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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

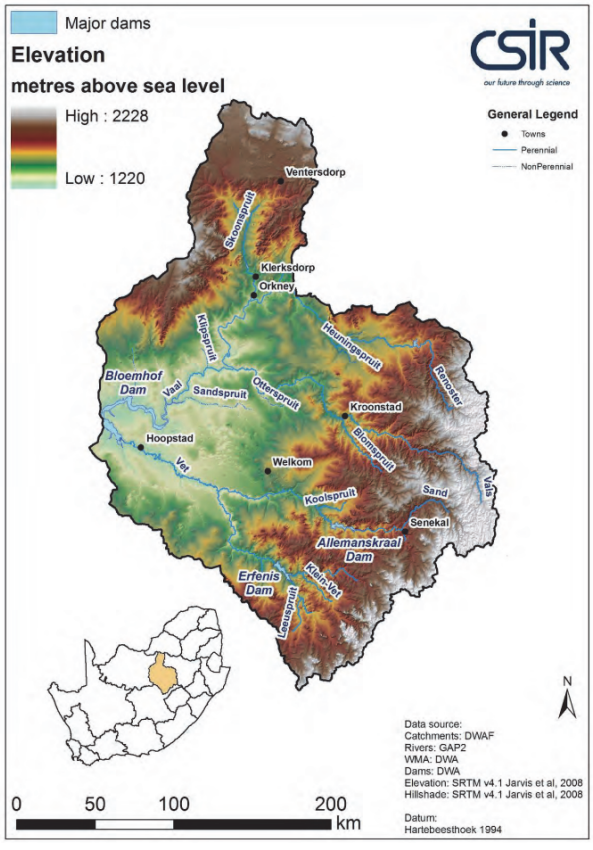
Groundwater

Groundwater Reserve determination for the Middle Vaal WMA

The Water Research Commission funded a groundwater Reserve assessment for the Middle Vaal Water Management Area.

Background

The Middle Vaal Water Management Area (MVWMA) encompassing around 52 500 km^2 in the north-central portion of the country, occupies a sensitive position within the Vaal River System because of its location downstream of the heavily urbanised and industrialised heartland of South Africa.



The Middle Vaal Water Management Area.

Although it hosts a mining industry of its own in the form of the Klersdorp (KOSH area) and Free State (Welkom-Virginia area) gold fields, mining activity is considerably greater and more varied in the neighbouring upper Vaal WMA, and it is the impact hereof that is of greatest consequence to the MVWMA.

This impact, however, is focused mainly on the surface water resources associated with the Vaal River. Groundwater resources typically fulfil a secondary water-supply function mainly in agriculture (stock farming), except in the northern portion of the study area where water-rich dolomitic formations yield sufficient water for large-scale irrigated agriculture and municipal water supply. A number of towns also rely partially or wholly on local groundwater resources for potable water supply.

Under these circumstances, it would appear that ambient groundwater resources largely fulfil a natural supporting role in the maintenance of the biophysical environment of the region. These circumstances dictate the need for a groundwater resource directed measures assessment (GRDM) to give effect to the informed consideration of the Reserve as required by the National Water Act.

GRDM

The GRDM assessment identified five groundwater resource units in the WMA. The units are the foundation on which the GRDM assessment is built. They represent a synthesis of the physical and chemical groundwater hydrology components as informed by the geological environment.

The groundwater resources of the WMA are described in terms of the physical and chemical hydrogeological characteristics associated with each of the groundwater resource

units. These characteristics define the quantity and quality components of this resource based on the basis of groundwater rest level data, groundwater chemistry data and the trends associated with these components.

The description comprises both the reference condition inferred from older (typically pre-1980) data, and the current condition inferred from more recent (typically post-2000) data. The more recent data are also used in assessment of the present ecological state of groundwater resources in the study area.

