

## Executive Summary

Karst aquifers are typically characterised by a dual or triple porosity, comprising of solutional voids, fractures and the rock matrix. While the fractures and the rock matrix provide predominately storage potential, the conduits act as drains, resulting in fast transport of pollutants with significant tailing effects. Recharge occurs by diffuse infiltration through the soil and by concentrated infiltration via dolines and swallow holes. Due to the duality of aquifer recharge, storage and discharge processes karst aquifers are highly vulnerable to pollution.

South African karst aquifers are mainly associated with the dolomitic lithologies of the Transvaal Supergroup. Despite their socio-economic and environmental importance, no scientifically based methodology to outline areas that need protection from potential harmful activities exists. Thus an intrinsic resource aquifer vulnerability mapping method for karst terrains in South Africa was developed. The methodology is a modification of the COP aquifer vulnerability mapping method, developed by the Hydrogeology Group of the University of Malaga. The method is predominantly based on the capability of the unsaturated zone to filter or attenuate pollutants by different processes (e.g. natural attenuation during retarded infiltration, sorption etc.). It considers two additional factors that either increase or reduce the protection provided by the unsaturated zone, namely surface conditions that control water flowing towards zones of rapid infiltration, and the temporal availability of a transport agent (rainfall). These 3 factors are combined to obtain a final vulnerability index, which is spatially visualised using five vulnerability classes (ranging from Very Low to Very High). Modifications to the original COP method include, amongst others, the consideration of rock types commonly found in South Africa, a statistical redefinition of high rainfall (wet) years, a revised consideration of rainfall rates to account for dilution processes and the consideration of older, sediment filled swallow holes.

The proposed aquifer vulnerability mapping methodology should be used to assess karstic terrains during land use planning and environmental impact assessments. As an easily understandable planning tool the maps can reduce the likelihood of aquifer pollution. Future integration of hazard and vulnerability mapping

is recommended to arrive at maps showing the extent to which the current land use is putting the groundwater resource at risk.

The method was applied to produce a vulnerability map for Cradle of Humankind World Heritage Site near Krugersdorp, South Africa. In this area the karstified dolomites of the Chuniespoort Group are capable of sustaining high-yielding boreholes and are the only readily available water resource for many towns, rural areas and farms. The vulnerability map clearly shows the inferior aquifer protection in areas characterised by dolomitic lithologies, while surrounding non-karstic areas offer moderate to high resource protection. The inferior aquifer protection in the dolomitic areas is predominantly caused by the occurrence of numerous swallow holes, which cause direct, localized recharge and bypassing of the unsaturated zone. Effects of precipitation regime, topography, vegetation cover and surface karst development on aquifer vulnerability are less important for the relatively small mapping area with a subdued topography.