



Prepared by the Isotope Hydrology Section  
Issue No. 18, August 2004

ISSN 1020-7120

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## From the Section Head...

Dear colleagues,

The international symposium on Isotope Hydrology was held in May 2003. This symposium marked the 40th anniversary of these quadrennial IAEA symposia first convened in 1963 and was one of the contributions of the Agency to the International Year of Freshwater. The symposium drew a record 274 participants from 69 countries. The state-of-the-art in isotope techniques and their application to water resources management were reviewed, confirming that groundwater sustainability issues remain the mainstay for isotope applications, while application in climate modelling and watershed management is also becoming increasingly important.

Water cycle research is one of the key elements of the Johannesburg Plan of Implementation resulting from the World Summit on Sustainable Development. As a result of the Agency's efforts since 2001, isotopes are now being integrated into the GEWEX (Global Energy and Water Cycle Experiment) project of WMO/ICSU's World Climate Research Programme



*River Nile at Jinja, Uganda (credit: Kahtij Kulkarni/IAEA)*

project. An IAEA-GEWEX workshop evaluated the potential means of integrating precipitation isotope data in moisture source tracing models and, as a first step, initiated an international inter-comparison of the isotopic modules in different global circulation models.

Two new research coordinated projects (CRPs) were recently initiated aimed at investigating the use of isotopes for groundwater sustainability assessment by characterizing the age of river baseflow, and for improved quantification of evaporation-transpiration fluxes by measuring isotopes in air, leaf and stem moisture. I am pleased to note that each of these

evinced tremendous response for participation by more than 20 research groups.

Partnerships with other international agencies and programmes were further strengthened. A strong link was established with the UNEP– Global Environment Monitoring System — Water Programme (GEMS/Water) through a joint project to undertake inter-laboratory comparison exercises for water chemistry aimed at improving the quality of chemical data worldwide. In collaboration with UNESCO, the Agency organized a meeting on groundwater resources sustainability indicators. The working group focused on identification and review of groundwater indicators and produced a draft document, which will be included in the next edition of the World Water Development Report of the United Nations.

Building and developing human resources in the field of isotope hydrology is an important activity for the Agency. Accordingly, nearly 20 training courses, workshops and seminars were organized in 2003 for developing Member States. In addition, human resource development is being implemented through computer aided self-learning tools and the appropriate printed material. More than 70 technical cooperation projects in water resources development and management are being implemented in Africa, Middle East, Asia, and Latin America in the 2003-2004 project cycle. In Uganda, a project implemented in cooperation with the Austrian Development Cooperation provided unique information on recharge areas and pathways for assessing the sustainability of surface springs as new sources of drinking water.

Opening new opportunities for greater impact of the Agency's technical cooperation programme, the Global Environment Facility (GEF) co-funded an effort to formulate a joint GEF/IAEA project. This project aims to strengthen human and institutional capacities and to develop strategies for the sustainable management of groundwater in the Nubian Aquifer, shared by Egypt, Libya, Sudan and Chad as one of the most important sources of freshwater in northern Africa.

This year we are developing the Agency's programme of work for 2006-2007. The major focus of our programme in this biennium will continue to be on developing data and data products for groundwater sustainability and water cycle studies. In addition, efforts to develop isotope applications for improved irrigation practices will be strengthened. The programme will receive additional resources of US\$115,000, bringing the total to US\$3.2 million. This represents a nearly 25% increase since the 1999-2000 programme cycle. The technical cooperation funding for water resources also has increased steadily and now stands at about US\$3.6 million per year.

We also have new colleagues who have joined us recently, bringing the total of professional and technical staff in the water resources programme to 22. Installation of the helium isotope facility in our laboratory is proceeding on schedule and is expected soon to be used for sample analysis.

I am excited about the prospects of increasing the application of isotopes in hydrology in the coming years and, together with you all, truly integrating isotopes in the hydrological sciences to improve water resource management.

Pradeep Aggarwal (p.aggarwal@iaea.org)

## **International symposium on isotope hydrology and integrated water resources management, Vienna, 19-23 May 2003**

The 11th International Symposium on Isotope Hydrology and Integrated Water Resources Management was held from 19-23 May 2003 at the Headquarters of the International Atomic Energy Agency in Vienna, Austria. The symposium was divided into an opening session, eleven technical sessions, and a closing session.

### **Opening Session**

Introductory remarks were made by Mr. W. Burkart, IAEA Deputy Director General and Head of the Department of Nuclear Sciences and Applications, Honorable Mr. S. Prabhu, Member of Parliament in India and Chairman of the National Taskforce on Interlinking of Rivers, H.E. Mr. K. C. Brill, Ambassador of the United States of America to the IAEA, H.E. Mr. Y. Takasu,

Ambassador of Japan to the IAEA, Mr. W. Schimon, Deputy Head of the Water Division, Federal Ministry of Agriculture, Forestry, Environment and Water Management of Austria (on behalf of the Federal Minister Honorable Mr. Josef Pröll), and Ms. I. Kossina, Executive City Councillor for the Environment, Vienna Provincial Government.

In his opening address, Mr. Burkart noted that substantial progress has been made in the application of isotope techniques in water sciences over the past 40 years and the number of publications based on these methods is growing rapidly. He also noted that global demand for freshwater has been increasing much faster than the ability of most nations to meet these demands. To sustain the current and future human development, extensive



hydrological information is necessary. Integration of isotopes techniques into mainstream hydrology still requires a closer interaction between isotope specialists and the hydrological community.

One of the common themes pointed out in the opening remarks was how water resources issues are presently evolving from local to global problems due to the expanding world population and increasing demand for water. The importance of three measures- (1) good governance and policy intervention, (2) community participation, and (3) advancements in technology – to tackle the problem was addressed.