Results of quantity and quality studies

The pattern and trend of groundwater levels in the various units in the long term does not indicate significant impacts, either a negative or positive direction in regard to the groundwater quantity component of the Reserve. The development of the water-supply potential associated with the dolomitic groundwater resources in the northern portion of the WMA (the Schoonspruit Dolomitic Aquifer) requires particular observation and attention.

The pattern and trend of groundwater chemistry in the various groundwater resource units in the long term indicates that, for the most part, groundwater quality is little changed from the reference condition. The exceptions in this regard are associated with the units that host the most vulnerable dolomitic groundwater resources that occur in conjunction with mining activity and large-scale irrigated agriculture.

It is postulated that the resilience of groundwater resources to anthropogenic impacts is substantial, and masks the mining-related impacts on groundwater quality in the Klerksdorp and Free State goldfields, for example. Where instances of this nature do exist, they are localised and limited in the extent of their hydrogeological footprint.

This is in contrast to surface water resources that are much more vulnerable to contamination, and provide rapid conduits for the linear transfer of impacts into the downstream aquatic environment. In essence, the impact of acid mine drainage on groundwater quality is largely externalised to the surface water environment.

The present ecological state of groundwater resources in the WMA is assessed as supporting a category B over 52% of the catchment, a category B/C over 46% of the catchment, and a category D over the remaining 2%. The category D portion of the catchment comprises the groundwater resource unit that hosts the mining activity in the Klerksdorp area and an associated comparatively large urban and industrial area.

The present ecological state categorisation of the groundwater environment shows congruence with that of the surface water resources under circumstances where most of the drainages are assigned a Class C at present ecological state classification, and the Vaal River is assigned a Class D classification at best.

Quantity component of the Reserve

The quantity component of the preliminary groundwater Reserve determination was calculated for each quaternary catchment and aggregated to the groundwater resource unit level. The outcomes indicates that the groundwater component of baseflow amount to around 202 million m^3/a (about 40% of the estimated total mean annual groundwater recharge). This value is almost twice the 109 million m^3/a suggested in the National Water Resource Strategy.

The basic human needs component of the Reserve amounts to 8.6 million m^3/a (about 2% of the estimated total mean annual groundwater recharge). The total volume of groundwater recommended for allocation to the Reserve therefore amounts to about 211 million m^3/a.

Quality component of the Reserve

The quality component of the preliminary groundwater Reserve determination recognises that impacts on this aspect of the resource are largely externalised to the surface water environment. This occurs under circumstances where 94% of the WMA is underlain by fractured and intergranular aquifers in which the potentiometric surface typically reflects the topographic surface, and the nature of surface water/groundwater interaction of most of the catchment therefore generally represents a reasonably simple gaining hydrologic environment (losing hydrogeological environment).

The remaining 6% of the catchment that comprises carbonate strata (dolomite), portion of which are severely compromised by gold-mining activity, represents the much more complicated exception to these circumstances.

The preliminary groundwater Reserve determination at quaternary catchment level served to identify those basins which exhibit a risk of experiencing a groundwater deficit. For practical purposes, an allocable volume <5% of the mean annual groundwater recharge of the host catchment in the study area exhibit this characteristic.

Conclusion

The observation that around 94% of the study area represents a fractured and intergranular aquifer suggests that comparatively simple and uniform resource quality objectives can be applied in regard to groundwater levels across almost the entire WMA. Only the relatively small area of karst hydrosystem needs to be approached differently.

Further, the relatively small proportion (2%) of the study area that reflects a significantly modified category D present ecological state, proposed desired status category and management class, implies that the remaining 98% requires a 'closer to natural' set of resource quality objectives in order to protect the ecological Reserve.

In the context of groundwater quantity, this will secure the surface water/groundwater interaction that support the bulk of the 202 million m^3/a groundwater contribution to baseflow in the WMA.

Further reading:
To order the report, *Groundwater Reserve determination for the Middle Vaal Water Management Area* (**Report No. KV 313/13)** contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.