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TECHNICAL BRIEF

Water resource management

Using isotope hydrology to assess water resources in southern Africa

A completed WRC-funded project has investigated the use of isotope hydrology to characterise and assess water resources in southern Africa.

Background

Environmental isotopes are routinely employed worldwide in the study of groundwater and surface water, as they provide unique information on transport and interconnectivity of water resources and reservoirs. The term 'environmental isotope' embraces the measurement of isotope ratios of the elements making up the water molecule and of substances dissolved in water that could give rise to hydrogen and oxygen.

These are subject to environmental processes and undergo changes, for example during evaporation. Water in specific environments, thus, obtains isotopic labels that are transported and can be traced along the flow pathway. The sustainable development and management of groundwater resources requires an accurate assessment of their occurrence, availability, sustainability and vulnerability to deterioration.

Using isotopes for water resources assessment

Environmental isotope studies have been shown to provide important information useful in the effective management of water resources in different parts of the world. The WRC funded a project to raise awareness of environmental isotope hydrology as a useful tool in the assessment of water resources at different spatial scale both at local and catchment level.

Generally, the project focused on previously executed studies as well as newly undertaken investigations to advance the understanding of the selected individual studies. Where further information had been gathered since the original investigation, interpretations on the capability of isotopes in water resource assessment were re-interpreted.

In particular, the involvement of students in this endeavour exposed them to the analytical disciplines, approaches and methodology of isotope hydrology as well as to the concepts, models and feel involved in the interpretation and integration of the isotope data.

The main objectives of the project were:

- To identify past studies and to undertake new studies suitable for demonstrating the contribution of isotope hydrology to an enhanced understanding of the systems studied
- Through re-assessment of isotope data to re-interpret former conclusions and identify data gaps, where new study areas are identified, to gather all necessary isotope, hydro geochemical and hydrogeological data, and produce the required conceptual and numerical framework highlighting the role of isotopes
- To gather all necessary isotope, hydro geochemical, hydrogeological and geological data, and produce the required conceptual and numerical framework highlighting the role of isotopes
- Develop course material on the discipline of isotope hydrology.

This project has involved a complex work programme with the participation of many individuals and institutions executing different studies. The main method focused on identifying completed and on-going isotope-related projects in different institutions. In some cases new isotope application projects were identified.

In the pre-project phase, a team of researchers were brought together in the light of individual interest, activity, potential contribution to the aims of the project such as existing or previous studies, knowledge of potential study areas etc. The team has identified nine existing and two new projects that form this report.

The compendium comprises the following case studies and applications:

- Application of isotope techniques to trace location of leakage from dams and reservoirs
- Application of isotope techniques to trace pollution in monitoring boreholes of waste disposal sites
- Oxygen and hydrogen isotopes record of Cape Town rainfall and its application to recharge studies of table mountain groundwater
- Towards a management model for the exploitation of groundwater from the Taaibosch Karoo graben, Limpopo Province
- Rainfall and groundwater isotope atlas
- Correlations between rainwater and groundwater geochemistry signatures with reference to episodic rainfall events in semi-arid environments, South Africa
- Kalahari groundwater isotope synthesis
- Environmental isotope contribution to a multi-disciplinary groundwater resource assessment in eastern Botswana
- Isotope and chemical feasibility of groundwater in Gordonia as a source for a local reticulated supply
- Surface water and groundwater interaction in the Upper Crocodile River basin
- Program debugging and application through case studies
- Use of isotopes in catchment hydrology, vegetation uptake and non-point source pollution analyses
- Hillslope response analysis for the Weatherley catchment
- Rainfall – runoff event isotope responses, Wartburg catchment

In addition, the final report is accompanied by the following material that can be used in education and training:

- Isotope Hydrology References
- Isotope Hydrology Teaching Material
- MSExcel Box Model and Guidelines

Further reading:
To order the report, ***The use of isotope hydrology to characterise and assess water resources in South(ern) Africa*** (**Report No. TT 570/13)** contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.