## Technical Sessions

The technical programme of the Symposium comprised nearly 55 oral and 120 poster presentations. The oral sessions were divided into nine technical sessions: keynote, groundwater sustainability and dynamics (2 sessions), river system dynamics, unsaturated zone processes & artificial recharge, geothermal systems, climate & atmosphere, and biogeochemistry & water quality. Two poster sessions were conducted, one focused primarily on groundwater and the other one on surface hydrology and geothermal systems.

### Session 1: Keynote Papers

Speakers in the keynote session pointed out the vital need of careful use and protection of water resources to ensure the future of civilization and integrity of the natural environment. The outcomes of the 3<sup>rd</sup> World Water Forum held at Kyoto, Japan in March 2003 were reported. The main outputs of the forum – global water resource issues and the portfolio of water actions – provided a timely vision for global water issues.

A provocative but relevant question was addressed to the Symposium: "What have isotopes told us about water systems that we didn't know before?" This is a relevant question that is often heard, especially amongst the water

management community, and that should be asked prior to all isotope studies. This message obviously struck a chord with conference participants because during the technical sessions presenters and audience alike often restated it. The answer was generally "a lot", but it was stated that a careful design of isotope studies is necessary to ensure that the isotopes will be used effectively and bring a novel information beyond the use of conventional hydrological techniques. Methods on how to facilitate adoption of isotope techniques for groundwater management were also presented.

An overview of methods using tritium, helium-3, chlorofluorocarbons, and sulphur hexafluoride for determining the age of young groundwater up to 50 years was presented. The statement made in 1983 by late Jean-Charles Fontes, a leading isotope hydrologist and former staff member of the IAEA, : "the concept of groundwater age has little significance," was explored. It was concluded that investigation with multiple environmental tracers in groundwater systems could often help to refine the interpretation of groundwater age, flow and transport concepts, and vulnerability of aquifers to contamination. The isotopic tools for groundwater dating are important because while shallow young groundwater provide drinking water supply in many parts of the world, they are the most vulnerable to contamination from anthropogenic activities. The Agency's recent setup of a  $^3\text{H}/^3\text{He}$  facility endorses the development of high-end isotope techniques for the dating of young groundwater.

### Sessions 2, 3 and 5: Groundwater Sustainability and Dynamics

More than 50 % of oral and poster presentations at the Symposium demonstrated that groundwater sustainability issues continue to be the mainstay of isotope applications. The two oral sessions on this issue included papers on groundwater dynamics, groundwater pollution and restoration, isotopic modelling approaches, origin and recharge of groundwater,

palaeowaters, recharge estimation, and the assessment of slowly renewing groundwater resources. An overview of the  $^{14}\text{C}$  method as a dating tool for old groundwater demonstrated its vital, effective and frequently indispensable role in hydrological studies, numerical modelling, and groundwater budget estimations. Many presentations included case studies on isotope techniques in groundwater dynamics and sustainability.

#### **Session 4: River System Dynamics**

In this session, papers were presented on the application of isotopes to continental-scale river systems. Advances in development of models using isotopic tracers and water balance in river systems at the continental scale were demonstrated. These efforts are at an early stage of development and indicate that future trends will focus on isotope applications to regional water balance and climate change responses over large river basins. Nutrient source identification in large rivers has received a boost from new analytical methods that permit rapid and accurate measurement of  $^{18}\text{O}$  and  $^{15}\text{N}$  in nitrate, a major pollutant in surface waters and groundwater.

#### **Session 6: Unsaturated Zone Processes and Artificial Recharge**

The principal subject of this session comprised the use of isotopes in understanding the movement of solutes (pollutants) and water through the unsaturated zone. Issues such as rate of contaminant migration, pathways of migration, mechanism of degradation of solutes/contaminants by biogeochemical reactions along flow paths, and impacts of solutes/pollutants on aquifer characteristics were presented. The papers on artificial recharge as a water resource management tool, showed novel applications of isotope techniques in the investigation of water quality and quantity in the unsaturated zone.

#### **Session 7: Geothermal Systems**

Papers in this session demonstrated the utility of isotope techniques in assessing the potential of geothermal resources and in the management of geothermal systems in a variety of geologic settings. Monitoring results on potential impacts of geothermal development on freshwater systems were also presented.

#### **Session 8: Climate and Atmosphere**

This session included papers that presented recent advances on coupling of atmospheric circulation models with data on isotope variations in the water cycle, where isotopes are proving particularly useful in validating the physical processes related to the hydrological cycle. Several papers considered the issue of moisture sources in the Asian monsoon region that showed the potential for employing isotopes to understand the source and transport of moisture and rainfall pattern variability. The isotopic links between key global cycles of water and carbon were highlighted. The Agency's role in developing and coordinating the GNIP database emerged as a key resource for these types of studies. Isotopes are also important in understanding past climate changes and predicting future changes – changes that may not only influence global temperatures but also energy needs, availability of drinking water, and food security.

#### **Session 9: Biogeochemistry and Water Quality**

Application of isotopes in biogeochemical processes is particularly important for understanding the transformations of nitrogen, sulphur, and carbon in the hydrological cycle, and hence it plays a key role in monitoring the impacts of contaminants on water quality and remediation.

## Sessions 10 and 11: Poster Sessions

In the groundwater poster session (Session 10), the main themes were pollution, modelling approaches, the origin and recharge of groundwater, and palaeowaters. Session 11 covered various aspects of precipitation, surface waters, watersheds, large rivers, lakes, wetlands, estuaries, geothermal systems, and recent analytical techniques. It also included new approaches in the area of compound-specific isotope analysis relevant to biodegradation of pollutants in groundwater.

## Closing Session

Arid zone hydrology is still considered as an important area of application of isotope techniques. The interface zones, such as the interface zone processes between the unsaturated and saturated zones, are still not well understood. Fractured rock aquifers are increasingly being used for groundwater supply. However, natural tracers and isotope techniques are not yet fully recognized for such investigations. Characterization of an ecosystem's dependence on groundwater is an important area where isotope applications would be vital. In large-scale river basin hydrology, the application of isotope techniques has a substantial scope. Various aspects are being studied within the framework of the Coordinated Research Project (CRP) of the Agency on this topic. This CRP is providing a global focal point for data collection on large river systems and is attracting significant attention. In addition, further potential applications exist in the ungauged basins worldwide.

