IAEA
International Atomic Energy Agency

Water & Environment News

Newsletter of the Isotope Hydrology Section
Issue No. 20, March 2006

ISSN 1020-7120

http://www.iaea.org/water

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IAEA Water Resources Programme

Mr. Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy, Government of India , H.E. Mr. Gregory Schulte, Ambassador, US Mission to International Organizations in Vienna and Mr. Pradeep Aggarwal, Head, Isotope Hydrology Section and Manager , IAEA Water Resources Programme, in discussions at the IAEA General Conference Event on Water (Photo Credit: D. Calma/IAEA)

The IAEA Water Tasting Event Even Fools the Experts...

Three glasses of water from around the world - Libyan Arab Jamahiriya, Australia and Vienna - sat on a table waiting for the ultimate 'taste test'. They all looked identical. They all smelled alike. They all originated from local rain. The big difference was, some of it fell recently and some thousands of years ago.

So how did the water taste?

Wet. The taste between the 140 thousand year old water from Down Under and five year old tap water from Vienna was not discernable to the water connoisseurs present - or the dozens of water experts who tried and were fooled by Mother Nature at the IAEA General Conference Water Event. Admittedly perhaps the Australian water was a little saltier.

Mr. Werner Burkart, Deputy Director General and Head, Department of Nuclear Sciences and Applications, IAEA leads the water tasting (Photo Credit: D.Calma/IAEA)

Participants at the IAEA Water Event (Photo Credit: D.Calma/IAEA)

The IAEA General Conference Event on Water

On 26 September 2005, a Side Event on Water "Meeting Global Challenges: The IAEA's Role" was held in the frame of the IAEA's Annual General Conference. The event was held to highlight the launching of the UN Decade for Action "Water for Life" 2005–2015 and to draw attention to the IAEA's growing role in meeting important elements of the global water agenda.

During the meeting, high level government representatives from Ethiopia, India and the USA as well as representatives from the UN DESA and the 4th World Water Forum in Mexico joined IAEA senior managers in underlining key water challenges, specific country needs as well as the IAEA's programmatic responses.

Distinguished panel members attempting to 'taste' the age of water (Photo Credit: D.Calma/IAEA)

A water-tasting served to demonstrate the use of certain isotopic investigations to determine the age of water, information often needed by water resource managers.

Revealing Water's Mysteries Where Taste Buds Fail

The water-tasting held during the event demonstrated that taste buds won't tell you much about the age of water but elements of water known as isotopes can.

Knowing the age of water reveals how long it has been underground. The younger it is, the more communities can pump with the confidence that rainfall is replenishing their water supply.

It's an opposite story for the 140 thousand year water from the Great Artesian Basin in outback Australia, and the 25 thousand year old water from the Nubian Aquifer in Libyan Arab Jamahariya. These ancient waters are limited resources. By knowing the age of water, countries can better manage and optimally plan the use of these precious freshwater sources.

Understanding rates of recharge (how fast groundwater is replenished) water managers can assess how much groundwater can be utilized without depleting the resource. In the case of such old 'paleo' waters as in Libyan Arab Jamahariya, there is, under current climate conditions, little recharge.

Whatever is used represents a 'mining' of a relatively finite resource. Therefore, in the case of paleo water,

it's not a question of 'sustainably' using the water, but, rather, the issue of its optimal use. Thus, understanding the age of water and determining recharge rates is key information; information that scientists are working to gain through many IAEA-supported projects around the world.

If you look at the Middle East, everywhere you are using old water, says Pradeep Aggarwal, who manages the IAEA's Water Resources Programme (WRP). "It is rainfall from 10 000 maybe 100 000 years ago. So countries have to understand there's a limit to how long this will last."

The natural isotopes of the water molecule, hydrogen (namely deuterium) and oxygen (oxygen-18), as well as carbon isotopes are studied using techniques collectively known as isotope hydrology.

Cheap and reliable, they can help scientists determine how much water is available, how often it is replenished, where it comes from (and if it crosses national borders), as well as what is the threats of pollution.

That is vital information in a world, where more than a billion people lack access to safe drinking water, resulting in death of some 15 million children under the age of five each year.

The IAEA´s water experts are further advancing these investigative tools and extending them to scientists around the world. This is done through coordinated research programmes for adapting applications for different water resource issues as well as via technical cooperation projects with the IAEA Member States to both transfer technology as well as to build capacity for its use. Currently there are more than 85 projects run in over 50 countries.

