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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Groundwater

Vadose zone hydrology

A newly-published WRC report grows the knowledge on vadose zone hydrology and introduces standardised approaches towards its assessment.

What is the vadose zone?

The vadose zone (also called the unsaturated zone or the zone of aeration) stretches through the soil zone and intermediate zone and incorporates the complete capillary fringe where the medium is still below saturation, gradually becoming saturated towards the water table.

The vadose zone can also be considered as the zone between the land surface and the water table, which includes the plant root and intermediate zones as well as the capillary fringe, representing that portion of the crust where the pore spaces contain water at pressure below atmospheric, air and other gases.

WRC project rationale

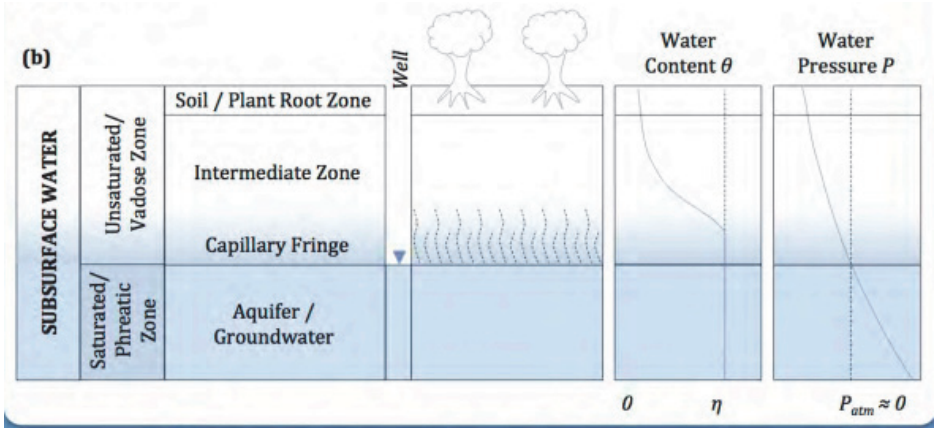
The WRC-funded project on ***Vadose zone hydrology: Spatial and temporal influences, assessment techniques and aquifer susceptibility***, follows from previous work outlining the importance of classifying the vadose zone for improved understanding.

Given the wide range of disciplines involved in vadose zone hydrology, detailed investigation of the vadose zone is generally subject to:

- 'Mono-disciplinary' investigation for specific purposes, such as either plant water availability and nutrients, potential groundwater recharge, groundwater vulnerability, seepage concerns for infrastructure development, and so on, without adequate ability to transfer the knowledge to other applications;
- Empirical or modelling assumptions based on measurable surface water and/or groundwater input data that compromises the integrity of any subsequent modelling.

The challenge of multi-disciplinary approaches

An approach involving numerous disciplines has numerous problems. Symbols and subscripts denoting parameters are not universal and are simplified in the report to include concepts from civil engineering, hydrogeology, chemistry, physics, soil sciences and other disciplines. Where possible, the symbols used in the WRC document represent those



The phreatic vs the vadose zone.

encountered in majority of the texts and those particularly pertaining the hydrogeology in favour of other disciplines.

Definitions differ per discipline. This becomes important in a multi-disciplinary field of study as confusion and misinterpretation become concerns. Hereafter, definitions apply mainly to the hydrogeological discipline where, for instance, soil refers to a mixture of solids and pore space containing essentially air or water (as opposed to a strength-based distinction from rock in engineering, or a medium subject to a long formation and inclusive of organic matter in soil sciences).

Where overlapping terminology exists, all relevant and important terms have been defined. Those pertaining to hydrogeology have, however, been used throughout the text (e.g. specific discharge instead of seepage velocity; pedocrete instead of laterite).

Techniques, methods and approaches

The report also touches on investigation techniques. Techniques, methods and approaches vary between disciplines and are based on the need for investigation. It is aimed in this study to address the most important techniques, emphasising the intermediate vadose zone and subsurface processes rather than soil moisture measurements, and to incorporate these for the use of other disciplines to avoid unnecessary repetition and to find agreement between disciplines.

One critical example of this is the quantification of readily available parameters such as hydraulic conductivity or permeability that, by definition, apply to saturated conditions and have to be corrected based on the moisture content or tension. Additional detailed emphasis is placed on the proper description of earth materials, deduction of the shallow flow processes and the development of the conceptual model.

The importance of mutual understanding

Although different disciplines should continue to exist within their own respective fields of expertise, unnecessary duplication and lack of cross-disciplinary understanding should be addressed. Consolidation of diverse aspects from such different disciplines will be beneficial to a holistic understanding of the vadose zone as well as on its importance in a vast number of applications.

Clarity regarding definitions is also important, notably given the duplicate concepts of, for instance, recharge (to groundwater table or that which is potential) confinement (of aquifers or stream channels) and infiltration (including or excluding the term percolation).

Without standardisation or infringing on the very important attributes of the individual specialist disciplines, a need exists for more open dialogue between 1) various earth scientists and 2) between earth scientists and other decision-makers. Earth scientists need to translate their findings for use by a broad audience in which the results can be interpreted to a variety of applications and by a variety of specialists.

As part of this study and towards this end, a standard multi-faceted Vadose Zone Assessment Protocol has been deduced which outlines stages of investigation. Competency of specialists and decision-making are continuously addressed.

The WRC vadose zone manual

The manual is divided into three sections. The first section provides an introduction to vadose zone hydrology. This includes properties and principles of the vadose zone, as well as methods to quantify porosity and hydraulic connectivity, among others.

The second section deals with methods and guidelines pertaining to the vadose zone. It offers a 5-tiered approach to a vadose zone hydrological investigation, including development of a conceptual model, cost-benefit analysis, minimum requirements, competent persons and decision-making.

The methods proposed in section have application for ephemeral inland wetlands, platinum tailings storage facilities, peri-urban cemeteries, variable land use in urban settings, aquifer vulnerability, engineering design, sanitation and agriculture, among others.

The third and final section of the vadose zone manual includes case studies. This includes descriptions, rationales, methods applied, results, interpretation, conclusions and provisional findings.

Further reading:
Vadose zone hydrology: Concepts and techniques (**Report No. TT 584/13**). To order this report contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.