One of the most useful areas of isotope application highlighted once again was the calibration and validation of global climate models (GCMs), and especially the validation of physical processes on which these models are based. There is a need to integrate climate records with isotope-based records, and to use isotopes to monitor climate changes. Global data collection should be expanded, and the GCMs

should provide guidance on the spatial and temporal frequency for the required data. The application of isotope techniques in tropical humid areas should not be neglected in favor of arid and semiarid zones.

In the area of water quality and pollutant source identification, isotope techniques have developed significantly in recent years and new tools and techniques for measuring  $^{18}\text{O}$ ,  $^{17}\text{O}$ ,  $^{15}\text{N}$  in aqueous nitrates, and  $^{18}\text{O}$  in dissolved oxygen, and  $^{18}\text{O}$ ,  $^{34}\text{S}$  in aqueous sulfates have become available. As these tools become available on a routine basis, existing applications may lead to better interpretation of hydrological processes.

It was recognized that ocean systems were largely under-represented at the Symposium and that there was a need to improve interaction with this field and integration between the ocean and hydrological sciences, especially in tracer oceanography. For example, a new method for measuring  $^{18}\text{O}$  in microgram quantities of aqueous nitrate was developed for oceanographic purposes. As a scientific community, we should facilitate the integration of isotope techniques in all areas of hydrological sciences.

Finally, the Symposium concluded that greater efforts are required to increase the acceptance of isotope methodologies in conventional water resource management. In this context there is a need to expand efforts in global data collection in all environments. A lack of substantial efforts in field data collection during the 1970s and 1980s were considered to be partly responsible for a perceived stagnation in the field of isotope hydrology, retarding its integration into hydrological sciences.

## **JIIHP programme news**

### **About JIIHP**

The Joint International Isotopes in Hydrology Programme (JIIHP) is a joint initiative between the IAEA and UNESCO with the aim of facilitating the integration of isotopes in hydrological practices. In the following we report some recent activities under the programme.

### **Central American Training Course on Isotope Hydrology held in Panama, October 2003**

In October 2003, a two-week training course on the use of isotopic tools for the sustainable management of groundwater resources in the Central American region was held in the framework of the JIIHP programme. This Central American Training Course was organized by the IAEA in cooperation with the Autoridad Nacional del Ambiente (ANAM) y del Ministerio de Economía y Finanzas, Dirección de Cooperación Técnica Internacional, the Water Centre for the Humid Tropics of Latin America and the Caribbean (CATHALAC) as well as support from the UNESCO-International Hydrological programme. A total of 25 participants from Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama participated in this course. It is foreseen that similar training courses will be held in the future in this and in other regions.

### **Artificial Recharge Training Course Held in Egypt, February 2004**

A training course on the Use of Isotopic Applications for Artificial Recharge of Groundwater was held in Egypt in Feb. 2004. The objective of the course was to train participants about the use of isotopic tools to facilitate and manage the artificial recharge of groundwater aquifers in arid areas. The interest in artificial recharge of groundwater aquifers continues to grow as water resources in many

arid areas become more strained. If managed properly, artificial recharge can be an effective approach to retaining water resources in a given area fostering use and reuse. The training course is coupled with a pilot activity in artificial recharge in Egypt which offers excellent opportunities for on-site training and investigations. Given the positive response to the workshop, a follow-up course is being considered for 2005.

### **Isotope Hydrology Training in the UNESCO IHP Postgraduate Course on Hydrology, Budapest, Hungary, June 2004**

For the thirty fifth consecutive year, the UNESCO IHP Postgraduate Course on Hydrology was organized and conducted by the Vituki Institute in Budapest, Hungary in April-July 2004. This year, as part of the IAEA/UNESCO JIIHP Programme, the IAEA supported a one week module on Isotope Hydrology from June 21-25, 2004. Basic principles of isotope hydrology applications were introduced with a focus on practical case studies related to surface water and groundwater. Over twenty-five people from hydrology and related fields participated in the workshop. Based on this pilot activity, the possibility of integrating an isotope hydrology component into future UNESCO-IHP courses will be considered.

For further information, please contact the JIIHP Programme Coordinator, Mr. Andy Garner at: [a.garner@iaea.org](mailto:a.garner@iaea.org) or look at the respective web sites: <http://www.iaea.org/programmes/ripc/ih> or <http://www.unesco.org/water/ihp/isotopes.shtml>

## Isotopic age and composition of streamflow as indicators of groundwater sustainability

A new coordinated research project entitled "Isotopic age and composition of streamflow as indicators of groundwater sustainability" has recently been launched by the Agency.

Water in streams has two main components (Figure 1): surface and near-surface runoff in overland response to rain or snowmelt, and baseflow, which is water that enters from persistent, slowly varying sources and maintains streamflow between water-input events. Baseflow generally comes from shallow unconfined aquifers containing water in depths between 10 and 100 m and enters the river through the river banks and the bottom of river beds. Streams that receive large proportions of baseflow tend to have relatively low temporal flow variability, and provide a more reliable source of water for water resource purposes. Changes in the baseflow impact issues such as water quality, wetland viability, water availability, ecological stability and risks as well as human health. The improved understanding of the role of baseflow in overall catchment vulnerability is one of key needs toward novel water resources management tools and best management practices on the scale of river catchments. Two questions are of particular importance: what is the water age of the river baseflow, and what are its sources.

