Water Resources Programme

ADDRESSING GROUNDWATER SUSTAINABILITY NEEDS

Photo: J. Perez Vargas | IAEA

Two-thirds of the Earth is covered by water yet less than one per cent of the world's freshwater is accessible for use. Groundwater is the largest component (about 70%) of the accessible freshwater. The amount of water stored in groundwater systems or aquifers is greater than that of all rivers, lakes and the largest man-made reservoirs combined. More than half of the global freshwater supply for drinking, industrial uses and irrigation comes from groundwater. Without detailed knowledge of the characteristics of a groundwater system – the amounts of water available, replenishment rate and threats to water quality – it is impossible to use groundwater resources sustainably.

ISOTOPES: UNIQUE TOOLS

Isotope techniques are an effective and often unique means to assess the long-term viability of groundwater resource exploitation. The costs are relatively small and techniques are complementary to classical hydrological investigations. In addition, isotopes provide insights that would not otherwise be possible or practical. By using isotope techniques water resource managers can quickly obtain information that may normally require decades of measuring rainfall and groundwater levels. The picture that emerges from isotopic investigations allows hydrogeologists to map the extent and age of groundwater, and to determine the sources as well as the rate of recharge.

Sustainable exploitation also involves knowing the balance between the natural replenishment rate and abstraction. Groundwater movement is often very slow and the water balance is delicately poised.

Isotopic analysis also allows one to understand and evaluate groundwater interactions with other aquifers, rivers, lakes, and wetlands.

Importantly, isotopes help build a deeper understanding of how groundwater has behaved in the past and help predict what may happen in years to come, providing a sound scientific basis for water resources planning and protection.

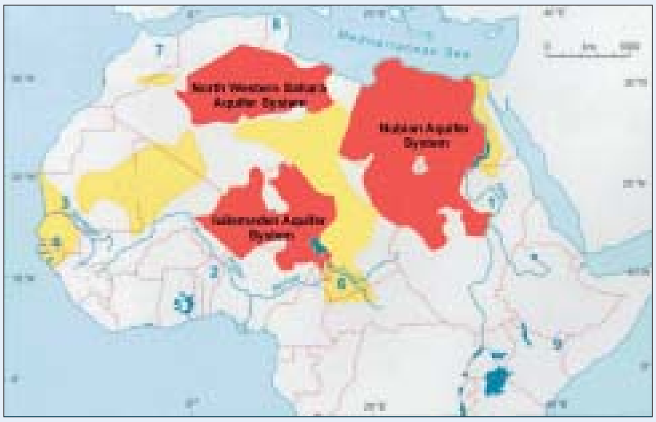
The IAEA's Water Resources Programme supports the application of isotope techniques to help its Member States to develop and implement their groundwater management strategies and policies. Currently it is supporting the implementation of over 60 technical cooperation projects related to groundwater management. It also undertakes coordinated research projects to develop new approaches on specific issues.

Isotopes, unique tools: Chuho Springs, Kisoro, Uganda

Chuho Springs, located north of the town of Kisoro in Southwestern Uganda, are being tapped for local water supply. A concern had been raised about the long-term sustainability of these springs in terms of both quality and quantity of water. Initial studies using other methods failed to provide satisfactory answers. Then an isotope study, with the assistance of the IAEA, was undertaken to delineate the source of water in the springs. This study revealed that water in the springs originated from a swampy area uphill (Kigyezi Swamp), and not from surrounding lakes in the mountains (Lakes Cyahafi, Kayumbu, and Muhavura) that were assumed to be feeding the springs. Knowing the source and pathways of recharge to the springs, it was possible to develop appropriate strategies for protecting the quality of spring water from pollution by urban and agricultural activities and to monitor its sustainability.

MANAGING TRANSBOUNDARY AQUIFERS

Freshwater resources shared by more than one country present special management challenges. Exploitation practices are often inconsistent and disagreements may arise over abstraction rights. Aquifers may receive the majority of their recharge on one side, while more of the discharge or abstraction might occur on the other side of an international border. Some transboundary aquifers contain huge quantities of freshwater, enough to provide safe drinking water amongst countries for centuries. Equitable and effective management of transboundary aquifers requires a coherent and defensible hydrological model supported by sound scientific information.



Major transboundary aquifers (shown in red) in arid regions of northern Africa.

Managing transboundary aquifers: Guarani Aquifer, South America

The Guarani is the largest aquifer in South America, shared by Argentina, Brazil, Paraguay, and Uruguay. The principal threat to this aquifer system comes from uncontrolled pollution in extraction and recharge areas. Isotope techniques are helping these four countries to improve their understanding by defining the key hydrodynamic features of the aquifer, assessing water quality and contamination patterns, determining the origin and age of groundwater, and assembling a comprehensive database to be shared among the four countries.

