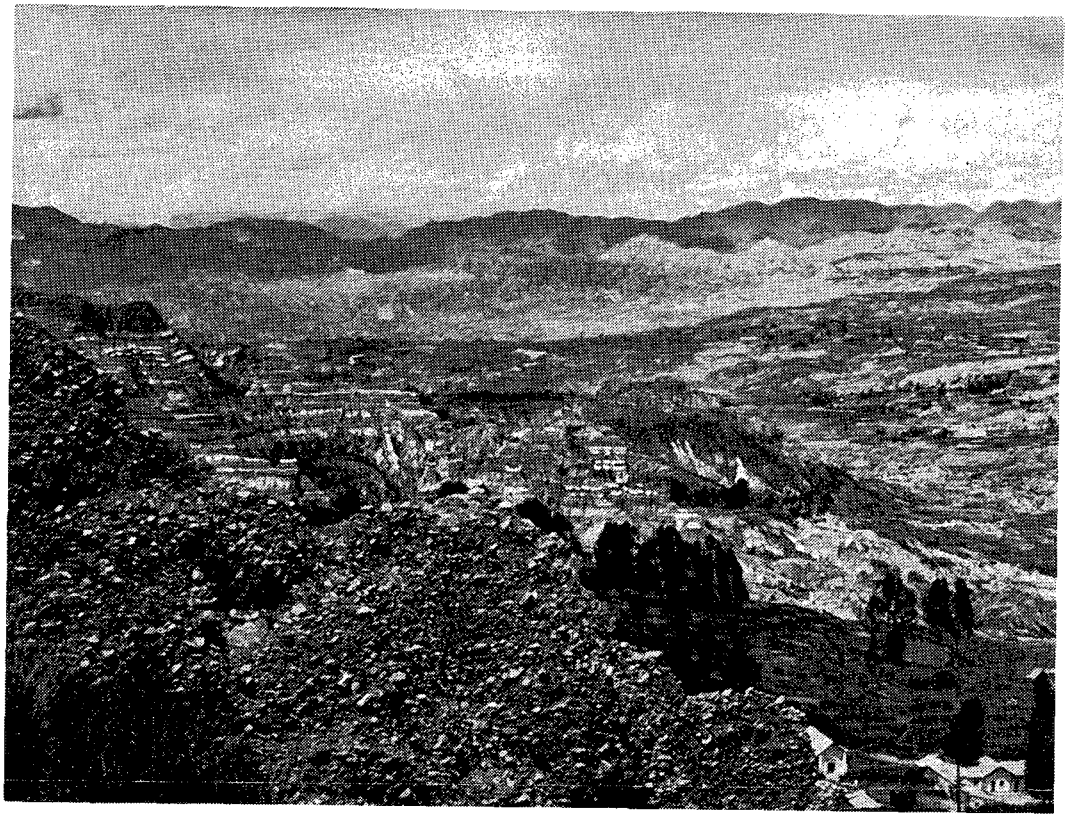
isotope hydrology in latin america

A wide variety of problems in hydrology have proved susceptible to the use of nuclear techniques. Conclusions may be drawn from the relative abundances of certain "environmental isotopes", such as heavy stable isotopes of hydrogen and oxygen in water molecules, tritium, carbon-14 and silicon-32, in atmospheric, surface or ground water; origin and rate of flow, for example, may be deduced. Artificial radioisotopes may be used similarly as a logical extension to well-known tracer techniques using dyes and salts. Inherent in the use of such radiotracers are the advantages of very high detection sensitivity (and thus very low required concentrations and the elimination of density effects), and a choice of a variety of nuclides alien to the geohydrological system (and hence unique identification and low background).
In the following article Mr. Bryan R. Payne, head of the Isotope Hydrology Section of the IAEA Division of Research and Laboratories, discusses work in his speciality in Latin America.