The formation of baseflow in catchments varies in time. Water infiltrates at different rates, mixes in the subsurface and thus has different travel times to the stream. The "age" of baseflow in a catchment is the average time elapsed since a drop of water enters the catchment and the time it is observed in the baseflow at the catchment outlet. The age describes the catchment response to water withdrawals, contamination, or landuse changes, and provides a basis for assessing sensitivity to imposed catchment management practices. In recent years, stable isotopes  $^{18}\text{O}$  and  $^2\text{H}$ , and radioactive isotopes  $^3\text{H}$  (also in

combination with stable  $^3\text{He}$ ),  $^{85}\text{Kr}$ ,  $^{35}\text{S}$ ,  $^{222}\text{Rn}$  and man-made compounds CFCs and  $\text{SF}_6$  have been the mainstays to estimate the water ages in catchments and shallow aquifers. During the past 40 years, a reasonable success in obtaining water ages of up to 10 years has been achieved in small well-instrumented experimental catchments, which are typically located in headwater areas. However, no thorough knowledge exists on the up-scaling of baseflow ages to regional systems and large catchments.

Besides the understanding of water age, the sustainable management of large catchments requires a thorough understanding of the baseflow sources, recharge areas, aquifer boundaries and groundwater flow-paths, which in larger catchments are extremely difficult to derive with confidence. The relation between the baseflow age distributions and spatial sources of baseflow along streams is poorly understood and has been rarely the object of thorough research. Baseflow in large rivers may increase or decrease with their downstream distance, depending on the distribution of recharge and discharge zones and sources along streams. In recent decades, stable water isotopes have allowed the identification of recharge waters isotopically enriched due to evaporative effects in lakes, streams, drainage channels and shallow river banks, and waters isotopically depleted from irrigation use and return flow in arid areas.  $^3\text{H}$ ,  $^3\text{He}$  and  $^{222}\text{Rn}$  have been used for studying leakage of river water into shallow aquifers and delineation of exfiltration and infiltration zones along river reaches. In zones where river baseflow exfiltrates into adjacent aquifers, recharge velocities and residence times of the recharged water can be obtained by use of the  $^3\text{He}/^3\text{H}$  techniques. Conversely, the source and residence times of groundwater seepage to streams can be evaluated by use of chlorofluorocarbons. Several studies documented increased recharge of shallow aquifers in developed areas, due to leakage from



water supply pipes, storm sewers, and septic leach-fields. These findings apparently contradict the common view of urban catchments as sources of low baseflow proportion due enhanced surface runoff on impervious areas. A large number of studies also used solute isotopes  $^{15}\text{N}$  and  $^{34}\text{S}$  to quantify baseflow sources from denitrification areas in shallow aquifers, from septic tank leakages and animal waste, and from natural soil nitrogen in fertilizer and wastes.  $^{87}\text{Sr}$  and  $^{210}\text{Pb}$  became tools for identification of the evolution and origin of river waters via tracing the weathering reactions along water pathways in catchments. This expansion of isotopic applications indicates a continuously growing interest in using multi-isotopic studies, which address complex hypotheses for better catchment management.

The working hypothesis of the new CRP is that the isotopic composition and water age distributions of the baseflow in rivers give suitable information on the subsurface mixing and groundwater discharge from adjacent regional aquifers, lakes, wetlands and human settlements. It is to be further explored whether the baseflow age scaled to regional systems and transferred to the large catchment scale, and

management tool for creating novel indicators of potential risks of aquifer perturbations and changes to water quality and quantity.

Therefore, the objective of the CRP is to develop and test an isotopic methodology for characterizing aquifers and catchments by monitoring baseflow age in rivers. The CRP will first focus on developing methods in selected catchments with long available isotope records and test the ability of the methods to describe baseflow age distributions from small catchments to large river catchments. Then the age distributions of baseflow will be tested as indicators for assessment of changes and risks to water quality and quantity in large river catchments.

This CRP will consider the preliminary results of the CRP "Design criteria for a network to monitor isotope composition of runoff in large rivers". A link to international programmes working in river catchments (UNESCO-IHP, UNEP, GLOWA etc.) is also anticipated.

For more information on this please contact Mr. Tomas Vitvar at [t.vitvar@iaea.org](mailto:t.vitvar@iaea.org).



Fig. 1. A conceptual model of river baseflow.

## Sustainable development and equitable use of the common Nile basin water resources



Fig.1, Countries sharing the Nile river

As one of the world's largest rivers, the Nile traverses almost 6.700 km from its source at the headwaters of the Kagera River in Burundi and Rwanda to its delta in Egypt on the Mediterranean Sea. Ten countries (Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda) with a population of around 300 million rely on Nile water (Figure 1). Its ecological system is unique, hosting various landscapes, such as high mountains, tropical forests, woodlands, lakes, savannas, wetlands, arid lands, and deserts. As the population is projected to double within the next 25 years, additional stress on water resources can be expected. It is therefore essential that the sustainability of water resources in the Nile basin be addressed with greater efforts.

The Nile Basin Initiative (NBI), jointly sponsored by several international organizations in the UN system, has been conceived to address

the most important issues on water resources in the basin, such as the processes affecting the water balance and water quality in the basin. The Agency is supporting the application of isotope techniques to study these hydrological problems.

The IAEA contribution to the Nile cooperation is being implemented through a regional project, RAF/8/037, on "Sustainable development and equitable use of the common Nile basin water resources," launched at the beginning of 2003. The project has two phases. Phase I (2003-2004) deals with the White Nile and Lake Victoria basins. Phase II (2005-2006) will cover the Blue Nile and Main Nile basins.

The first project coordination meeting of the project was held in Entebbe, Uganda from March 31 to April 01, 2003. It was agreed that one of the most important issues for isotope techniques to study is the refinement of the water balance of Lake Victoria. In particular, the flux of ground water into or out of the lake is completely unknown at this point. Issues concerning evaporation and precipitation also need to be better understood. Lake water sampling stations (Figure 2) have already been identified through



Fig.2, Lake Victoria Environmental Management Programme (LVEMP) Monitoring Stations in Lake Victoria



A sign at Jinja, Uganda describing the geographical setting of the source of the Nile (credit: Kshitij Kulkarni/IAEA).

the Nile Basin Initiative under the Lake Victoria Environmental Management Programme (LVEMP) and these will be used for isotope sampling. An equivalent network for sampling the groundwater around the lake was established. Sampling at these sites consists of the stable isotopes of water, tritium and helium-3.

