

A review of information on interactions between vegetation and groundwater

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Abstract

Vegetation plays key roles in the interactions between groundwater and surface-water systems, because of its direct and indirect influence on recharge and because of the dependence of vegetation communities on groundwater. Despite this, groundwater and surface water have traditionally been treated as separate legal entities in South Africa and scientific disciplines have also tended to view them as separate, or at least separable, hydrological systems. This situation is beginning to change as South Africa's new Water Act recognises them both as inseparable elements of the hydrological cycle. The Act also requires that water resources be managed sustainably and a much greater understanding of these interactions is needed to meet this obligation. This paper provides a review of what is known about groundwater - vegetation interactions based on local and international literature and on information from the "grey" literature and unpublished sources. Changes in vegetation cover and structure, particularly from low vegetation such as grassland to tall vegetation such as a forest can have a significant impact on groundwater recharge by altering components of the hydrological cycle such as interception and transpiration. Recent research has shown that root systems often extend to more than the 1 m maximum used in defining agricultural soils and frequently to more than 10 m deep where the physical conditions permit root penetration. Woody plants have the deepest root systems and are capable of extracting large volumes of water from depths of 10 m or more. In South Africa the impacts of vegetation changes on baseflow or groundwater have been documented in both humid and sub-humid catchments but the greatest changes in groundwater levels have followed type conversions in semi-arid savanna and on the coastal plains of Zululand. Transpiration of water by plants accounts for about half of the largest changes in the water balance associated with vegetation type conversions. Many plant communities, particularly those of wetlands and riparian strips are highly susceptible to changes in the depth to the groundwater, both annual and seasonal. The rate of change (positive or negative) in water-table levels may be important but the data are not conclusive. Interactions between groundwater and vegetation appear to be generally more pervasive and important than was believed in the past. This will be an important area for future research in SA.

Definitions of key terms

Aquifer	A saturated, permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients.
Ecological reserve	A legal term; the quality and quantity of water required to protect the water resource for ecologically sustainable development and use of the relevant water resource.
Evaporation	The total loss of water in vapour form from all sources - open water, from the plant surface (interception), through plants (transpiration) and from the soil surface. It involves the transition of water from the liquid phase to the vapour phase, and during this process energy (termed latent heat) is absorbed. Symbol E or Et.
Evapotranspiration	In modern usage is replaced by the term evaporation, as defined above.
Groundwater	Subsurface water in the saturated zone.
Phreatophytes	Plants, typically riparian, that habitually obtain their water supply from the saturated zone. Obligate phreatophytes are dependant on access to groundwater; facultative

phreatophytes are species with the ability to develop deep root systems, enabling them to tap deep soil or groundwater resources to maintain high transpiration rates.

Riparian Transpiration

Growing alongside rivers or streams. The loss of water vapour from the living cells in the plant through pores (stomata) in the leaves in vapour form. Symbol often E_t but sometimes Et.

Water table

The upper surface of the saturated zone where the water pressure is equivalent to atmospheric pressure (the upper surface of an unconfined aquifer).

Introduction

This review was performed as part of a project undertaken by the CSIR under contract to the Water Research Commission (WRC), culminating in a report entitled *The Interaction between Vegetation and Groundwater: Research Priorities for South Africa* (Scott and Le Maitre, 1998). It concentrates on studies of the impacts of vegetation on groundwater recharge as well as those which assess the potential impacts of groundwater extraction on vegetation health, at the landscape to regional scale. Evidence has been gathered from the published literature and supplemented with information from 'grey' literature and unpublished records supplied by various sources.

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