

The challenges and implications of assessing groundwater recharge: A case study – northern Sandveld, Western Cape, South Africa

Julian Conrad^{1*}, Jaco Nel² and Johan Wentzel²

¹GEOSS - Geohydrological and Spatial Solutions, Innovation Centre, Techno Park, Stellenbosch, 7600.

²DWAF - Department of Water Affairs and Forestry, Pretoria.

Abstract

The Department of Water Affairs and Forestry (DWAF) is currently carrying out detailed hydrogeological studies within the northern Sandveld area, Western Cape, South Africa. In addition, preliminary studies funded by DWAF, have also been carried out in the area assessing hydrological, ecological and botanical components. The area is receiving much attention due to its environmental uniqueness (part of the area is a Ramsar site) and its significant groundwater resources, which are being utilised for agricultural purposes and municipal water supply. In certain areas this groundwater abstraction is impacting on surface water flows, groundwater and associated ecosystems.

In order to gain an understanding of the systems and their inter-relationships within the area, it is necessary to carry out water balance calculations. In carrying out such calculations, the quantification of the “input” component and associated temporal and spatial variability is important to address. With special emphasis on groundwater recharge, the area may be receiving both direct groundwater recharge, (as a consequence of precipitation), and distant groundwater inflow, via the large faults that transect the area, which may be importing groundwater from the inland recharge areas (i.e. the Cederberg Mountains).

Earlier groundwater recharge studies within the area and in geologically similar settings indicate a wide range in recharge values. With special reference to the primary aquifers, earlier conservative recharge values indicate 8% recharge, with values as high as 15% being obtained. The current study indicates direct recharge values in the region of 0.2 to 3.4%. Assessment of water balance calculations indicate these recharge values are more realistic. The groundwater recharge quantification has huge significance for the Resource Directed Measures that are also being carried out in the area, in line with the requirements of the South African National Water Act of 1998. The Resource Directed Measures are aimed at ensuring water resource use and development is balanced by protection measures thereby guaranteeing the sustainable use of the resource.

Introduction

In order to optimally manage a groundwater resource that is being utilised, it is highly beneficial to carry out water balance calculations. One of the components of the water balance equation that needs to be determined is the rate of groundwater input. This input can be subdivided into three main components, namely: direct (vertical) recharge; recharge from river flow; and lateral inflow. For the study being carried out it is particularly important that the inputs be accurately determined.

The study area is located in the northern Sandveld, Western Cape, South Africa (see Fig. 1). The main reason for the area being studied is that it is a low rainfall area where significant groundwater abstraction occurs for both municipal and agriculture purposes. In addition, sensitive and important ecosystems in the area are showing varying degrees of impact. The objective of these studies is to understand the environmental linkages with surface and groundwater, and impacts resulting from groundwater use so management measures can be designed and implemented to ensure ongoing sustainable development of the area.

It is particularly important to define groundwater inputs and especially direct recharge as significant economic benefit is being derived from groundwater usage by the agricultural sector, whilst the fragile ecosystems within the area are also very groundwater dependent and showing signs of being stressed and significantly impacted. Thus a balance needs to be sought between resource utilisation and ecological protection. De Vries and Simmers (2002) state that the quantification of groundwater recharge is a prerequisite for efficient and sustainable groundwater resource management in arid regions. They also state that recharge is defined in the general sense as the downward flow of water reaching the water table, forming an addition to the groundwater reservoir.

This paper discusses the main challenges associated with determining vertical groundwater recharge in an arid to semi-arid environment.

Background information

There are many references in international literature stating that groundwater recharge is one of the most difficult components of the hydrologic budget to quantify (Stephens and Knowlton, 1986; Jackson and Rushton, 1987; Cook and Kilty, 1992; and Stone et al., 2001). There is an increased difficulty in dealing with arid regions because of the variability of recharge with respect to time and space that is characteristic of arid areas (Verma, 1979; Yair and Lavee, 1985 and Simmers, 1988).

Natural recharge to an aquifer in an arid region may occur by various mechanisms, such as infiltration from the beds of ephem-

This paper was originally presented at the 2004 Water Institute of South Africa (WISA) Biennial Conference, Cape Town, South Africa, 2-6 May 2004.

* To whom all correspondence should be addressed.

☎+2721 880 1079; fax: +2721 880-1164 ;

e-mail: julian@geoss.co.za