Although isotope techniques are not yet being applied in hydrology as widely as they might, discussions at a recent working group – organized by the Inter-American Nuclear Energy Commission in collaboration with the Brazilian Nuclear Energy Commission and held in Belo Horizonte – indicated that these relatively new techniques are likely to be used increasingly in Latin America in the near future.

The scope of applications in the region covers practically the whole range of available techniques, from problems concerning snow hydrology to those concerning the development of groundwater in arid areas. At present, however, perhaps the most common problems concern the use of radioisotopes in the study of sediment transport and of pollution, as well as the use of environmental isotope techniques in projects for the development of groundwater in arid and semi-arid areas.

Radioisotopes have already been used in studies of sediment transport in about six countries in the region, mostly with support from the Technical Assistance programme of the IAEA and the United Nations Development Programme, and with bilateral aid from France. Although the

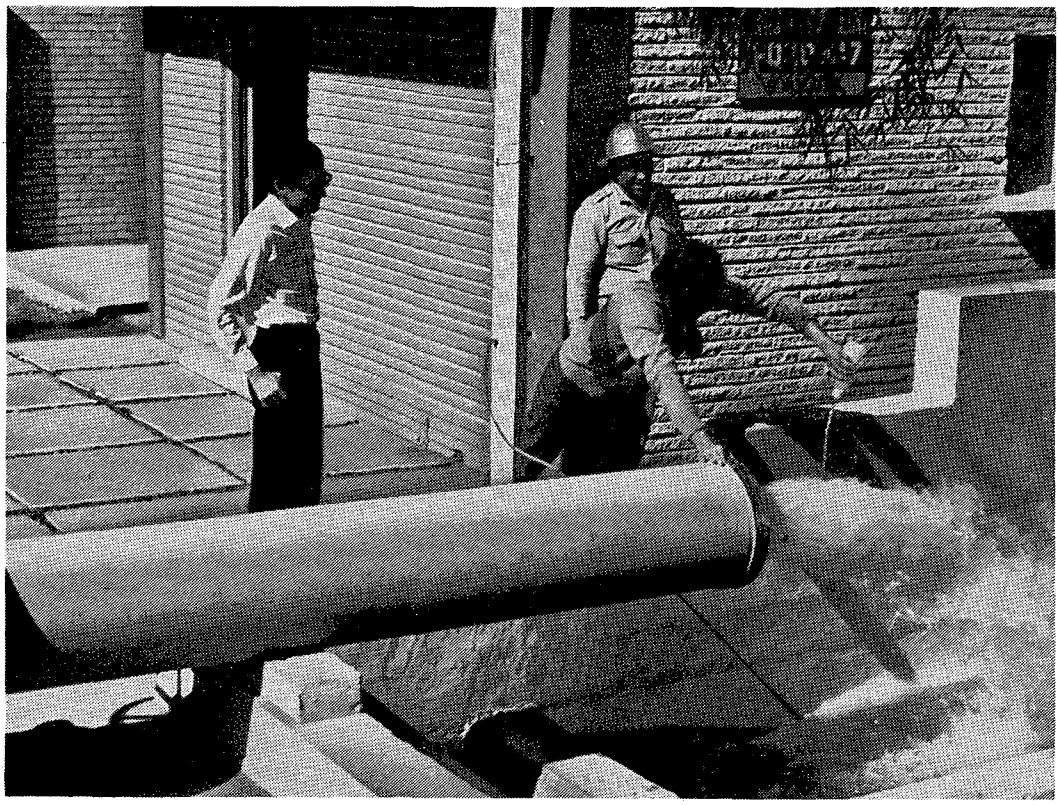


Part of La Paz Basin, Bolivia. Within a UNDP project the IAEA is using isotope techniques to find the origin of water issuing from springs which support cultivation of the area in the foreground. Photo: IAEA/Payne

early work was associated mainly with problems of maintenance of harbours and navigable channels, such as those at Buenos Aires and Maracaibo and in Brazil, the range of applications is now widening, and problems arising in the planning of new projects are being tackled: for example, deciding upon the optimum location of power station cooling intakes (Mexico) and the most economic location of sites for dredging of sand for building purposes (Uruguay); and the design of a new harbour in Valdivia (Chile).