The Coordination Meeting was followed by the first sampling campaign in the Uganda part of Lake Victoria (2 - 7 April 2003). Water samples were taken from the lake itself as well as from incoming streams, swamps and shallow groundwater bodies in the surrounding areas.

A workshop was held in Mwanza, Tanzania from 24 August to 2 September 2003 to review previous isotopic study of Lake Victoria basin and to determine what type of network could be established for monitoring isotopic ratios in groundwater, precipitation and surface water in the three countries sharing the lake (Kenya, Tanzania and Uganda). The workshop was followed by a sampling campaign to collect

water samples from the shallow groundwater, near-shore lake water and the surface water in adjacent wetlands.

During the last two sampling campaigns, more than 300 water samples have been collected from Lake Victoria and the surrounding swamps and aquifers. The samples have been analyzed for chemical and isotopic composition. Distinctive patterns of isotopic composition were found for the lake water, the groundwater, river water and swamp waters. The isotopic composition of lake water is relatively homogeneous from surface to a depth of 60 meters, with a mean value of  $3.40 \pm 0.07$  for O-18 and  $25.18 \pm 0.86$  for H-2. The isotopic compositions of the groundwater and swamp water are similar to each other but much different from that of the lake water. These data indicate that there is no lake water flowing into adjacent aquifers and that most of the swamps are of groundwater origin.

For more information, please contact Mr. Cheikh Gaye at [c.gaye@iaea.org](mailto:c.gaye@iaea.org).

## Groundwater indicators and protection zones

As part of the World Water Assessment Programme (WWAP), the IAEA and UNESCO are jointly supporting a working group on "Groundwater Indicators". The working group is tasked to develop a technical document on groundwater indicators. The second meeting for this working group was held at the Agency's headquarters in Vienna in June 2003. Five members of the group participated in the meeting, together with representatives from UNESCO and IAEA. The meeting selected core variables on groundwater indicators both from quantitative and qualitative aspects. The meeting also proposed methods of groundwater indicators construction, groundwater monitoring and assessment programmes. It also selected case studies for groundwater indicators testing. The meeting suggested that groundwater indicators should be scientifically robust and policy relevant, based on reliable measurable and observable data. A holistic concept in the policy and management of water resources should consider the close connection between groundwater and surface water, give the same attention to both quantitative and qualitative aspects and reflect the social, economic and ecological value of water. The output of the meeting is a draft document with a list of core variables needed for the development of groundwater indicators.

Another working group jointly supported by IAEA and UNESCO through its International Hydrological Programme (IHP) is working on developing a technical document on "Guidelines for Delineation of Protection Zones around Public Groundwater Supplies and Management Policy". The first meeting of this working group took place in Ustron, Poland, in June 2004. The project is also supported by the International Association of Hydrogeologists (IAH) and United Nations Economic Commission for Europe (UNECE). Six members of the working group participated in the meeting, together with representatives from UNESCO and IAH. A Methodological Guidebook being developed under this project will contain two major parts: a general section and a section of case studies. The first one will focus on methodological and technical aspects as well as policy aspects while the second one will present selected case studies in different countries and in different hydrogeological environments. It is planned that the book will be ready for publication in the first half of the year 2006.

For more information please contact Mr. Bill Wallin at [b.wallin@iaea.org](mailto:b.wallin@iaea.org) and Mr. Tomas Vitvar at [t.vitvar@iaea.org](mailto:t.vitvar@iaea.org), respectively.

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## Agency awards

### Team award

An IAEA interdepartmental team led by Section Head Pradeep Aggarwal, received a Merit Award for Outstanding Teamwork for its collective efforts to organize the UN's World Water Day 2002. Other Section members that received the award were Ms. Nanette Azucena, Mr. Kshitij Kulkarni, and Mr. Jeff Turner. Ms. Melissa Flemming, Mr. Peter Rickwood, Ms. Joanne Ford, Ms. Patricia Murphy, Ms. Alexandra Disner-Kuepfer, Ms. Cynthia Coolbaugh and Mr.

Anatoli Bourykine and Mr. Christophe Yvetot, from the IAEA's Division of Public Information, Division of Information Technology, Conference Services Section and Concepts and Planning Section of the Technical Cooperation Department, respectively, were the other members of the team.

### Individual awards

Ms. Cecilia Devia-Torres and Mr. Liang-Feng Han received merit awards. Ms. Laurence Gourcy received a merit promotion.

## GNIP updates

The GNIP database has seen steadily increased entries over the last years. By the end of 2003, data for year 2001 from participant laboratories had been entered into the database. The number of active GNIP stations in 2003 is 164.

Among the twenty-four GNIP participant laboratories, twenty of them participated in the inter-laboratory comparison on stable isotopes of water organized by the IAEA in 2002. Among the nineteen participant laboratories, eighteen of them participated in the inter-laboratory comparison on tritium organized in 2000. These regular inter-laboratory comparison exercises have helped to ensure quality of the data received from participant laboratories.

In 2003, there were 469 new registered ISOHIS/GNIP database users. Data downloads have been recorded for 5940 times between 2000 and 2003. 34% of the users that have downloaded data are from European countries out of a total of 106 countries. 10% of the data downloaded is from the US stations and 7.3% the Chinese ones.

