Water Resources

Objective

To enable Member States to use isotope hydrology for the assessment, use and management of their water resources.

Water Resources in a Changing Climate

Seasonal snow cover is present on about a quarter of the world's land surface, at high latitudes and altitudes. Recent climate warming and changes in atmospheric circulation patterns have led to shorter snow cover seasons, reduced amounts of water stored in the snowpack and a widespread trend toward earlier spring melt and enhanced glacier melting. As part of a CRP on the Use of Environmental Isotopes in Assessing Water Resources in Snow, Glacier, and Permafrost Dominated Areas under Changing Climatic Conditions, the Agency used isotope techniques to assess the critical linkages between snow and ice systems and groundwater and surface water systems.

At the CRP's final Research Coordination Meeting held in Vienna in November, research groups from 12 Member States shared the results of their work using multiple isotope tracers to investigate the transit times of meltwater through snow and ice layers, and water to rivers and lakes. Several newly developed or more effective devices for field sampling were tested, such as a passive capillary sampler for collecting snow-meltwater at different locations within a snowpack. The results of this CRP provide insights into the causes of spatial and temporal variability of the isotopic composition of snowmelt. The sampling and data interpretation methods used in the CRP will be transferred to hydrological studies in snow dominated areas under various Agency technical cooperation projects. The CRP also resulted in a first — a dataset of isotopes in ice cores from Mount Elbrus in the Russian Federation.

'Old' groundwater — water stored in geological formations for a thousand to a million years — is an excellent archive of the nature and distribution of precipitation in past climate regimes. In early 2013, the Agency published a monograph entitled *Isotope Methods for Dating Old Groundwater*, which provides theoretical and practical information on using multiple isotope tracers for age dating groundwater. This information will contribute to greater confidence in groundwater assessments, to the development of management strategies in changing climate regimes, and to better assessments of the impact of climate change on aquifer systems.

Two new CRPs were initiated in 2013 aimed at improving isotopic methods for better understanding climate change impacts on tropical precipitation and large rivers (Fig. 1). The first CRP focuses on understanding the causes of present-day variations of isotopes in tropical

FIG. 1. Isotope measurements of river flow in the upper section of the Actopan River in Mexico. Such measurements are a key part of the data in the Agency's global networks of isotopes used for understanding climate impacts on the water cycle.

precipitation, so that isotope archives of precipitation in past climates, such as in groundwater and in carbonate deposits in caves, can be reliably interpreted. Research groups from 13 Member States will collect daily or event based precipitation samples and analyse them for stable isotopes; these data will then be compared with isotope data obtained from palaeoclimatic archives in the tropics. The isotope data will contribute to a better understanding of present-day atmospheric and climatic processes in tropical areas and will provide key basic data for isotope based palaeoclimatic reconstructions.

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The use of isotope tracers to study water and contaminant transport in low permeability rocks such as shale was reviewed at a consultants meeting held in Vienna in November. Knowledge of transport processes in such rocks is critical for characterizing the potential for groundwater pollution, as well as the potential for their use as host formations for radioactive and other hazardous waste. The meeting provided an overview of the use of isotopes to characterize solute transport through low permeability rocks, and outlined areas for future research.

The Agency also provided support, within the framework of a technical cooperation project, for the use of stable and radioactive environmental isotopes to improve management of the Valle de Leon aquifer, near the city of Leon, Mexico. The aquifer is the principal source of water supply for this large city and is crucial to the local economy. The results were shared with local water resource management authorities and are contributing to efforts to adopt sustainable water use policies.

Expanding Laboratory Access and Building Capacity for Isotope Hydrology

In 2013, a new system to pre-concentrate low levels of natural tritium in water samples was tested for routine operation at the IAEA Isotope Hydrology Laboratory (Fig. 2). Tritium is one of the fundamental isotopes used in hydrology, and this relatively inexpensive and compact system will greatly expand access to tritium analysis for Member States. The new system is being provided to interested laboratories and is expected to help increase the efficiency of Member State technical cooperation projects.

In 2013, 14 participants from nine Member States were trained in the installation and operation of laser absorption spectrographs, used for the analysis of the stable isotope composition of water samples. Sixteen trainees from five Member States participated in another training course on the use and interpretation of isotope data in hydrological investigations. In addition, an international intercomparison of tritium analysis of water samples was completed in 2013, with more than 60 laboratories taking part. The exercise helped tritium laboratories assess their overall performance and identify whether corrective actions are required to reach the expected analytical accuracy and precision. Together, these efforts have expanded the capacity of Member States to measure and interpret the isotopic composition of water samples for improved assessment and management of water resources.

FIG. 2. Development and testing of a high performance electrolytic tritium enrichment system (left, centre) for groundwater age dating were completed in 2013. A laser absorption spectrograph (right) being tested at the IAEA Isotope Hydrology Laboratory for the analysis of the carbon-13 content of dissolved carbon in water samples.