ISOTOPE TECHNIQUES IN A WATER SURVEY

The circulation of water is one of the most interesting of natural phenomena. The broad outline of this process is well-known. Evaporation of water on the sea surface and the eventual precipitation of the vapour follow a complete cycle that sustains life on the earth. The working of the cycle, however, is not quite uniform; the rate of precipitation varies from one region to another. That is why some areas have an excess of rain while some others are turned into deserts from a lack of it.

Exact knowledge of fluctuations in precipitation and other factors in water circulation is extremely important for areas which have a very limited water supply. These areas are turning more and more to artificial irrigation for the improvement of agriculture. Any scheme of irrigation must depend on exact knowledge and proper use of the sources from which water can be drawn and led into the fields. That again depends on detailed information about the circulation of water in nature and the pattern and amount of water sources in different land areas.

The information is also important for the disposal of radioactive wastes on land and in the sea. Before satisfactory methods of disposal can be devised, it is essential to know precisely whether and to what extent the wastes can be transferred from one place to another as a result of the circulation of water.

Isotopic Ratios

At present, the pattern of circulation is known only in rough outline; detailed information on a global scale is lacking. One of the most effective ways of gathering such information is to study the isotopic ratios of hydrogen and oxygen in water in different areas. The ratios vary for rain, river and ocean water, and the variations have a relationship with the rate at which water circulates in nature. Water contains two stable hydrogen isotopes and three stable oxygen isotopes. In addition, very small quantities of radioactive hydrogen or tritium are added from outer space or as a result of reactions in the atmosphere brought about by cosmic rays or as a result of the testing of thermonuclear weapons. Tritium can serve as a tracer in the study of water circulation.

A variety of information can be obtained by measurements of the isotopic composition of water. For example, by comparison of the tritium concentration of inflowing water with that of outflowing water, the average age of the water molecule in a lake can be deduced. The stable isotope ratios of lake water show what fraction of the inflowing water is lost by evaporation and what fraction leaves the lake through drainage, provided these isotope ratios are known for the water that feeds the lake. Again, tritium determinations can sometimes yield valuable information on the age of ground water and on the size of the ground water body. In a similar way, the storage time and flow rate of ground water for the drainage system of a river or of a whole continent can be determined.

All this has a direct bearing on the irrigation plans of countries with limited water supplies. In another field, better knowledge of the rate at which surface water in the oceans mixes with deeper water masses is important for plans of radioactive waste disposal.

The modern tools of hydrological research cannot be employed by every country, because measurements of the isotopic composition of water require great technical skill and scientific knowledge. Besides, interpretation of isotope data in terms of hydrology and climatology requires the knowledge of certain basic data for the whole world or at least for large areas. A more complete knowledge of the world-wide variations in the isotopic composition of water would greatly facilitate the interpretation of local conditions.

World-Wide Distribution

Guided by these considerations, the International Atomic Energy Agency has decided to initiate a study to determine the world-wide distribution of hydrogen and oxygen isotopes in water. On the basis of this study, it will be possible to make available basic data for the use of any country that wishes to apply isotope techniques for hydrological and climatological research.

Under this project, it is proposed to collect samples of rain, river and ocean water in different parts of the world and carry out measurements through a world-wide network of sampling stations. The measurements will be interpreted by qualified experts with the object of assisting different countries in the evaluation of local data and in estimating the conditions of present and future water supplies.

Part of this work will consist of a global survey of tritium concentrations in rain water. Similar surveys will be made also of samples of river and ocean water. Simultaneously, measurements will be made of the stable isotope ratios. Detailed plans for carrying out this programme are now being worked out by the Agency.