The Agency organized a consultant meeting on "Strengthening of National Networks for Monitoring Isotopes in Precipitation" in Rome, Italy in September 2002 that was hosted by University "La Sapienza". The meeting discussed the stable isotopes and meteorological data obtained on a daily or event basis from rainfall and atmospheric moisture samples around the Mediterranean basin and revised the sampling strategy including network design for the period 2002-2003 in order to serve the regional climate studies. This new sampling strategy is being implemented within the framework of the IAEA coordinated research project on "The isotopic composition of precipitation in the Mediterranean basin in relation to air

circulation patterns and climate".

Over the years, many scientific articles have cited the ISOHIS/GNIP database. The majority of the recent papers are more related to paleoclimatological or paleohydrological studies. In year 2002 and 2003, there were 47 papers published in International Journals that cited the database. A full list of the papers is available on our Internet website (<http://www.iaea.org/programmes/ripc/ih/>).

For more information please contact Ms. Laurence Gourcy at [l.gourcy@iaea.org](mailto:l.gourcy@iaea.org).

### Editor's note

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Alternatively, it is also available in pdf format on the Internet at <http://www.iaea.org/programmes/ripc/ih/>

Contributions to the newsletter are welcome.

## Meetings, training courses and workshops

### IAEA technical meetings held recently

Research coordination meeting (RCM) on isotopic composition of precipitation in the Mediterranean basin in relation to air circulation patterns and climate, Vienna, 15-19 March 2003

Consultants meeting on isotope tracers for moisture source characterization, Vienna, 7-9 April 2003

International symposium on isotope hydrology and integrated water resources management, Vienna, 19-23 May 2003

RCM to assess the effectiveness of soil conservation techniques for sustainable watershed management/isotope techniques for sediment source characterization, Vienna, 19-23 May 2003

RCM on isotope response to dynamic changes in groundwater systems due to long term exploitation, Vienna, 12-16 May 2003

Consultants meeting (jointly with UNESCO) of the working group on groundwater indicators, Vienna, 26-27 May 2003

RCM on origins of salinity and impacts on fresh groundwater resources: optimization of isotopic techniques, Vienna, 10-13 June 2003

Consultants meeting on preparation of a tritium helium guidebook, Vienna, 30 June - 2 July 2003

UN-water meeting, Vienna, 2- 4 July 2003

Consultants meeting on discussions and compilation of isotopic and hydrological data collected from northern Africa by the Heidelberg and Berlin group, Vienna, 3- 7 November 2003

Assess the use of isotope techniques for evaluating impacts of irrigation practices on groundwater quality and quantity, Vienna, 17-20 November 2003

Consultants meeting on preparation of a document on river sediment transport studies, Vienna, 26-28 November 2003

Consultants meeting on writing background paper for the scientific basis for GNIP, Vienna, 17-18 November 2003

Consultants meeting to discuss means to develop an agency initiative for a terrestrial moisture isotope network, Vienna, 17- 18 November 2003

Consultants meeting to develop background papers and plans for initiating coordinated research projects on groundwater sustainability and fossil water mapping, Vienna, 17- 21 November 2003

RCM on application of isotopes to the assessment of pollutant behavior in the unsaturated zone for groundwater protection, Vienna, 17 to 19 December 2003

RCM on design criteria for a network to monitor isotope compositions of runoff in large rivers, Vienna, 10- 14 May 2004

Consultants meeting on terrestrial moisture isotope network, Vienna, 25-27 May 2004

### **IAEA workshops 2003**

National workshop for Moldova on tracer techniques and risk assessment with particular emphasis on dam safety, Chisinau, Moldavia, 29 September - 3 October 2003

Regional workshop on quality assurance of chemical analyses on geothermal gas samples, Panama City, Panama, 24-28 March 2003

Regional workshop on the application of isotopes techniques in the development and management of geothermal resources, 10 – 14 November, Managua, Nicaragua

Regional workshop to establish groundwater, precipitation and evapotranspiration sampling networks in the lake Victoria region, 25 August - 2 September 2003, Kwanza, United Republic of Tanzania

Regional workshop on contamination and vulnerability of aquifers, San Jose, Costa Rica, 10-21 March 2003

Regional workshop on discussion on quality control of chemical analysis, Santiago, Chile, 23-27 July 2003

Regional workshop on monitoring network, Montevideo, Uruguay, 28 July - 8 August 2003

Regional workshop on water balance calculation, Cali, Colombia, 20 April - 2 May 2003

### **IAEA training courses 2003**

Advance regional training course on isotope methods for watershed management, 14 – 31 July 2003, Argonne, U.S.A.

AFRA regional training course on basic isotope hydrology and groundwater field sampling techniques, Addis Ababa, Ethiopia, 1 - 12 December 2003

AFRA regional training course on isotope hydrology with particular emphasis on dam safety and sustainability, Addis Ababa, Ethiopia, 29 September – 3 October 2003

AFRA regional training workshop on tracer demonstration technique in isotope hydrology with particular emphasis on dam safety, Pretoria, South Africa, 14 – 19 June 2003

IAEA/RCA regional training course on application of isotope and geochemical techniques to groundwater contamination studies, Jakarta, Indonesia, 8-19 December 2003.

IAEA/RCA regional training course on chemical analysis of geothermal waters and gases, the Philippines, 10 March - 4 April 2003

International seminar on development and application of isotope tracer diagnostics in regional climate models, ICTP, IAEA, Trieste, Italy, 22 - 26 September 2003

Subregional training course on isotope hydrology, IAEA UNESCO, Panama City, Panama, 20-31 October 2003

## Staff members of the Isotope Hydrology Section



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## News in brief...

### New Staff Members

*Mr. Andy Garner* joined the Isotope Hydrology Section in May 2004 as a Water Resource Management Specialist. Mr. Garner was formerly serving as Environmental Specialist for the UNDP/GEF Danube Regional Project. In the Isotope Hydrology Section, Mr. Garner will work to more fully integrate isotope hydrology into water resource management activities. This will include leading the further development of the IAEA/UNESCO Joint International Isotope in Hydrology Programme (JIIHP) as well as the coordination of new initiatives like the IAEA/UNDP/GEF Nubian Aquifer Programme. He will also work to strengthen communication activities and products to build greater awareness of the activities, results and further possibilities of using isotope hydrology applications.

