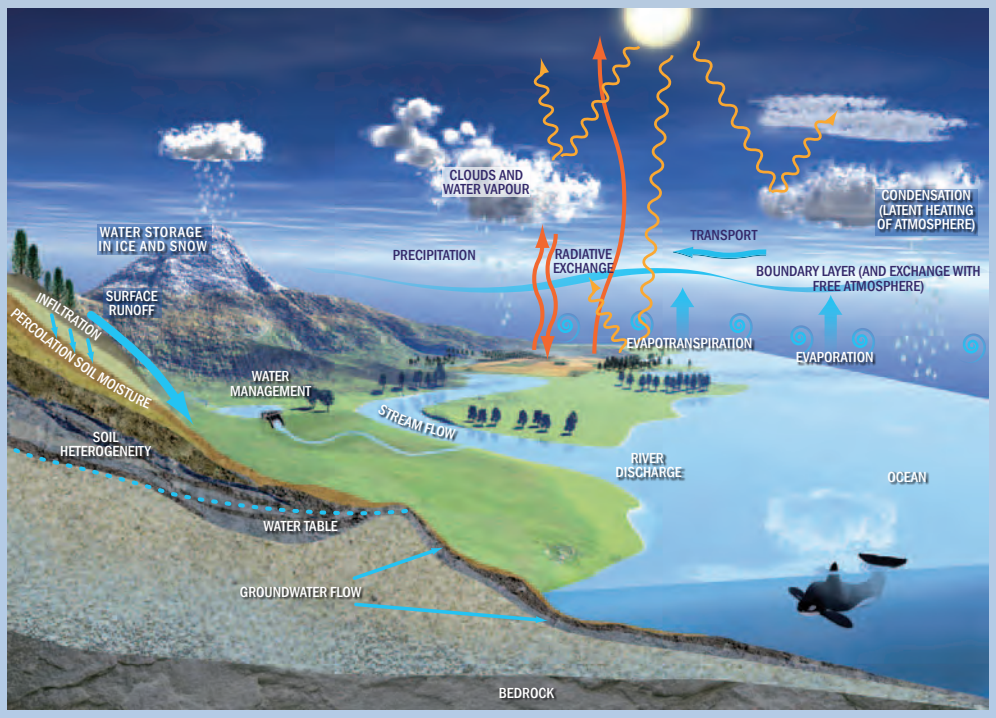
Global Network of Isotopes in Precipitation

IAEA Water Resources Programme

The Johannesburg Plan of Implementation from the World Summit on Sustainable Development concluded there is an urgent need to expand scientific information to improve understanding of the water cycle. Over the last 50 years, data from the Global Network of Isotopes in Precipitation (GNIP) have become an increasingly important tool to meet these information needs, providing unique insights into hydrological and climatic processes at the local, regional and global scales.



Schematic representation of the water cycle.

While water looks the same everywhere, it carries isotopic 'fingerprints' which can be used to determine its origin and age. Isotopes are atoms of the same element with different weights.

Across the globe, proportions of isotopes in water molecules in precipitation vary as a result of natural processes of evaporation and condensation, and because of the effects of temperature and altitude. Consequently, precipitation in each location has its own isotopic 'signature' or 'fingerprint'. These isotopic 'fingerprints' are carried into groundwater and can be used to determine the age, recharge rates, and flow velocities of groundwater.

Through study of water isotopes 'naturally archived' in polar ice caps, lake sediments, and groundwater, past hydrological conditions can be reconstructed. Understanding how past hydrological and climate systems have changed over time holds the key to predicting future change — looking 'back to the future' — to develop options for minimizing the adverse effects of the world's changing climate.