Countries with sea coasts, and particularly those in which centres of high population density are located on bays or estuaries, are becoming increasingly aware of the problems of locating sewage outlets in such a way that fouling of beaches may be avoided. Radioisotopes are very useful in studying the dispersion and dilution which will take place at a proposed site. Last year, for example, the Brazilian authorities carried out a number of experiments using bromine-82 to study the dispersion and dilution which would take place if sewage were discharged from an ocean terminal to be constructed at Barra da Tijuca, west of Rio de Janeiro. Undoubtedly, nuclear techniques such as these are likely to find increasing application along the coasts of Latin America in future.

Problems of water supply in arid and semi-arid areas are usually focussed on groundwater, since surface water resources are very limited. At the same time, one must bear in mind that an evaluation of groundwater resources is more costly than a similar study of surface water, so that any technique which contributes to a more precise assessment of groundwater resources in a particular region is certainly valuable. Studies of the natural variations in the natural water content of the stable isotopes deuterium and oxygen-18 and of environmental tritium and



Sampling of groundwater, for analysis of its stable isotope and tritium content, from a well in La Mina well field near Monterrey, Mexico. Photo: IAEA/Payne

carbon-14 are frequently extremely useful in conjunction with 'conventional' hydrological methods. In many instances these nuclear techniques are unique in their ability to give information on the speed of groundwater flow and the origin of the water being studied. The use of such techniques does, however, carry with it the need for certain analytical facilities and expertise. The Agency has helped in the establishment and continues to support the capability to do such work in Brazil, Chile and Mexico.

In Brazil, priority is being given to the use of this capability in the north-eastern part of the country, where water supply problems are particularly acute. Studies are being carried out in close cooperation with the hydrological authorities in order to ensure that the optimum benefit is derived. The arid coastal regions of Chile and Peru are also potential areas for the use of such techniques, a fact which was recognized by the working group at Belo Horizonte.

The Agency has collaborated with other UN organizations in applying these techniques within the framework of UNDP projects in countries which do not yet have the necessary capability. In Nicaragua, for example, the problem studied was whether groundwater occurring in a coastal plain originated from local precipitation or from precipitation falling on a Cordillera about 20 km inland, which then travelled underground to the plain. Isotope data showed that the groundwater was predominantly from the latter source. Similar studies are currently in progress in Bolivia and in Surinam.

More than 70 per cent of Mexico is classed as an arid or semi-arid zone. The water supply situation is even further aggravated by the fact that 70 to 80 per cent of both the population and the industry is at high elevations, where the principal water supply is groundwater. As a

result the wells used are often deep and therefore expensive – some of the deepest water wells in the world, going down to 2000 m. are found near Monterrey.

The Agency is collaborating with the Mexican authorities in applying environmental isotope techniques to hydrological problems in the Monterrey area, which is the second industrial centre of the country. Water supply demands have necessitated the drilling of new well fields, and it is essential to know whether these well fields are independent, and where the water in them originates. Preliminary results from a study of the isotope data point to the independence of the Buenos Aires well field there from wells in Monterrey itself and at La Mina, and suggest also that the origin of the water tapped by the latter two areas is most probably relatively local. Other problems concerning the origin of groundwater in different parts of the country have been earmarked for study with isotope techniques. To meet the needs for provision of isotope techniques Mexico has established analytical facilities for stable isotope analyses and is planning similar facilities for tritium and carbon-14. At the same time staff are gaining valuable experience in the field studies initiated with the help of the Agency, and have established working agreements between the different organizations which have experience in the use of isotope techniques, and the hydrological authorities.

Sampling of groundwater for carbon-14 analysis at Leiding, near Paramaribo, Surinam, in a UNDP project. Photo: PAHO