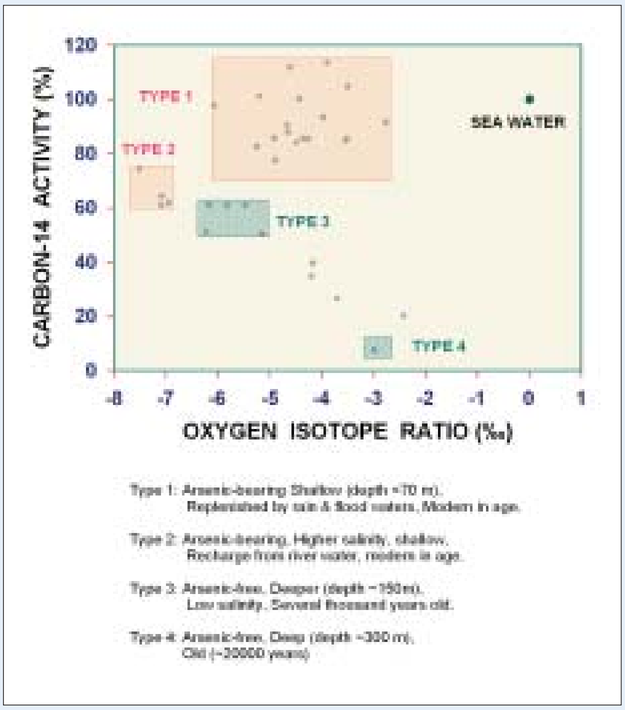
PROTECTING GROUNDWATER QUALITY

One of the obvious criteria for groundwater exploitation is that it be of appropriate quality for its intended use. In many cases, groundwater sustainability may be constrained not by the amount available, but by deterioration of quality due to pumping. This may be caused either through entrainment of poor quality saline water from adjacent aquifers, or seawater intrusion in the case of coastal aquifers. Isotopes play a key role in identifying the relationships between different water bodies as well as in locating recharge protection zones.

Isotopes are also being used to trace the pathways of contaminants and predict their fate in groundwater systems. One can assess the vulnerability of groundwater to pollution by using isotopes. This information is used to identify sources of pollution or to take action to prevent contamination. Isotopes also serve as early warning indicators of pollution when chemical or biological indicators may not give cause for concern.

Photo: G. Bizarri | UN FAO

Assuring groundwater quality is vital for safe drinking water and agricultural production.

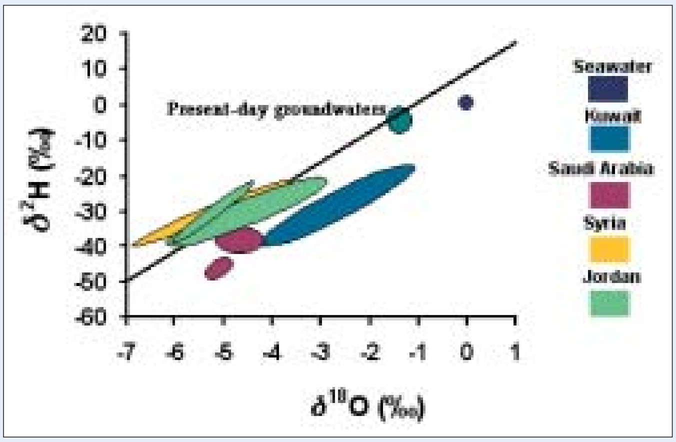


Isotopes helped to characterise arsenic contaminated groundwaters in Bangladesh.

Protecting groundwater quality:
Arsenic Contamination in Bangladesh

One of the options to mitigate the adverse health effects of arsenic contamination of groundwater in Bangladesh is to use deep aquifers as alternative sources of safe drinking water. The isotopic fingerprints of groundwaters showed that depth alone is not a reliable criterion to locate arsenic-free groundwater. Additionally, presently uncontaminated groundwater from so-called deeper wells may not remain so over a long period of time. However, with the increased use of much deeper groundwater (~300 m) potential groundwater "mining" is clearly evident and the sustainability of exploitation of resources needs to be evaluated through a programme of detailed mapping, sampling, and hydrogeological assessments.

MAPPING PALAEOWATERS



Isotopes form a valuable tool for fingerprinting paleowaters of different ages.

Water resources in many parts of the world are severely stressed as witnessed by declining water levels. Over wide areas abstraction is exceeding natural recharge and it is apparent that palaeowaters are being mined in many arid and semi-arid areas. Isotope studies have been particularly useful in understanding the origin of palaeowaters. A new initiative has been launched by the IAEA to map the extent of palaeowaters and bring together information from various sources on the global distribution of non-renewable groundwaters in a series of maps and supporting text. The aim is to create an understanding of the finite nature of these resources, and to provide a sound technical basis for their management.

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