Evaluation of groundwater resources using geo-spatial information and developments in earth observation techniques

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The Western Cape province of South Africa is a water-scarce area with a Mediterranean climate. The majority of rainfall occurs in the cold winter months and the area experiences hot and dry summers. Due to increased usage of groundwater and the requirement to know how much water is available for use, the Water Availability Assessment Study (WAAS) was commissioned nationally by the Department of Water Affairs and Forestry (DWAF) to support, inter alia, allocable water quantification as a prerequisite for compulsory licensing. In this study it is imperative to establish a groundwater balance that can be reasonably linked to the surface water balance. The main elements of the groundwater balance are recharge, storage and discharge, while the surface-water balance consists of rainfall, run-off, evaporation and abstraction.

The approach adopted in the study ensures that the input parameters for the estimation of the different components are the same as for the surface-water modelling. The storage capacity, viz. the total available storage of the different aquifers, is calculated with an in-house-developed Geographic Information System (GIS) model based on aquifer geometry, calculated using first principles of structural geology and estimated values (based on textbook and measured data) for effective porosity and storage coefficient.

Up-scaling from dry-sample laboratory measurements of elastic properties of borehole-core samples at ~10-cm scale to saturated rock volumes on 100- to 1000-m scale, is methodologically problematic. Measuring directly the compaction of, and corresponding surface subsidence above, the pumped aquifer, and using these field-experimental measurements to determine the framework compressibility and the specific storage, can obviate such problems. Historically, such aquifer-deformation measurements have used costly devices (borehole extensometers), but recent advances in GNSS technology (e.g., GPS), and also Interferometric Synthetic Aperture Radar (InSAR), now provide noninvasive methods of geospatial data collection, which can be used in conjunction with borehole hydrograph information to estimate the specific storage and hydraulic conductivity of the aquifers

The Overstrand Municipality of the Greater Hermanus Area has embarked on a major groundwater development to augment the water supply. As a foundation for sustainable management of the groundwater resource, a detailed monitoring programme was developed for a better understanding of the hydraulic system, and of the interconnections between surface water, the shallow primary aquifer and the remarkable, deep, fractured-rock (FR) aquifer of the Table Mountain Group (TMG), which underlies a large part of the

Western Cape province in South Africa. In addition to this groundwater monitoring network, a local network of three new cGPS stations on the borehole infrastructure of the Gateway Wellfield has been established, for the purpose of quantifying the vertical and horizontal surface deformations related to groundwater abstraction, prior to a phase of aquifer test-pumping that will begin early in 2009.

It is envisaged that using the emerging technology on Global Navigational Satellite Systems (GNSS) such as GPS observations, complemented by satellite-gravity and satellite-radar methods for monitoring deep-aquifer storage changes and determining fundamental hydromechanical properties of the aquifer such as its bulk compressibility, will improve the estimated values used to calculate aquifer storage.