PATHS TO LIFELONG LEARNING
EDUCATION & TRAINING IN ISOTOPE HYDROLOGY

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Human life and development rests upon the availability of freshwater. This basic need has fostered an intuitive human skill for managing water resources -- practices such as rainwater harvesting, for example, have been employed for more than 4000 years in different civilizations. Today, more sophisticated scientific and systematic approaches are needed to assess and manage water resources, as freshwater is becoming harder to exploit.

Since the mid-1900s, the science of hydrology has developed as a discipline for understanding the physical, chemical, and biological processes governing the occurrence, circulation, and distribution of water on the earth. Within the specialized branch of hydrology, the application of nuclear or isotope techniques is a relative newcomer, having reached a level of maturity recognition in the last 20 years or so.

The IAEA has played a major role in developing isotope hydrology as a scientific discipline and in building a cadre of trained isotope hydrologists worldwide. Until recently, IAEA publications were the sole source of written material for training and education in isotope hydrology. Since isotope hydrology is an advantageous tool for the sustainable management of water resources, it is imperative that hydrologists are competent in the use of isotope techniques. This article reviews the evolution of strategies and mechanisms for training isotope hydrologists, in the context of the needs of developing and industrialized countries.

EVOLVING TRAINING APPROACHES

Historically, isotope hydrology was the domain of physicists and chemists who had the ability to measure isotope concentrations in natural substances. As a result, there was a substantial gap between scientists who practiced isotope hydrology and hydrologists who practiced water resources management. The IAEA's efforts for capacity-building in isotope hydrology focused on individual or group training of hydrologists who were active in research and field applications. More than 700 individual fellowships have been awarded over the last four decades for training at IAEA headquarters or other established isotope hydrology centers. These fellowships typically included some class-room instruction and intense interaction with one or more experts to develop skills in data gathering and interpretation. Group training events involving national, regional, and inter-regional courses of varying duration from one to eight weeks have been conducted with more than 600 participants. The trainees further improved their skills through on-the-job training associated with technical cooperation projects.

Coordinated research projects (CRPs) provided more advanced training to a limited group of participants from developing countries. Many of them received their initial training through IAEA fellowships. A CRP affords a less experienced researcher the opportunity to improve his or her skills by interacting with others, including experienced researchers, while working on a common research theme.

Availability of trained scientists with competence in isotope hydrology has improved the implementation of technical cooperation projects by interfacing indigenous capability with outside expertise and developing capacity for related research. However, training events have been steadily increasing in recent years owing to an explosive growth in technical cooperation projects. For example, 51 technical cooperation projects in isotope hydrology were

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completed between 1980-90. This number increased to 141 for the period 1991-2000. Presently, about 56 projects are active for the 2001-02 cycle, with two regional projects designed specifically for capacity building.

ELEMENTS OF A NEW STRATEGY

The world is seeing an increased demand for training in all aspects of isotope hydrology. This is even the case in countries where hydrological programmes have become more established over the years. Greater efforts now are needed to transfer imparted knowledge and skills to a new generation of hydrologists. A careful analysis of the successes and failures of the past efforts is used to suggest the following approach for training in isotope hydrology.

■ University Courses in Isotope Hydrology. In the past, the IAEA's training programmes in isotope hydrology have relied almost exclusively on the continuing education model and therefore placed emphasis on training after formal education. However, continuing education in a discipline can achieve a higher level of knowledge and skill capacity if basic training is included in the formal education phase. Such a benefit warrants refocusing of the IAEA's programme to include formal training in isotope hydrology.

"Hydrologists" may come from a variety of disciplines such as geology, geography, civil engineering, agricultural engineering, chemistry, or meteorology. This academic background is often supplemented with by post-graduate courses in hydrology. The International Hydrological Decade (IHD) launched by UNESCO in 1965 helped to develop a better appreciation for hydrology education. Post-graduate courses and then fully-fledged degree or diploma programmes were initiated in many institutions in both developing and developed countries through UNESCO sponsorship.

Considering the heterogeneous background of students attracted to hydrology programmes, it is important to design an isotope hydrology curriculum that meets the needs of the various students and is responsive to available job opportunities. Specialized educational programmes which do not enhance employment skills would not attract students for too long. Introductory topics in isotope hydrology should be included in hydrology-related courses in earth science and engineering schools to provide a basic exposure to the subject. A structured course in isotope hydrology should be included within post-graduate hydrology programmes.

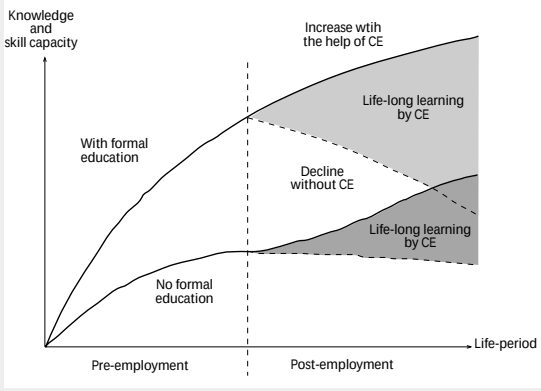
Efforts to initiate isotope hydrology courses may initially target hydrology programmes begun under the auspices of or in collaboration with UNESCO in order to achieve easy integration into hydrology education. IAEA-prepared and supplied teaching materials and necessary support for lecturers would minimize any financial impact to institutions choosing to include a course in isotope hydrology in their hydrology programmes.

