

Using isotopic techniques to map and analyse groundwater resources in the Sahel

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Despite a series of droughts and consistently low rainfall over the past few decades, the Sahel is home to rich bodies of water — hidden underground.

Increasing water demand resulting from population growth and the uncertainties caused by climate change and land use on water resources raise the question of how to ensure the safety and sufficiency of clean water for drinking, food production and sanitation. For a semi-arid region like the Sahel, having the right scientific tools to find out more about groundwater supplies could mean long-term access to clean water.

Through an IAEA technical cooperation project that began in 2012, scientists from Algeria, Benin, Burkina Faso, Cameroon, the Central African Republic, Chad, Ghana, Mali, Mauritania, Niger, Nigeria, Senegal and Togo were trained in water sampling for isotope analysis in order to carry out a detailed survey of groundwater supplies. The project covered parts of five major transboundary aquifer systems in the area: the Iullemeden Aquifer System, the Liptako-Gourma-Upper Volta System, the Senegalo-Mauritanian Basin, the Lake Chad Basin and the Taoudeni Basin.

Over 2000 water samples were collected from different aquifers over a four-year period during both the dry and humid seasons.

“By using isotopic and chemical tracers, scientists were able to collect important information on the origin, flow patterns, residence time and renewal rate of groundwater,” said Kamel Zouari, Professor and Laboratory Head at the National Engineering School of Sfax, Tunisia, who worked on the project. “Scientists also determined the hydraulic interactions between shallow and deep aquifers and between aquifers and surface water. This information has been compiled in a dedicated database for each basin.” To learn more about the techniques used, see page 4.

These research activities led to the creation of the first broad overview of groundwater in the Sahel, covering an area of five million square kilometres. “In general, the aquifer systems located in the different shared basins represent a significant reserve of good quality water to cover most human needs,” said Zouari.

Using data to develop water management practices

Scientists from each country produced national reports now available to their water authorities to use as a basis for decision making. In northern Ghana, for example, routine monitoring of the chemical and isotopic composition of groundwater revealed recharge mechanisms and sources of contamination that were previously overlooked.

“By using stable isotopes of water — oxygen-18 and hydrogen-2 — we revealed that the groundwater is meteoric, meaning its source is local precipitation,” said Enoch Asare, Head of the Groundwater Division at the Ghana Water Resource Commission. Tritium analyses revealed that groundwater has recharged the aquifer in the last 50 years, he said. “Nitrogen-15 was used to determine sources of nitrate contamination in parts of the White Volta River Basin, showing that the contamination mostly emanated from human and animal waste.” Identifying the source of contamination can help authorities protect the water, as it reveals how groundwater is being replenished, which is key to ensuring its sustainability.

The availability of groundwater to cover human needs depends on its quantity, quality and rate of replenishment. Information on the source and age of groundwater is required to properly assess the sustainability of the resource, particularly in view of existing or planned withdrawal activities.

“It is expected that the project’s activities could further enhance the capacity of



stakeholders to better understand Ghana's hydrogeological system and thus establish policies that will safeguard the exploitation of groundwater resources, ensuring that water will be available at all times," Asare said.

A follow-up project to further integrate the management of groundwater resources in the Sahel countries began in 2018. It will follow the IAEA Water Availability Enhancement (IWAVE) methodology — led by Benin, Cameroon, Ghana, Niger and Nigeria — to identify gaps in national hydrological information and develop appropriate capacity building plans.

The IWAVE methodology consists of a gap analysis and stakeholder consultation, the development of an optimal strategy for groundwater management and the identification of essential technical capacities to invest in.

The established network of national institutions will contribute to better characterization, management and monitoring of groundwater resources using isotope hydrology and conventional techniques.

Researchers from the University of Bangui take water samples from a well in the Central African Republic.

(Photo: L. Gil/IAEA)

