

Basic information: Water isotopes

In the NAQUA National Groundwater Monitoring programme ISOT module, isotope reference data in precipitation and watercourses are collected for applied hydrological studies.

Basic information

Isotopes are different types of an atom whose nuclei contain the same number of protons but different numbers of neutrons. There are three isotopes of hydrogen and three of oxygen. The hydrogen isotopes ^1H and ^2H (deuterium) and the oxygen isotopes ^{16}O , ^{17}O and ^{18}O are stable, i.e. they do not decay. However, the hydrogen isotope ^3H (tritium) is unstable and decays with a half-life of 12.43 years. ^1H and ^{16}O are light isotopes which occur much more frequently in water molecules in nature than the other heavy hydrogen and oxygen isotopes. In a given water sample, the ratio between the stable hydrogen isotopes ^1H and ^2H ($\delta^2\text{H}$) and between the oxygen isotopes ^{16}O and ^{18}O ($\delta^{18}\text{O}$) is determined relative to a standard (expressed in negative ‰ values), referred to in the National Isotope Survey as deuterium and oxygen-18.

Data acquisition

Back in the 1960s, the University of Bern (Institute for Climate and Environmental Physics) began to analyse isotopes in the Swiss water cycle. In 1992, the university's representative precipitation and watercourse monitoring stations were incorporated into the national isotope monitoring system (now the NAQUA ISOT module). Deuterium and oxygen-18 are now analysed as part of the ISOT module at 13 precipitation and 9 watercourse monitoring sites. Precipitation samples are collected monthly, while samples to assess discharge proportions are collected from watercourses every four weeks and random samples every fortnight. Since 2009, samples have no longer been analysed for tritium in the ISOT module as the values measured did not lend themselves to determining the age of groundwater. The Federal Office of Public Health (FOPH) continues to carry out tritium analyses as part of the national monitoring of environmental radioactivity. In a pilot study, the 50 groundwater gauging stations in the NAQUA TREND module were analysed for deuterium and oxygen-18 from 2006 to 2013 to establish groundwater recharge dynamics and surface water/groundwater interactions. Between two and four water samples were taken at each gauging station each year.

Statistics

The statistical analyses of the stable water isotopes are based in each case on the mean value for deuterium and oxygen-18 at each gauging station. The radioactive tritium analysis is based on the maximum tritium activity value per gauging station. Tritium activity is expressed in tritium units (TUs). The statistical analyses are presented in the 2019 report 'Status and development of groundwater in Switzerland'.

Reference values

In 1953, the IAEA set up the Global Network of Isotopes in Precipitation (GNIP) in order to observe the dynamics of the hydrological cycle using these natural tracers. This was followed by the Global Network of Isotopes in Rivers (GNIR). The Swiss

Climate Observing System (GCOS Switzerland) has listed water isotopes as an essential climate variable since 2007. The NAQUA ISOT module provides Switzerland's reference data for GNIP, GNIR and GCOS. In Switzerland, isotope reference data are mainly used in applied hydrological studies.

Link

NAQUA National Groundwater Monitoring

<https://www.bafu.admin.ch/bafu/de/home/themen/wasser/publikationen-studien/publikationen-wasser/ergebnisse-grundwasserbeobachtung-schweiz-naqua.html>