An additional avenue for promoting isotope hydrology education at the university level is to sponsor Chairs in Isotope Hydrology at selected universities. This sponsorship would provide a higher profile to the awardee and enable him or her to serve as a magnet or focal point for national or regional educational and applied research activities.

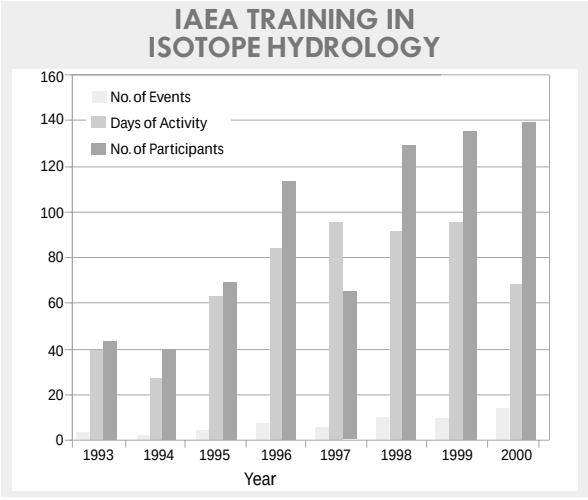
■ Building Linkages Between Centers. Fellowship training is a principal mechanism for the IAEA's training programme. A majority of these fellowships in isotope hydrology have been implemented at isotope hydrology centers in Europe and North America. However, these fellowships are becoming difficult to implement because of the changing research environments in developed countries where most researchers have to compete for research funds from increasingly scarce national funding sources. In many instances, it has taken more than a year to reach an agreement with a host institution for a fellowship training, only to find out that the needs and availability of the proposed fellow have changed. This situation arises

LIFELONG LEARNING IN HYDROLOGY

As this schematic shows, both formal and continuing education play important roles in developing skills that are needed by hydrologists.



Source: Adapted from A. van der Beken, "Continuing Education in Hydrology", UNESCO (1993).



from the fact that many potential hosts view the presence of a fellow with little training in isotope hydrology, and on a project that is not related to their research focus, as a drain on resources rather than a mutually beneficial exchange programme. As a result, fewer and fewer opportunities are available for a four-to-six month individual training cycle.

Greater interest in scientific exchange and training perhaps can be developed through longer-term linkages between institutions in developing and developed countries. For example, an established isotope hydrology group may be asked to assist in conducting group training or university courses at a national or regional level. Selected participants from these events may then be provided a short-term group training in more advanced techniques at the cooperating institution. During this period, joint research or field projects may be identified that would be consistent with the host's research plans. Eventually, such institutional linkages will raise the skills and capacity at institutions in developing countries to run some of the isotope hydrology courses on their own, with little or no external input.

■ Targeting a Wider Group of Hydrologists. Hydrology is an inter-disciplinary, practical and field-based science. It is necessary to provide continuing education in isotope hydrology to a large group of practicing hydrologists who may not have any previous exposure to isotope techniques. Cooperative activities with other UN agencies and professional associations can best achieve these objectives.

A natural partner in inter-agency cooperation is the International Hydrological Programme (IHP) of UNESCO. The IHP has been in operation for about 30 years, and one of the most valuable features of this programme is the organization of national IHP committees. These committees, operated under an agreement between UNESCO and the national governments, have many activities in the education and training of hydrologists, as well as in the coordination of hydrological research and practice.

The IAEA's isotope hydrology programme and IHP have a long record of cooperation, although in limited areas. Several guidebooks on isotope applications in hydrology have been jointly published by the IAEA and UNESCO. There is substantial scope for and potential benefits in broadening this cooperation. Consequently, an inter-agency programme called Joint International Isotopes in Hydrology Programme (JIIHP) has been proposed to integrate isotope techniques in the practice of hydrology. As a part of this programme, IHP National Committees are requested to broaden their membership to include isotope experts and to conduct joint educational activities and projects that will result in integrating isotopes in the water resources sector.

Increased cooperation with professional associations such as the International Association of Hydrological Sciences (IAHS) and the International Association of Hydrologists (IAH) would also serve to broaden the audience for IAEA activities and develop competence in isotope hydrology. This cooperation is being increased through sponsorship of international conferences and symposia of the IAHS and IAH and through short-term training courses at these conferences. These activities within the scientific societies serve to increase the profile of isotope hydrology and to stimulate interest from within the scientific community and in aspiring young scientists.

This new strategy is expected to result in continually producing a large number of hydrologists who have acquired some experience with isotope applications. Many of these hydrologists would eventually develop a career in water resources management. These water managers would have the ability to view isotope techniques as an integral part of hydrology tool kits and, if necessary, to improve their skills through continuing education and training. ❐