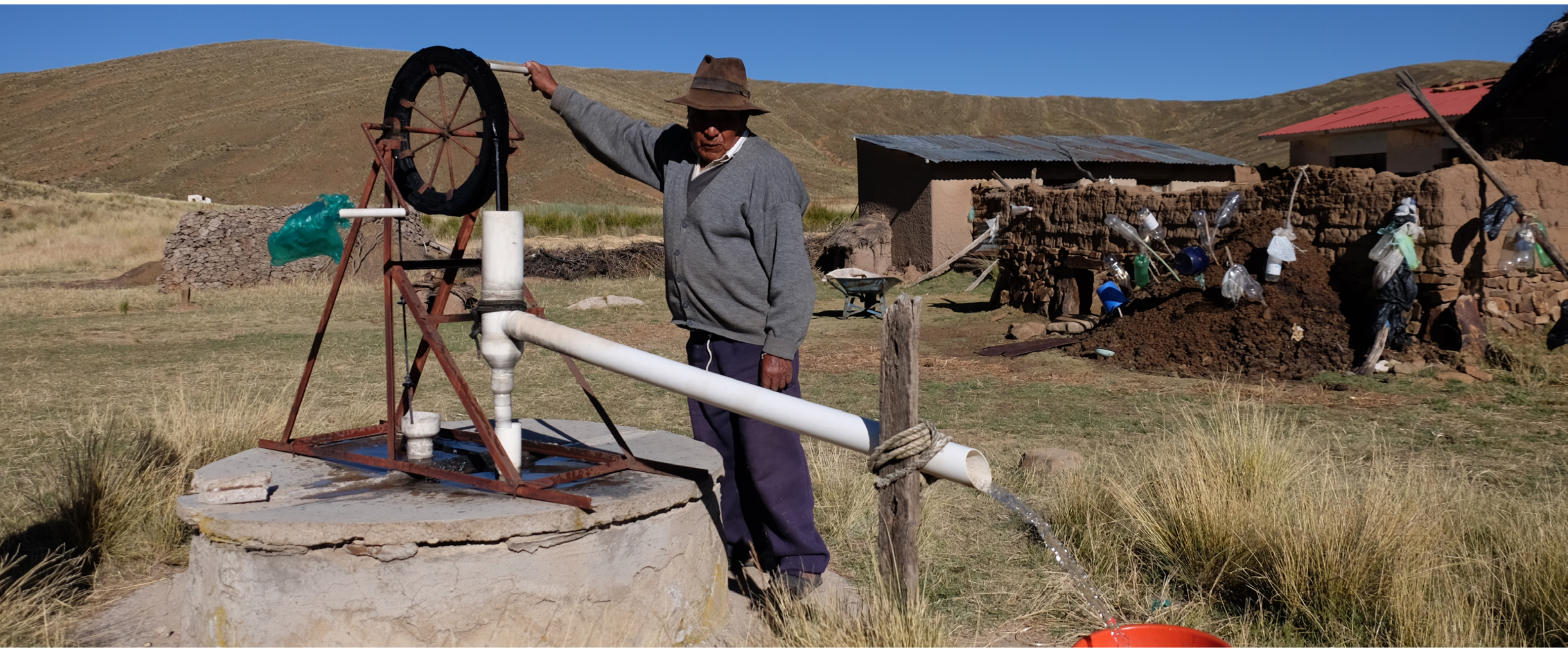
Managing water resources: Bolivia uncovers aquifer's secrets with nuclear technology

By Laura Gil



In certain regions of Bolivia, people depend on water from aquifers for many uses.
(Photo: L. Potterton/IAEA)

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— Paola Mancilla Ortuño, hydrologist, Ministry of Environment and Water, Bolivia

More than 2000 years old: that is one of the secrets stored in the atoms of water that flow in the Purapurani aquifer hidden underground in Bolivia. Despite centuries of supplying water to the cities of El Alto and Viacha near the capital of La Paz, little was known about Purapurani. But with the help of nuclear technology, scientists are gathering key details about the age, quality and source of water in the aquifer. This information is helping them find ways to protect and sustainably use this valuable resource.

"Thanks to isotopes, we are unveiling our aquifer's secrets," said Paola Mancilla Ortuño, hydrologist at the Ministry of Environment and Water. "Now we know that in the northern area of the aquifer, water at shallow levels is sadly contaminated. We also know that part of the water in the eastern area is possibly over 2000 years old. And we also know that groundwater in another part of the aquifer comes from rainwater in the Andes Mountain Range."

Purapurani is a key resource for development in the area, where more than a million people depend on this 300 km² aquifer. "The two cities have developed economically thanks to Purapurani," Mancilla Ortuño said. A growing population relies on it for everyday use, companies draw heavily from it to keep up with urban expansion, and farmers need it to sustain their crops and livestock.

