

# Preparing input data for a national-scale groundwater vulnerability map of Southern Africa<sup>#</sup>

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## Abstract

Groundwater quality is affected by virtually every activity of society, thereby making groundwater protection complicated and of national importance. However, protection of the groundwater will always be cheaper and less protracted than restoring an already polluted aquifer.

In compiling a national-scale groundwater vulnerability map of Southern Africa, it was decided to use the widely known DRASTIC methodology that includes the following components:

- the Depth to groundwater
- the Recharge due to rainfall
- the Aquifer media
- the Soil media
- the Topography
- the Impact of the vadose zone
- the Conductivity (hydraulic).

This methodology is well suited to gridded information sets of factors influencing groundwater vulnerability. The fact that the major strength of a grid cell-based model lies in its analytical capabilities, makes the ARC/INFO geographic information system (GIS) the ideal choice for manipulation and displaying the data surrounding the DRASTIC model.

This paper outlines the techniques used in compiling the data sets for those factors that influence the susceptibility of groundwater to contamination over Southern Africa and the techniques involved in manipulating and displaying these data in a GIS. The different techniques employed in the gathering and calculation of the different information sets required by the DRASTIC model to describe the groundwater vulnerability are presented in detail. The final output, which is in the form of a colour paper map, will be useful in presenting the concept of groundwater vulnerability and groundwater protection to the layman.

## Introduction

Southern Africa has an average mean annual precipitation of approximately 460 mm distributed over roughly  $1 \times 10^6$  km<sup>2</sup>. This average is well below the world average of approximately 860 mm and therefore groundwater has to play an important role in supplying water to many regions in Southern Africa, and in particular the rural areas. Concern is being expressed in terms of the quality of Southern Africa's groundwater resources and consequently attention is being focused on the need for a proactive approach to protect these resources from contamination.

Groundwater protection is complex and, as groundwater is affected by virtually every activity of society, the development and implementation of effective groundwater protection programmes are difficult exercises. In addition, many potentially hazardous contaminants are colourless, odourless and tasteless, and therefore difficult to detect by passive means (Barcelona et al., 1988). In spite of these problems, a comprehensive integrated approach to groundwater protection is essential if groundwater quality

standards for highest beneficial use are to be met and maintained.

Not all land-use activities pose the same pollution threat to groundwater resources and different parts of the environment have varying capacities for dealing with pollution (Born et al., 1988). Consequently, it is necessary to review the susceptibility of an aquifer to contamination in two separate but essentially inter-related ways, namely, by considering pollution risk assessment and aquifer pollution vulnerability. Pollution risk assessment considers factors such as the source, loading and characteristics of the pollutant itself. Aquifer vulnerability on the other hand is used to represent the intrinsic characteristics that determine the sensitivity of various parts of an aquifer to being adversely affected by an imposed contaminant load (Foster, 1987).

The National Research Council (NRC) has defined groundwater vulnerability to contamination as: "The tendency or likelihood for contaminants to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer" (NRC, 1993).

Contamination releases to groundwater can occur by design, by accident, or by neglect. Most groundwater contamination incidents involve substances released at or slightly below the land surface. Consequently, it is shallow groundwater that is effected initially by contaminant releases. There are at least 4 ways by which groundwater contamination occurs: infiltration, direct migration, inter-aquifer exchange, and recharge from surface water (Barcelona et al., 1988).

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