Water Resources

Objective

To enable Member States to use isotope hydrology for the assessment and management of their water resources, including the characterization of climate change impacts on water availability.

Water Resource Assessment

Many important aquifers have experienced a lowering of water tables and progressive deterioration of water quality as a result of overexploitation. In 2016, the Agency completed the coordinated research project (CRP) entitled 'The Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems', which utilized isotope hydrology tools to assess groundwater hydrology and evaluate long term aquifer sustainability. The project's 14 participants from ten Member States reviewed the results of assessments carried out on aquifers located under different climatic and hydrological settings and produced a synthesis report of their findings. A comparison of the results obtained in the CRP enabled the participants to identify the tracers most suitable for assessing hydrological processes affecting intensively exploited aquifers.

During the year, the Agency launched a CRP entitled 'Use of Isotope Hydrology to Characterize Groundwater Systems in the Vicinity of Nuclear Power Plants', aimed at developing guidelines for using environmental isotopes and conventional techniques to improve the hydrogeological characterization of local and regional groundwater systems in the vicinity of nuclear power plants. During the first Research Coordination Meeting, held in October in Vienna, six participants from six Member States developed plans for studies of the use of newly available methods — such as noble gas isotope analysis — to provide better information on the dynamics of very fast or very slow moving groundwater in the vicinity of plant sites.

To develop more effective means of building Member State capacity in isotope hydrology, the Agency conducted an interregional training course with 16 participants from 14 Member States. The course, held in October in Vienna, covered the use of multiple stable isotopes and radionuclides, and an isotope-enabled water balance model for estimating water availability at basin and sub-basin scales.

A Technical Meeting on the use of isotopes for characterizing water source, transport and pollution in relation to hydraulic fracturing (fracking) and mining operations was held in December in Vienna. The meeting's 14 participants, from 10 Member States, highlighted the potential for hydrocarbon and other gases from deep geological formations to migrate into shallow aquifers and potentially contaminate drinking water sources.

An agreement to initiate a new project entitled 'Study of Simple and Rapid Analysis Methods for Radionuclides' was signed in October within the framework of Practical Arrangements between the Agency and Fukushima Prefecture, Japan. This new project

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aims to expand and improve the Prefecture's analytical capacity for measuring tritium and strontium-90 in water, fish and other media.

The Agency continues to work with Japan to address the issue of the inflow of groundwater into reactor and turbine buildings at the Fukushima Daiichi nuclear power plant. In cooperation with Japan's Ministry of Economy, Trade and Industry (METI), the Agency organized an experts meeting on groundwater modelling. The meeting was held in Tokyo, Japan, in February, with financial support from the Government of Japan. Participants included Agency experts and representatives of METI and the Tokyo Electric Power Company (TEPCO). The meeting reviewed TEPCO's achievements and future plans for understanding and managing groundwater inflow, and participants made recommendations for improvements to models used for simulating groundwater flow. These recommendations were also disseminated to nearly 20 participants from various Japanese academic and research institutions through a seminar organized by METI immediately after the conclusion of the experts meeting.

The final coordination meeting of the regional technical cooperation project entitled 'Integrated and Sustainable Management of Shared Aquifer Systems and Basins of the Sahel Region' was held in Accra, Ghana, in December. The aquifer synthesis reports presented at the meeting provided the conclusions and recommendations jointly prepared by project counterparts and experts for improving the use and protection of each of the transboundary aquifers of the Sahel region. Based on new hydrological information acquired using hydrochemical and isotope tracers, project participants concluded that most of the shallow aquifers contained good quality, recently recharged, partly untapped groundwater, but that some were locally affected by various sources of pollution.

A regional technical cooperation project entitled 'Mainstreaming Groundwater Considerations into the Integrated Management of the Nile River Basin' was completed in 2016. Nine of the 11 Member States sharing the Nile Basin — Burundi, Democratic Republic of the Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, United Republic of Tanzania and Uganda — participated in the project. The project assisted the nine Member States in building capacity for incorporating and assessing groundwater bodies in the management of the Nile basin water resources. The Agency, in collaboration with Colorado State University (United States of America), developed a new model called IWBMIso (IAEA Water Balance Modelling with Isotopes) that was used in the framework of the project for improved estimation of catchment scale water balance using isotope data. The model has been made freely available on the Agency's web site.

Climate Change Impacts

In 2016, the Agency developed new isotopic methods to improve understanding of climate change impacts on precipitation using data collected since 1961 within the Global Network of Isotopes in Precipitation (GNIP). While these data have long been used to characterize climate changes in the Earth's history, the newly developed methods allow them to be used for understanding precipitation changes that have occurred over the past 50 years. This greatly expands the usefulness of GNIP data for Member States, allowing an improved understanding of both short term, weather related processes, and long term, climate related processes. At a Technical Meeting on Reappraising the Use of Data on Isotopes in Precipitation, held in Vienna in September, experts reviewed these developments and recommended more intensive collection of high frequency isotope and atmospheric radar measurements to reach a robust understanding of climate–isotope relationships.

The Agency completed the CRP entitled 'Environmental Isotope and Age Dating Methods to Assess Water Quality in Rivers Affected by Shallow Groundwater Discharges' in 2016. Project participants used isotopic methods to assess how groundwater discharges impact river water quality, particularly in the light of climate change impacts on rainfall patterns

and groundwater recharge. Participants used oxygen-18, deuterium and radioisotopes to identify areas of nitrate contaminated groundwater discharge to rivers; locate the flow of nitrate contaminated groundwater towards the Volta River; and identify sources of hydrocarbons or natural organic pollution resulting from aquifer discharge entering rivers used for municipal water supplies. Results of individual studies were published in peer reviewed journals in 2016 and will be used as references for future technical cooperation projects.

Analytical Capacity and Services

The number of Member State laboratories equipped through the technical cooperation programme to use isotope measurement techniques based on laser spectroscopy increased by ten in 2016. A total of 65 laboratories in 54 Member States now have operational laser spectroscopic instruments to measure stable oxygen and hydrogen isotopes (Fig. 1). Also during the year, three laboratories in Bangladesh, Peru and the Philippines were equipped with lower cost and easy to use tritium enrichment units developed by the Agency. Training in the use of laser spectroscopy and tritium methods has been provided to 174 participants since 2008. As a result, more than 60 Member States are now self-sufficient in the key aspects of isotope hydrology for water resources management.

As Member States increase their capacity for tritium analysis, accurate and precise measurements remain a challenge for many laboratories. To better assist Member States, the Agency developed a new database software system known as TRIMS (Tritium Information Management System), which is freely available to Member States on-line. TRIMS has a user friendly interface and helps laboratories achieve the precision and accuracy required of low level tritium measurements for groundwater age purposes.

FIG. 1. As part of a technical cooperation project, Bolivian counterparts collect groundwater samples in the field (left), which are then analysed to measure the isotope ratios using a laser analyser provided by the Agency (right).