Water Resources

Objective

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

Water Resource Assessment

The IAEA Water Availability Enhancement (IWAVE) Project, which is being piloted in Costa Rica, Oman and the Philippines, reached significant milestones in 2015. National workshops held in Oman and the Philippines brought together different local, regional and federal water resource agencies to discuss the achievements to date; a national workshop for Costa Rica is planned for early 2016. Among the achievements highlighted were strengthened collaboration among government agencies; recognition of the importance of comprehensive water resource assessment; strengthened capacity to conduct surface water and groundwater assessments; and improved synthesis and evaluation of hydrological data. In the Philippines, the project led to improved assessments of water resources and groundwater vulnerability in two regions of the country. In Oman, the project focused on water resource evaluation in the Samail catchment near Muscat. In Costa Rica, participants developed comprehensive maps showing the distribution of the isotope content of precipitation. These maps will be used in connection with studies to evaluate sources of recharge of major springs near the mountain ranges and water sources along the Pacific coast.

"the Agency strengthened Member State capacity for carrying out isotope based evaluations of groundwater resources through a series of field studies"

More than half of all fresh water used for domestic and agricultural use worldwide comes from groundwater resources. Understanding the age of groundwater, and therefore aquifer renewability, is critical for sustainable water management. During the year, the Agency strengthened Member State capacity for carrying out isotope based evaluations of groundwater resources through a series of field studies in Estonia, Hungary, Thailand, Tunisia and Viet Nam. These studies tested the use of krypton-81 for measuring the age of very old groundwater. Results indicate that many of the aquifers tested have groundwater ages of 50 000 to 600 000 years, which is much older than previously considered. Krypton-81 can be used to measure the age of groundwater in a wide range of climates and aquifer conditions, allowing the Agency to assist many more Member States in using this technique.

The Agency helped develop better methods for using isotopes for aquifer characterization and management through work carried out in three coordinated research projects (CRPs) that were completed in 2015. Participants in a CRP entitled 'Estimation of Groundwater Recharge and Discharge by Using the Tritium, Helium-3 Dating Technique' tested the tritium–helium-3 isotope method and reviewed the results obtained from 600 water samples collected under different hydrological settings. The findings of this CRP will be useful in technical cooperation projects that make use of this methodology. In a second

FIG. 1. Sampling of groundwater discharging into rivers through the subsurface.

CRP, entitled 'Environmental Isotope and Age Dating Methods to Assess Water Quality in Rivers Affected by Shallow Groundwater Discharges', ten Member States evaluated the use of multiple isotope tracers to assess the impact of groundwater discharge on water quality in rivers (Fig. 1). At the CRP's third meeting, held at the Agency's Headquarters in May, participants reviewed existing and new approaches to assessing transport processes of water and pollutants based on environmental tracers. In October, the Agency held the final Research Coordination Meeting of a CRP entitled 'Use of Environmental Isotopes to Assess Sustainability of Intensively Exploited Aquifer Systems'. Participants from ten Member States reviewed the results of assessments carried out in aquifers located under different climatic and hydrological settings, and produced a synthesis of their findings.

Fourteen Member States (Australia, Bangladesh, India, Indonesia, Republic of Korea, Malaysia, Mongolia, Myanmar, New Zealand, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam) participated in a regional technical cooperation project entitled 'Applying Isotope Techniques to Investigate Groundwater Dynamics and Recharge Rate for Sustainable Groundwater Resource Management'. The project focused on issues concerning the recharge rate and dynamics of groundwater, and used isotope techniques to study specific groundwater issues in each Member State. At the project's final progress review meeting, held in Bali, Indonesia, in November, participants concluded that the project had achieved its goals of developing institutional capability in isotope hydrology, establishing a comprehensive database of isotopes and chemical constituents, and promoting a better understanding and a greater appreciation of the techniques used.

Climate Change Impacts

An Agency CRP entitled 'Stable Isotopes in Precipitation and Paleoclimatic Archives in Tropical Areas to Improve Regional Hydrological and Climatic Impact Models' aims at developing new methods of using isotopic techniques to understand and monitor the impacts of climate change. At the CRP's second Research Coordination Meeting, held in

Vienna in June, the 12 participating Member States examined stable isotopes in rain and snow to evaluate the main factors controlling their distribution. The results were used to develop a plan for further testing and analysis, which will be reviewed in the CRP's final meeting.

In November, the Agency held a training course on the application of isotopes for monitoring river hydrology, including impacts of climate change. Participants from 11 Member States attended the two week course, which provided training in the use of isotopes for evaluating the source of water and pollutants in rivers; geochemical processes that affect water quality; and long term monitoring using isotopes.

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The final results of a CRP entitled 'Use of Environmental Isotopes in Assessing Water Resources in Snow, Glacier and Permafrost Dominated Areas under Changing Climatic Conditions' were published in 16 peer-reviewed scientific papers. Twelve Member States participated in the CRP, performing research to quantify the contribution of snow, glaciers and permafrost to rivers and groundwater recharge (Fig. 2). The papers reported on the field testing of an innovative sampling device to collect samples of snowmelt and demonstrated the distinct isotopic labelling of various sources of water.

FIG. 2. Ice coring (up to a depth of 181.8 m) from the glacier at Elbrus Mountain, Russian Federation, for investigation of the palaeoclimate isotope record.

Analytical Capacity and Services

Thirteen Member States took part in a one week training course, held in Vienna in October, on low level tritium analyses for hydrological studies using a system developed by the Agency. The new system is easy to operate and costs about 25% of the cost of existing systems. The Agency also developed a computer program to enable standardized collection and evaluation of data on tritium. The program has been made available to Member State laboratories through the Agency's web site to facilitate its wider use and to improve laboratory performance.

Through training provided in the framework of its technical cooperation programme, the Agency assisted nine Member State laboratories in strengthening their capacity to carry out stable isotope analysis using laser spectroscopy. A total of 58 laser spectroscopy laboratories have been established in 53 Member States over the past eight years, contributing to national and regional technical cooperation projects.

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As many Member States have increased their capacity for stable isotope analysis, the Agency's Isotope Hydrology Laboratory has been able to shift a portion of its efforts away from supplying routine services in support of technical cooperation projects. Instead, in 2015 the focus was increasingly on supporting analytical services for global isotope monitoring networks and laboratory intercomparison exercises, and on facilitating wider participation in CRPs by Member States that do not have their own laboratory. During the year, some 7000 samples were analysed for stable oxygen and hydrogen isotopes, 400 for tritium and 320 for noble gas isotopes.

In 2015, the Agency installed a new mass spectrometer, expanding its capacity to provide analytical services to Member States for groundwater age dating using noble gas isotopes. The new equipment doubles the number of samples that can be analysed for technical cooperation and research projects.