 2012 and Lindhe, et al, 1014). In most cases, the main purpose of MAR in Southern Africa is to augment water supplies and to enhance water security. Two schemes, however, are for mine water disposal in order to comply with environmental regulations. In these cases, it is not permitted to dispose surplus water from the mines' dewatering processes on the land surface, so aquifer recharge has become the alternative, and as a by-product, local farmers benefit from it. Table 1 presents an estimate of MAR volumes since 1960.

**Table 1.** Growth in Managed Aquifer Recharge 1965-2015 (in million cubic metres / year)

| Date | Atlantis | Polokwane | Windhoek | Williston | Kolomela | Total |
|---|---|---|---|---|---|---|
| 1965 | 0 | 1 | 0 | 0 | 0 | 1 |
| 1975 | 0 | 2 | 0 | 0 | 0 | 2 |
| 1985 | 2.7 | 3 | 0 | 0 | 0 | 5.7 |
| 1995 | 2.7 | 3 | 0 | 0 | 0 | 5.7 |
| 2005 | 2.7 | 4 | 0 | 0 | 0 | 6.7 |
| 2015 | 2.7 | 4 | 2.83 | 0.09 | 0.65 | 10.3 |

While the current scale of MAR activities is very small in Southern Africa, the potential for up-scaling is huge. The additional storage that could potentially be gained over and above natural groundwater storage if MAR was implemented in all prime MAR areas is South Africa is estimated to be 7.9 billion $m^3$ (7 944 million $m^3$ ) (DWAF, 2007). Considering that South Africa uses an estimated 2.7 billion $m^3$/annum (2 723 million $m^3$/annum) (DWA, 2016) it is evident that MAR practices on a large- and wide-scale could substantially enhance the country's water security.

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