Introduction

The groundwater group of the CSIR has led groundwater research in South Africa in three critical areas during the past three decades: nitrates in groundwater; groundwater for ecosystems; and artificial storage and recovery of groundwater.

Nitrates in Groundwater

South Africa is a water-scarce country and it is believed that current levels of nitrate pollution in groundwater may be close to sustainable limits. It is estimated that groundwater supplies 15% of bulk water supply, around 10% of agriculture and over 50% of rural communal supplies (DWAF, 2004). Many rural and urban communities use untreated groundwater. High nitrates in drinking water tend to be more common in groundwater supplies than in surface water supplies (Kempeter, 2005). South Africa has some of the highest natural nitrate levels in the world (>10 mg/L NO3-N). These are shown in Figure 1.

In South Africa, high nitrate levels in groundwater are the single most important reason for groundwater sources to be declared unfit for drinking, i.e. nitrate N exceeding 10 mg/L (Marais, 1999). In 1999, the CSIR's Hydrochemical results held by the Department of Water Affairs and Forestry (DWAF) showed that 27% of groundwater abstraction points (approximately 5 000) in South Africa yield groundwater with greater than 10 mg/L NO3-N. These are shown in Figure 1.

High levels of nitrate in drinking water may cause methaemoglobinemia or Blue Baby syndrome (WHO, 1993) and death of livestock. In the future the risk is expected to increase as a result of efforts to contain HIV (Cavin and Ganthia, 1999). The South African Department of Health advises HIV-positive mothers to bottle-feed infants to reduce the risk of mother to child transmission of the HIV virus via breast milk, if the water is safe to use. This reduces the risk of infant mortality as a result of AIDS, but may expose infants to other risks from contaminated drinking water.

Groundwater Nitrate

Current research is looking at microbial contaminants and organic compounds and the risk that the potable water poses to immune-compromised individuals.

Aquifer Dependent Ecosystems

If we are to use groundwater sustainably in the future we need to understand how ecosystems rely on natural flows of groundwater to springs, rivers and wetlands. Aquifer dependent ecosystems are often important in sustaining surrounding ecosystems: the oasis effect. Figure 2 shows the riparian ecosystem on the Limpopo river at the mouth of the river fed by groundwater in the delta. The groundwater group has looked at the wide array of groundwater-linked ecosystems in southern Africa and developed guidelines for their identification and protection within catchment management (Cavin et al., 2007; Cavin and Savitzky, 2006).

The CSR assisted DWAF in developing a policy to enable the protection of ADEs and sustainable management of groundwater. The policy proposes a new Aquifer Health Programme linked to the successful River Health Programme and Working for Wetlands. Initial focus areas will include monitoring and improving our knowledge of aquifer dependency and sensitivity to change, identifying ADEs at a catchment scale, informing dissolution, determination and resource quality objectives linked to groundwater licensing.

Aquifers as Storage Dams

In South Africa the rate of potential evaporation is high at between 1 000 mm along the cooler south coast and 3 000 mm in the dry interior. South Africa has a low mean annual rainfall of about 490 mm compared with a world average of about 860 and only 9% of this is connected to rains run-off (Wagile et al., 1994). The risk of water losses and contamination in surface water storage dams is significant. Aquifers are often thought of nature’s dams – over 98% of terrestrial freshwater is stored underground. Unused aquifer storage capacity can be used to significantly lower cost than surface storage facilities, and without the environmental problems frequently associated with surface storage. The overall costs of artificial recharge operations are often less than the capital costs of conventional water supply alternatives. Artificial recharge schemes may be considered in areas where there are surplus surface water resources at certain times of the year and available unsaturated storage with sufficient permeability for injection and recovery. Opportunities for artificial recharge should also be considered in areas where evapotranspiration losses from open water bodies are excessively high.

During the 1980s Windhoek experienced an acute shortage of water and the CSR was directly involved in the development of the water reclamation system at Windhoek, which came into operation towards the end of 1968. In the 1970s, the CSIR commissioned a large scale artificial recharge research in the Cape Flats (Cape Town), and CSIR equipment is still in place in parallel to the Dan Region Project of water recycling at Al Ain. The studies in the Cape Flats paved the way for the Atlantis artificial recharge project that started in 1980.

Figure 2: The Limpopo riparian aquifer dependent ecosystems uses water stored in the alluvial sediments long after the rain and surface flows have abated.

Research into nitrates in groundwater; ecosystems; and artificial storage and recovery of groundwater.

Figure 3: National scale indication of terrestrial ADEs (based on National Biodiversity Initiative, NBI vegetation classes) and aquatic ADEs (based on GRAS calculated groundwater-fed baseflow as a percentage of total flows in quickermack in catchment streams in South Africa).

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Using Aquifers as Storage Dams

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