The IAEA has helped Bolivia establish its first isotope hydrology laboratory, and since 2012, IAEA experts have been training a group of Bolivian scientists on the use of isotopic techniques to assess water resources and determine their origin, age, vulnerability to pollution, movement and interactions, both above and below ground (see The Science box, page 23). "Isotopic techniques give us useful information that we could not get from other methods. This gives us a wider vision," Mancilla Ortuño said.

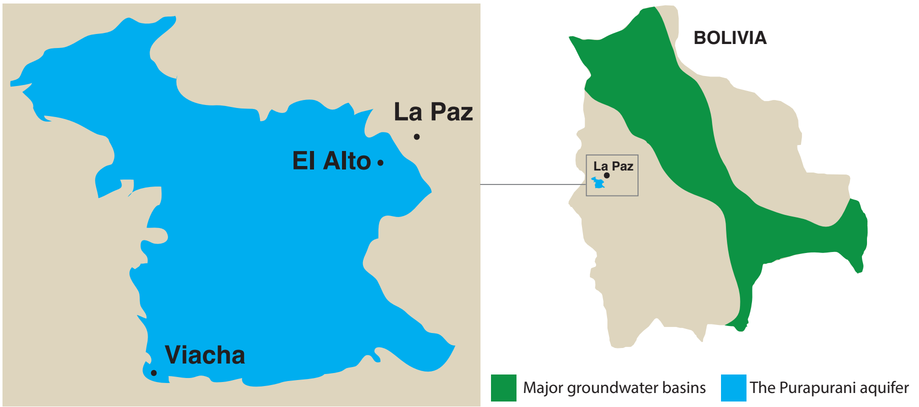
The improved capacities allow scientists to answer questions they could not properly address before: How old is the water and where does it come from? Is it still of good quality? How much of it is left? The answers to these questions help advance scientific research on Purapurani and shape water protection and management policies to reflect the aquifer's potential and limits.

What they studied and found

Bolivian scientists study the water's age because it indicates roughly how long it takes the aquifer's resources to replenish — in this case, thousands of years — and helps to estimate the aquifer's supply limits. Similarly, they check for contaminants to determine threats to the aquifer that could jeopardize its future use. At Purapurani, contamination has only been identified in a limited area of the aquifer and is likely related to river water mixing with aquifer water.

"Now that we know where the water comes from, we have to protect the aquifer's sources to ensure its sustainability and quality," said Rafael Cortéz, Consultant for the Ministry of Environment and Water and lecturer at San Andrés University. As the next step, he and his team of scientists plan to build artificial water recharge schemes to guarantee a stable supply of rainwater.

The Purapurani aquifer



While Bolivia's humid lower lands (jungle) host major groundwater basins, populated cities like La Paz, El Alto and Viacha are located on the highlands, where water is scarce. The three cities depend on the water from the 300 km^2 Purapurani aquifer.

Two worlds

Working with the IAEA has yielded another benefit to Bolivia: a multidisciplinary team of chemists and hydrologists.

"With these projects we are bringing together experts from different disciplines, hydrologists and chemists," said Luis Araguás Araguás, isotope hydrologist in the IAEA's Division of Physical and Chemical Sciences. "A hydrologist doesn't usually study isotopes, and a chemist doesn't usually study water resources. Thanks to our projects, they meet and exchange their expertise."

The team is now working to apply isotopic techniques to the aquifers of the city of Oruro and to replicate the same studies in other cities of Bolivia. Bolivia has five main large urban aquifers, but only three have been studied so far. The recent hydrological studies supported by the IAEA are gaining attention in conferences at the national level, and universities have now introduced the concept of isotope hydrology in their curricula.

"We've grown with each project," Cortéz said. "We have crawled, stood up, learned to walk, and are now starting to jog."

THE SCIENCE

Isotope hydrology

Water molecules carry unique 'fingerprints' based on their different proportions of isotopes, which are chemical elements with atoms that have the same number of protons, but a different number of neutrons. They may be natural or artificial. Radioisotopes are unstable and are constantly releasing energy called radioactivity as they decay to regain stability. Scientists can measure the period of time it takes for half of the radioisotopes to decay, which is known as the half-life. By knowing the half-life of a radioisotope and the isotope content in water or in other substances, scientists can determine the age of water that contains those radioisotopes.

Stable isotopes do not disintegrate and remain constant throughout the entire period they are present in water. Scientists use the different isotope contents in surface water and groundwater to determine various factors and processes, including sources and history of water, past and present rainfall conditions, recharge of aquifers, mixing and interactions of water bodies, evaporation processes, geothermal resources and pollution processes.