IAEA Deputy Director General Mr. Werner Burkart points out that the lack of freshwater availability is not the only cause of looming water scarcity. "The global water crisis is also a crisis of governance," he says, as countries work with the IAEA to improve their management of precious groundwater sources. In his comments, Mr. Werner Burkart, referred to Mahatma Gandhi who aptly said many years ago, "There is enough water for human need, but not enough for human greed".

Mr. Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy, Government of India , addresing the gathering. (Photo Credit: D.Calma/IAEA)

Mr. Mulugeta Amha, Commissioner, Ethiopian Science and Technology Commission, testing the age of water (Photo Credit: D. Calma/IAEA)

Mr. K.M. Kulkarni, IAEA Water Resources Programme and Ms. Christina Vilaplana Milla, IAEA testing different water (Photo Credit: D.Calma/IAEA)

US Government Announces Enhanced Support to the IAEA Water Resources Programme

H.E. Mr.Gregory Schulte, Ambassador, US Mission to International Organizations in Vienna, announces increased US support to the IAEA Water Resources Programme (Photo Credit: D.Calma/IAEA)

H.E. Mr. Gregory Schulte, Ambassador, US Mission to International Organizations in Vienna, used the occasion of the Side Event on water during the IAEA General Conference to announce two important actions by the US to further strengthen the IAEA's efforts in water.

First, in recognition of the growing cooperation with the United States Geological Survey (USGS), Ambassador Schulte, informed the audience about a Memorandum of Understanding between the IAEA and the USGS that will serve to facilitate cooperation on applied research, within the IAEA technical cooperation projects as well as in other possible joint activities.

The Ambassador also announced a $160 000 extrabudgetary contribution to the IAEA's Water Resources Programme to be used to adapt recent US technology – the development of a portable laser instrument for in-field analysis – for use in developing countries under various field conditions.

This relatively inexpensive, low-skill and low-cost instrument, compared with a mass spectrometer, may be operated at a minimal operational cost by researchers and practitioners alike, and would overcome the present barrier of easy availability of isotope analysis.

The use of the laser isotope machine could result in a large number of isotope measurements worldwide, which would help to provide the necessary information to address some key hydrogeological challenges, such as the understanding and management of aquifer recharge, identifying groundwater flow parameters etc., a significant benefit to the IAEA Member States.

During his address, Mr. Anil Kakodkar, stressed the need of innovations in analytical techniques for stable isotopes in hydrological studies.

This Special Event on Water served to highlight the IAEA's commitment to enhance its efforts to assist Member States to manage their water resources as effectively and efficiently as possible.

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This is based on a recent IAEA web story on this topic http://www.iaea.org/NewsCenter/News/2005/water_exhibit.html

Editor's Note

To receive a free copy of Water & Environment News regularly, please write to:

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Contributions to the newsletter are welcome.

Groundwater Management in an Urban Aquifer

Isotopes contribute to improved groundwater management in the urban aquifer of Santiago City, Chile.

A study supported by the IAEA assessed the impact of urbanization in the Santiago, Chile aquifer (Photo Credit: S. Iriarte).