*Mr. Brent Helliker* joined the Isotope Hydrology Section in June 2004 for a one-year assignment. Mr. Helliker was formerly a post-doctoral fellow at the Carnegie Institution of Washington's Department of Global Ecology. He has interests in stable isotope applications to plant physiology, ecology and meteorology, particularly how oxygen isotopes allow for the measurement of plant processes from leaf to global scales. In the Isotope Hydrology Section, Mr. Helliker will both assist with the commencement of the worldwide Moisture Isotopes in the Biosphere and Atmosphere (MIBA) program and further develop atmospheric water vapor sampling techniques in the laboratory. In recognition of the importance of Biosphere-Atmosphere interactions, the MIBA program was initiated to gather global data on water isotopes in plants, soil and atmosphere, an endeavor that will reduce our uncertainty in closing the global carbon budget as well as improve upon mid-range to long-term weather forecast.

### Departing Staff Members

*Mr. Jeff Turner* left the Isotope Hydrology Section in Feb. 2004 to return to his position at the CSIRO Institute in Perth, Australia. Mr. Turner joined the Section in 2001 and subsequently focussed his work on isotope techniques in

groundwater pollution studies, groundwater-surface water interaction and modelling etc. Mr. Turner has worked on efforts to develop isotopic techniques to support river basin management. He was active in IAEA Technical Cooperation activities as well, working in China, Pakistan and other countries particularly in the Asia and Pacific region.

*Mr. Ken Hollett* has left the IAEA as of July 2004. Mr. Hollett worked in the Section on a special assignment for 10 months where he used his extensive experience from his career at the USGS to strengthen several initiatives in the Section. Ken worked to establish a GIS platform for the Isotope Hydrology section, which will form the basis of the GIS application that is currently being developed by a team at the University of Vienna. He also supported efforts to prepare new projects in North Africa, based on his previous experience in the region. Finally, Ken provided inputs to Strategic Planning of future Isotope Hydrology programmes. Mr. Hollett is retiring and is returning to his home in the USA at Tucson, Arizona.

### Visiting Scientists

*Dr. Bernhard Mayer*, Associate Professor in the Department of Geology & Geophysics at the University of Calgary (Alberta, Canada), arrived at the IAEA on June 24, 2004. During his 2 month stay at the Isotope Hydrology Section he will compile and review available information on the isotopic composition of nitrate and sulfate in surface water and groundwater published in IAEA documents and the refereed literature since the early 1960's. The outcome will be a comprehensive report documenting the potential and the limitations of stable isotope techniques in identifying sources of dissolved nitrate and sulfate in the hydrosphere and in describing the processes these solutes may have undergone in aquatic systems. This study will support the Isotope Hydrology Section in evaluating whether it is desirable to more actively engage in the study of the isotopic composition of dissolved water constituents such as nitrate, among others, e.g. within existing (e.g. Global Network of Isotopes in Rivers, GNIR) or new programs.

## TRIC2004: the seventh inter-laboratory comparison exercise of tritium analysis of water at environmental activity levels

- Deadline for registration: 15 September 2004

The IAEA Isotope Hydrology Laboratory is organizing the seventh inter-laboratory comparison exercise of tritium analysis of water at environmental activity levels (TRIC2004). All laboratories and institutes having analytical capabilities for low-level tritium measurements with an estimated measurement uncertainty below  $\pm 5$  TU (resp.  $\pm 0.6$  Bq/kg), using gas proportional counting, liquid scintillation counting, or  $^3\text{He}$  ingrowth method are invited to take part in the exercise. The purpose of the inter-laboratory comparison is to give the participating laboratories the opportunity to check the agreement of their measurements with those of other laboratories, to discover the occurrence of any errors and systematic deviations and, eventually, to improve the quality and reliability of their analytical procedures.

A set of six water samples will be dispatched in the course of the inter-laboratory comparison to participating laboratories. Five samples consist of 500ml water in polyethylene bottles with tritium concentrations ranging from 0-30 TU (0-3Bq/kg) with codes TRIC2004-T7 to TRIC2004-T11, and one sample (code TRIC2004 - T12) consists of 50 ml water in a glass bottle with a tritium concentration of about 1000 TU (120 Bq/kg). This sample should be analyzed by direct counting without enrichment and thus allow the proper calibration of the laboratory standards, as well as the precision of the methods used for the analysis of samples with higher tritium concentration levels.

The samples will be prepared by spiking tritium-free water obtained from an Artesian well in Steiermark, Austria with well-specified dilutions of a NIST tritium water standard (NIST 4927F). The samples will not be pretreated. Participating laboratories will be requested to report for each sample the results of the tritium measurement in TU and the assigned standard uncertainty at the 1-sigma level. In addition, laboratories will receive a questionnaire to collect information about their individual uncertainty components, such as standardization, enrichment, counting. Other mandatory information includes the equipment used and analytical procedures applied, as well as the calibration method specifying the tritium standards and dilutions used. Any other information that is considered useful would be appreciated. The

relevant forms including detailed information and instructions for preparation of the data report will be sent out together with the samples. The results will be evaluated by the IAEA and each participating laboratory will receive a report with the individual data, the statistical evaluation of all results, and their graphical display. Participating laboratories will be identified by a code, thereby ensuring full confidentiality of the results and their origin.

Laboratories using the  $^3\text{He}$  ingrowth method are particularly requested to participate in the inter-laboratory comparison. The fact that laboratories using this analytical procedure might take longer than the beta-counting laboratories will be taken into consideration. Please specify in your response if you do not want to receive the sample with high tritium activity.

