OPINION

Isotope hydrology: An indispensable tool in the hydrogeologist's toolbox

Water Research Commission Research Manager, Yazeed van Wyk, elaborates on the importance of isotope hydrology as part of water resource management.

Every year on 22 March World Water Day is celebrated around the world. This day is designated by the United Nations to focus on the of freshwater and its sustainable management, and provides an opportunity to raise awareness about the global water crises and the need to conserve and protect this vital resource.

According to the United Nations, more than 2 billion people lack access to safe drinking water, and by 2050, up to 5.7 billion people could be living in areas with water scarcity. In Sub-Saharan Africa, for example, an estimated 40% of the population lacks access to basic water services, and more than 300 million people do not have access to improved sanitation facilities. Based on this we are seriously off-track to meet Sustainable Development Goal (SDG) 6: water and sanitation for all by 2030. The use of isotope hydrology is a powerful tool that can help meet Sustainable Development Goal (SDG) 6, which aims to ensure the availability and sustainable management of water and sanitation for all. With this in mind, isotope hydrology is an important approach to achieve this goal. Isotope hydrology is a field of study that uses the natural variations in stable and radioactive isotopes of water to study the movement and behaviour of water in the environment. It can be used to study a variety of hydrological processes, including groundwater recharge, water quality, groundwater/surface interaction, evaporation, and precipitation. It can also be used to understand the behaviour of contaminants and pollutants in the environment, such as the movement of radioactive isotopes or the distribution of contaminants in a river and groundwater systems. Isotope hydrology is thus particularly useful for understanding the water cycle in regions where traditional hydrological methods may be limited.

This information can be used to better understand water resources and develop more effective strategies for managing them. In South Africa and the Southern African Development Community (SADC) region, the use of isotope hydrology is vital in managing and conserving water resources.

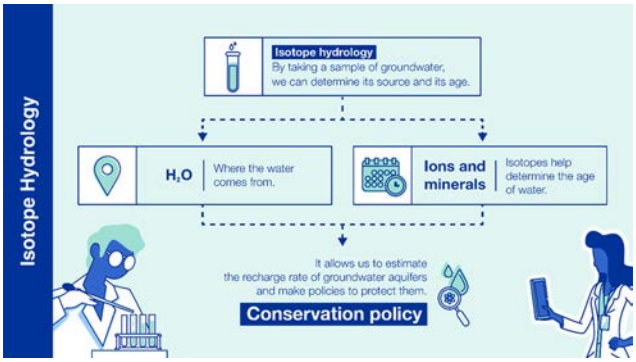
However, the region faces a significant shortage of skilled professionals in isotope hydrology. This shortage has resulted in inadequate monitoring and management of groundwater and surface water resources, which poses a significant threat to the South Africa's socio-economic development. In the late 1970's to early 2000's South Africa had a vibrant and actively engaged community of isotope hydrology practitioners. This has changed dramatically over the years with most researchers having either retired or moved abroad, which has resulted in a "stagnation" of new research ideas. South Africa has also fallen behind other African counterparts in the North (Egypt, Tunisia, and Morocco) in terms of having well equipped Regional Designated Centres (RDCs). These International Atomic Energy Agency funded RDC's are instrumental in building the necessary capacity of member states in a range of areas related to isotope hydrology, nuclear technology, including nuclear safety and security, radiation protection, and nuclear energy. They also provide training and educational programs, as well as access to specialized equipment and expertise.

To address this shortage, there is a need for the development of isotope hydrology skills in South Africa and the rest of the SADC community. This can be achieved through the implementation of training programmes, capacity building initiatives, and research partnerships. Training programmes in isotope hydrology can offer theoretical and practical knowledge to individuals interested in pursuing careers in the field. These programmes can also provide opportunities for current professionals to upgrade their skills and knowledge, ensuring that they are up-to-date with the latest developments and technologies in the field.

Capacity building initiatives, such as mentorship programmes and exchange programmes that has been a hallmark of past practices, can again provide opportunities for individuals to work with experienced professionals and learn from their expertise. These initiatives can also provide opportunities for knowledge-sharing between countries in the SADC region, promoting collaboration and building regional networks. Research partnerships between academic institutions, research organizations, and industry can also promote the development of isotope hydrology skills in the region. These partnerships can provide opportunities for students and professionals to work on research projects, promoting innovation and new technologies in the field.

The development of isotope hydrology skills in South Africa and the SADC region has significant benefits. Effective management and conservation of water resources are critical for the region's socio-economic development, and isotope hydrology plays a vital role in achieving these goals. Moreover, the development of isotope hydrology skills can promote the growth of local industries and job creation. With a skilled workforce, the region can develop new technologies and innovations that can be used to address local water resource management challenges and contribute to the global water resource management field.

The Water Research Commission (WRC) through its groundwater hydrology portfolio has been rebuilding the isotope capacity in South Africa in partnership with the IAEA, Universities, DMRE and the Department of Water and Sanitation. Through the "RAF7021 Enhancing, Planning, Management and Sustainable Utilization of Water Resources (AFRA)"program, where the WRC is the National project counterpart. In addition, the WRC has funded key isotope hydrology projects focusing on the use of stable , carbon , nitrogen, and sulphur isotopes. However, the quality and state of analytical laboratories for analysing these isotopes are in a poor state and suffer from major backlogs as a result of a lack of funding, equipment, and staffing issues. If invested in by local government structures and catchment management agencies, these tools can be used to enhance environmental monitoring of water resources, by discriminating between different forms of anthropogenic stress and potentially identifying critical sources of water resource quality degradation, which then can be targeted for stricter enforcement of water resource protection measures.



A. Vargas/IAEA

Overall, isotope hydrology is an important tool for understanding the movement of water and other substances in the environment and can provide valuable insights into hydrological processes and water resource management. It is by no means the only tool and should be used in combination with other techniques to improve water security. These include remote sensing, hydrogeological models, geochemical modeling, and water quality analysis.

In conclusion, South Africa has a rich history of nuclear research and development, and it has played an important role in global efforts to promote isotope hydrology research. However, in recent years, its participation in the IAEA has been limited, and there has been a lack of investment in developing isotope hydrology capacity. To revitalize South Africa's role in the IAEA and ensure that the country can fully benefit from isotope research initiatives, it is crucial to add additional GNIP stations in key areas and establish a local regional designated centre that can provide training and support to isotope hydrology professionals in the region. This will not only enhance South Africa's capacity to contribute to global research efforts but also strengthen regional cooperation and enhance economic development. With the right investment and support from the government, industry, and international partners, South Africa can once again become a leading player in the isotope hydrology space and help drive efforts towards sustainable water resource management.