"Human survival and the quality of life... will always be inextricably tied to the availability of fresh water"

Mohammed ElBaradei
IAEA Director General

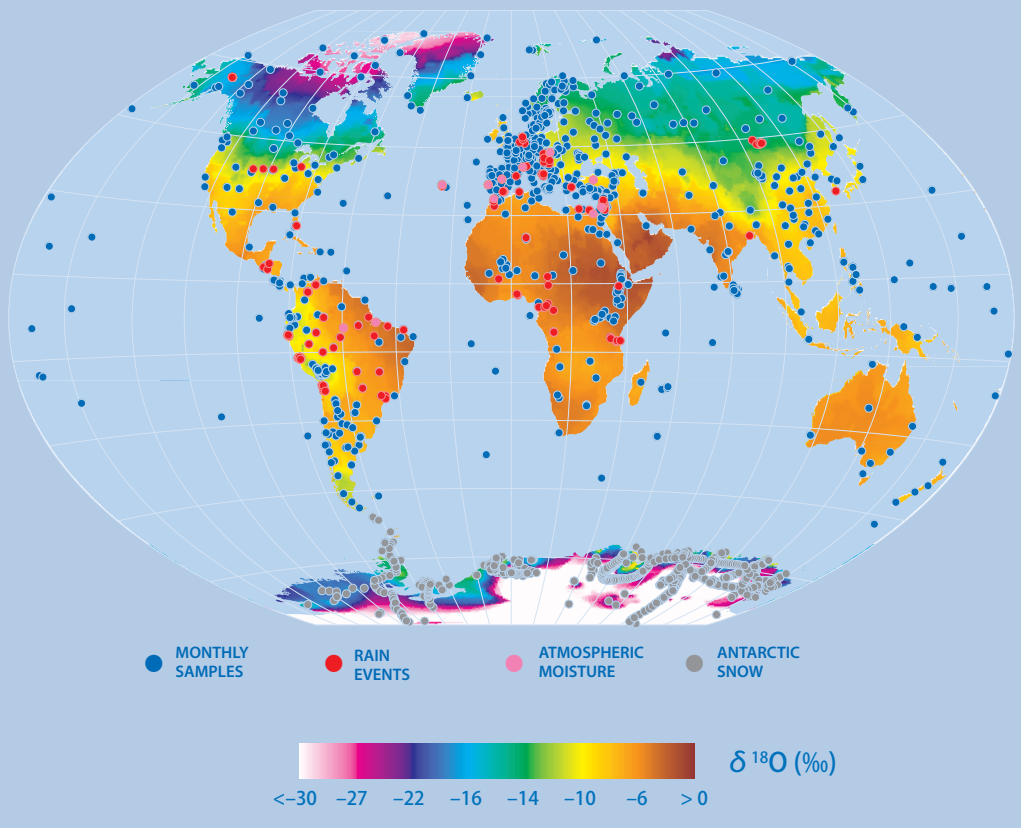
The GNIP Network

Since 1961, the Global Network of Isotopes in Precipitation (GNIP) has provided the isotopic signatures of precipitation worldwide. The GNIP network is a survey of oxygen and hydrogen isotope contents in precipitation, including oxygen-18 (^{18}O), deuterium (^{2}H) and tritium (^{3}H). Managed by the IAEA in cooperation with the World Meteorological Organization, the network is composed of about 900 monitoring stations in over 100 countries and territories. The IAEA provides logistical support to monitoring stations in sampling of precipitation and analysis, and maintains the quality and consistency of the data.