Participation in the exercise will be limited to approximately 150 laboratories. To be registered as a participant and to receive samples for the analysis, please respond by email at your earliest convenience, but not later than September 15th, 2004, to the e-mail account ([isotope.hydrology.lab@iaea.org](mailto:isotope.hydrology.lab@iaea.org) [\(<mailto:isotope.hydrology.lab@iaea.org>\)](mailto:isotope.hydrology.lab@iaea.org)) specifying the subject TRIC2004. Please indicate the full address for shipment of samples as well as the email and fax numbers for further correspondence.

In case email is not available, please send the information to the following postal address:

Isotope Hydrology Laboratory, "TRIC2004", International Atomic Energy Agency, P.O. Box 100, Wagramerstrasse 5, A-1400 Vienna, Austria, Fax +43-1-26007, Tel: +43-1-2600-21766, Fax: +43-1-26007.

Time schedule: Deadline for registration of the participation: 15 September, Expected shipment of samples: August/September 2004, Deadline for submission of the results to IAEA: 31 January 2005

For more information please refer to the home page of the IAEA Isotope Hydrology Laboratory at <http://www.iaea.org/programmes/rial/pci/isotopehydrology/>

## Ongoing IAEA coordinated research projects

- ◆ Origin of salinity and impacts on fresh groundwater resources: optimization of isotopic techniques
- ◆ Application of isotopes to the assessment of pollutant behaviour in the unsaturated zone for groundwater protection
- ◆ Isotopic composition of precipitation in the Mediterranean Basin in relation to air circulation patterns and climate
- ◆ Nuclear and isotopic techniques for the characterization of submarine groundwater discharge (SGD) in coastal zones
- ◆ Design criteria for a network to monitor isotope compositions of runoff in large rivers
- ◆ Isotopic age and composition of stream flow as indicators of groundwater sustainability
- ◆ Development of new methodology for the determination of  $^{18}\text{O}$  of water in biological systems

## Upcoming IAEA meetings

- ◆ Consultants meeting on calibration of organic carbon stable isotope reference material, Vienna, 30-31 August 2004
- ◆ Symposium on quality assurance for analytical methods in isotope hydrology, Vienna, 25-27 August 2004
- ◆ Workshop on infrared spectrometry (SIRIS), Vienna, 6-9 September 2004
- ◆ RCM on isotope techniques for sedimentation source characterization, Istanbul, Turkey, 4-8 October 2004
- ◆ RCM on isotopic age and composition of stream-flow as indicators of groundwater sustainability, Vienna, 15-19 November 2004
- ◆ RCM on nuclear and isotopic techniques for the characterization of submarine groundwater discharge (SGD) in coastal zones, Vienna, November 2004

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## Preparing a joint IAEA/UNDP/GEF Nubian Aquifer project

A Project Formulation Meeting to develop a project for the "Integrated Management of the Shared Nubian Aquifer", was held from March 1-5, 2004 in Vienna. The meeting was co-sponsored by the IAEA and UNDP utilizing a Project Development Fund (PDF) Grant from the Global Environment Facility. Over 20 experts participated including representatives from the 4 Nubian countries i.e. Chad, Egypt, Libya and Sudan, IAEA experts as well as representatives from UNDP, UNESCO and CEDARE. The participants agreed on the main objectives, activities and expected results of the planned

project. The GEF is expected to provide a grant of approximately 1 million USD via its Implementing Agency, UNDP, coupled with funding from the IAEA Technical Cooperation Fund; the IAEA will be responsible for Executing the project in close cooperation with the 4 countries and key cooperating organizations, in particular, UNESCO. It is expected that the project will begin in early 2005.

For more information please contact Mr. Andy Garner at [a.garner@iaea.org](mailto:a.garner@iaea.org).

## Isotope Hydrology CD-ROM, available soon...

**Are you a student or teacher in isotope hydrology ? Are you practicing isotope hydrology in water resources applications? Check out this comprehensive CD-ROM !**

**Isotope Hydrology**  
By P.K. Aggarwal<sup>1</sup>, A. El-Kadi<sup>2</sup>, W.G. Mook<sup>3</sup>, and M.A. Dillon<sup>4</sup>

**Textbooks**

The documents included with this package are all PDF files. Volumes I through VI are from the publication: Environmental Isotopes in the Hydrological Cycle, Principles and Applications, by W. G. Mook (editor), UNESCO/IAEA Series on Environmental Isotopes in the Hydrological Cycle Principles and Applications.

The volumes are:

- Volume I Introduction: Theory, Methods, Review
- Volume II Atmospheric Water
- Volume III Surface Water
- Volume IV Groundwater: Saturated and Unsaturated Zone
- Volume V Man's Impact on Groundwater Systems
- Volume VI Modelling

The Adobe Acrobat Reader is needed to open such documents. The Reader is available for free from the Adobe web site.

**Contents**

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  - 1D Transport with Decay (averaged to transport equation)
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  - Oxygen (concentration + isotope diffusion with consumption)
  - Non-linear fitting of soil gas O<sub>2</sub> concentration
  - ▾ Help File: Soil Oxygen Migration

Close Window  
1 IAEA; 2 University of Hawaii; 3 University of Groningen, Netherlands; 4 Chicago, USA.  
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IAEA  
International Atomic Energy Agency

**Contents include: Six volumes of IAEA/UNESCO textbook series in isotope hydrology; Graphical solutions to selected equations in the textbooks; Geochemical modeling softwares: NETPATH, SOLMINEQ and transport models...**

**The official issuance of the product by the IAEA is expected late 2004. Write us to get a free beta version for testing (email: [ih@iaea.org](mailto:ih@iaea.org)).**



**IAEA**  
International Atomic Energy Agency

**Water and Environment News  
No. 18**

August 2004

The Water and Environment News is prepared twice a year by the Isotope Hydrology Section, Division of Physical and Chemical Sciences, Department of Nuclear Sciences and Applications.

International Atomic Energy Agency  
Wagramer Strasse 5, P.O. Box 100,  
A-1400 Wien, Austria

Printed by the IAEA in Austria,  
August 2004