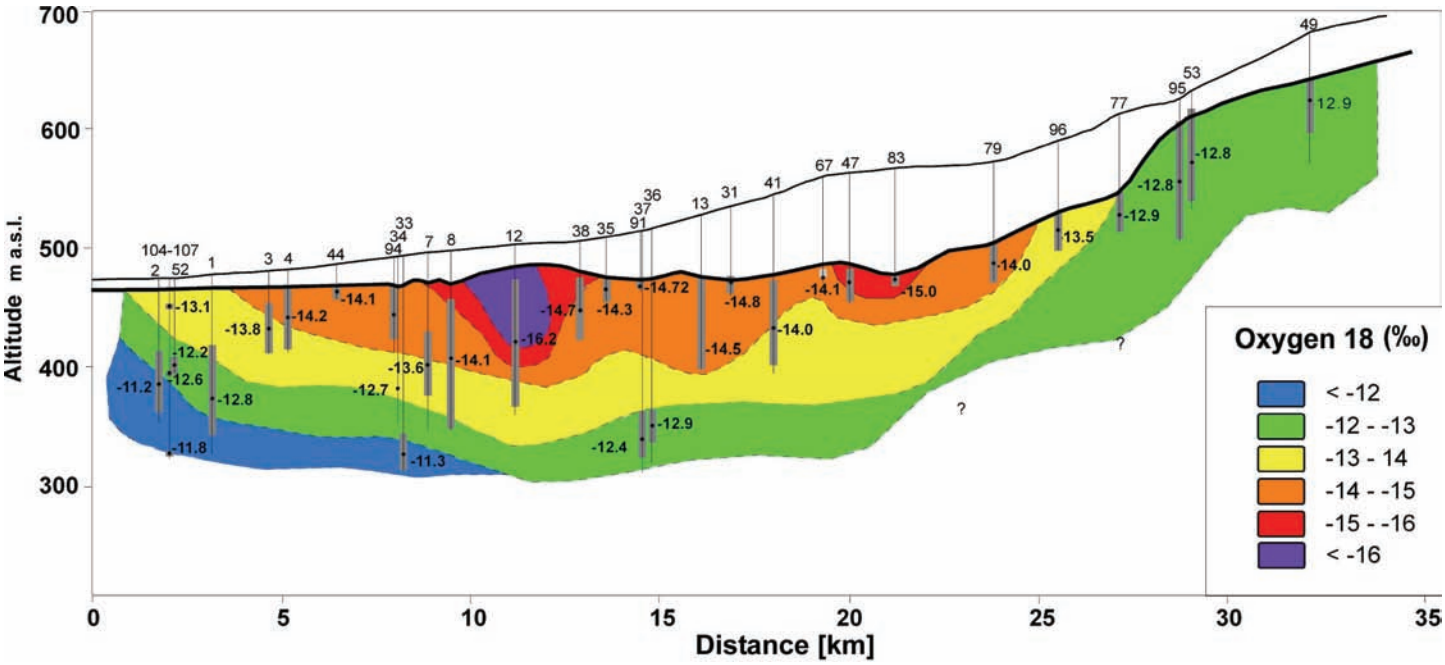
The exponential growth rate of Santiago, Chile during recent decades has been accompanied by a sharp increase in the demand for water, for domestic and industrial use. This trend, together with the recurrence of prolonged dry spells, has resulted in high groundwater extraction, especially in certain areas and periods of the year when surface water resources are unable to fulfill the growing water demand.

The intensive use of groundwater, the water transfer between hydrological basins, and the city's expansion to the recharge areas in the hills around Santiago have affected groundwater availability and quality, as well as recharge processes.

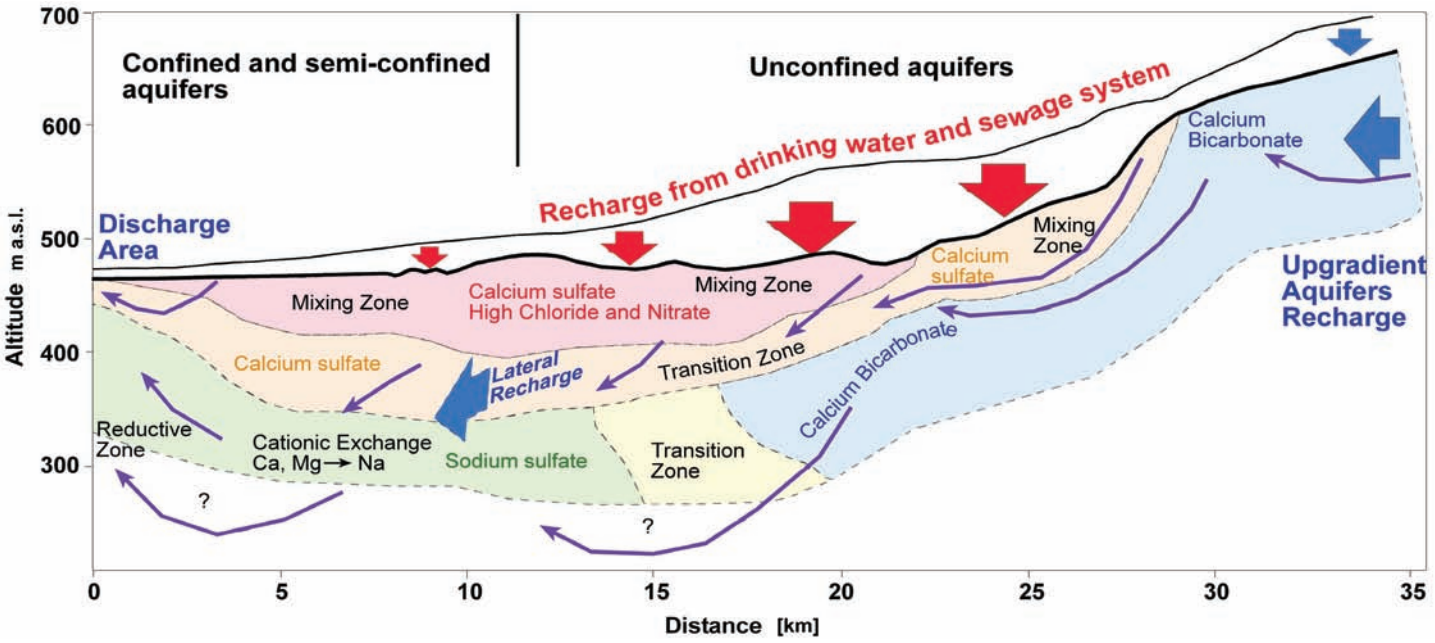
A recent study supported by the IAEA aimed to assess the changes in groundwater circulation, dynamics and quality as a result of the intensive use of urban aquifers.