The GNIP Database

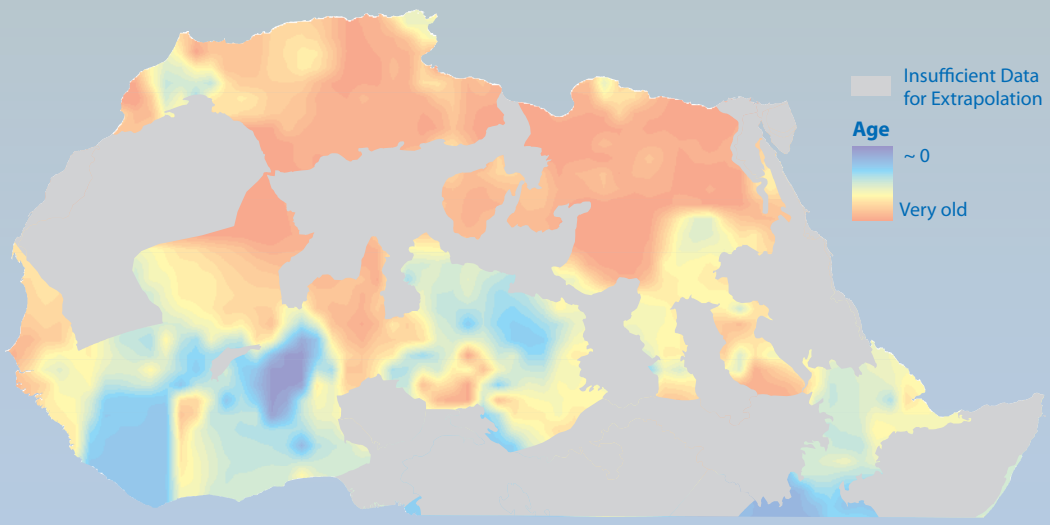
The GNIP database of the IAEA, now includes over 120 000 monthly data records. The entire GNIP database is available to the public for viewing and can be downloaded from the IAEA website (www.iaea.org/water). The database is accessed through the new GIS-based, user-friendly computer-assisted mapping environment known as 'WISER'.

A new gridded data set for isotopes in global precipitation has been developed, including mapping modules and animations which can be used to produce custom-made global- and continental-scale maps of annual and monthly precipitation values for various isotopes and meteorological data.



Global distribution of oxygen-18 (per mil, ‰) in precipitation produced by interpolation of long-term annual means from about 700 GNIP stations.

Reach of Isotopes Extended



Groundwater ages derived from carbon-14 contents in deep groundwaters of northern Africa reaching back to hundreds of thousands of years.

The IAEA has initiated efforts to improve the availability of isotope data in other water cycle components. The Global Network of Isotopes in Rivers (GNIR) was launched in 2007 to complement the GNIP program. It functions in a similar way, with the focus on data compilation specifically for rivers. It started with a coordinated effort between 2002–2006 to monitor the isotopic composition of about 20 large rivers from headwaters to deltas. Isotope data provides information about the impact of climate change on river runoff, as well as human impact and stream/aquifer interactions. Streams and rivers are particularly vulnerable to the effects of storage, diversions, and redirection, which may in the future overtake climate change in terms of impact. The consequences of changes in river runoff include upstream-downstream inequities and potential political disputes. The data collected by the IAEA provide a protocol for continuous monitoring of specific rivers.

Moisture Isotopes in the Biosphere and Atmosphere (MIBA) started with a consultants' meeting in 2003, and focuses on the regular sampling of isotopic composition of water in plant stems and leaves, as well as in soil and atmospheric vapour. The idea was conceived to answer a need for experimental data on stable isotopes in the biosphere and in atmospheric moisture.

GNIR focuses on monitoring the isotopic composition of rivers, such as this one in Central America, to understand river basin hydrology.

Potential for Cooperation

GNIP station at Ny Alesund, Svalbard, Norway.

Recently established GNIP station in El Salvador.

There is a need for additional long-term isotope monitoring stations and laboratories to improve the global coverage of isotope monitoring efforts. This is especially true in regions with poor coverage or with high relevance for hydrological or climatological research. In response, the IAEA helps countries and actively looks for partners to build new, or strengthen existing, sampling stations and laboratories.

The IAEA is a world leader in searching out and testing new applications for isotopic techniques to address environmental issues. The UN agency also acts as a global information clearinghouse and provides forums and encouragement to scientists and researchers, supporting the exchange of information and building of innovative partnerships.

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