Impact of urbanization on groundwater

An extensive set of tools, including hydrochemistry, isotopes (employing stable isotopes of water and the sulphate ion), radiocarbon dating, and other



Distribution of $\delta^{18}O$ values (in water) along the main flowpath in the Santiago City aquifer. Recharge derived from leakage of the water supply system is characterized by depleted oxygen-18 contents.



Conceptual model showing the flow patterns and the main water types present in the Santiago, Chile aquifer

groundwater tracers were used to identify and quantify the changes in the sources of recharge to the various geological units forming the Santiago aquifer.

The study showed that a significant fraction of the original recharge, derived from the infiltration of rainwater or river-bank filtration, has been replaced by the leakages from the water supply and/or sewage mains.

Most of the newly recharged waters derive from surface waters transferred from another basin, having more depleted oxygen isotope contents compared with local water.

Recent recharge derived from leakages from the mains is of poorer quality than the original groundwaters.

The study has provided, for the first time, a clear picture of the origins, volumes, differences in quality and fluxes of the different types of groundwater present in the aquifer.

The interaction between surface waters and shallow aquifers has also been assessed by means of hydrochemistry and isotopes.

Managing groundwater resources in Santiago – the future

The unique information provided by isotopes and other tools has been synthesized into a consistent conceptual hydrological model, explaining the recent evolution observed in the aquifer system.

This understanding is being used to develop vulnerability maps and specific recommendations to local water authorities.

The project has also fostered closer collaboration between the institutions responsible for groundwater management and water supply of Santiago, Chile.

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Isotopes for Assessment of Pollutant Behaviour in the Unsaturated Zone

A Coordinated Research Project (CRP) has demonstrated the use of isotopic methodologies for understanding the migration of potential contaminants through the unsaturated zone (UNZ) into the underlying groundwater.

For proper management of groundwater resources, it is important to know the location and rate of recharge as well as source and pathways of contaminants. Recharge or contamination of aquifers usually occurs through the unsaturated zone (UNZ). A Coordinated Research Project (CRP) was conducted from 2001–2005 by the IAEA with the purpose of studying what isotopic information is required to help understand migration of potential contaminants through the UNZ into the underlying groundwater. The ten projects in this CRP covered a wide range of approaches and sites typically encountered in unsaturated zone research. A demonstration site was set up at an agricultural experimental farm near New Delhi, India with proper instrumentation to conduct controlled studies in the UNZ. The studies included measuring movement of water, solutes, and gasses through the UNZ using an assortment of tracers and approaches.

One project was in a karst terrain in Slovenia, where transport can be relatively rapid through channels/large fractures. At the same site, slower movement occurs through small fractures where chemicals can be retained in the UNZ for some years after they have been introduced. The site in Germany had relatively rapid movement through the UNZ and investigations showed the differences in contributions between overland flow, subsurface flow and groundwater input in total runoff. The Austrian site was at a research station in an intensive agricultural area. The project made use of isotopic data from lysimeters and soil cores to elucidate microbial processes in the UNZ. The contribution from the United Kingdom investigated UNZ processes in the Chalk aquifer system, beneath an extensive impermeable drift cover. Determination of nitrogen species combined with groundwater age indicators and data from gas samplers were used to develop a conceptual regional model of contaminant transport for the study site. The project in Pakistan studied an area where extensive industrial pollution occurred. Gas samples and soil cores were used to study the movement and reactions of pollutants in the UNZ. The site in India, which was selected for extensive study, was in an agricultural research site where agro-chemical use has occurred. Radiotracers were applied to the surface and their movement through the UNZ was monitored by analysis of soil cores and in-situ measurements. The project in China, which was located near Shijiazhuang City, was in an area which has suffered extensive degradation of its groundwater quality due to leaching of nitrate and other contaminants through the UNZ. The site was investigated using tritium and stable isotopes from soil cores and groundwater. The project in the United States of America collected data from sites in arid and semi-arid climates with deep (~100–200m) UNZ. One of the locations, the High Plains Aquifer, is a region where irrigation has increased movement of pollutants through the UNZ. The Syrian study, in the region of the Damascus Oasis, investigated migration of heavy metals into the UNZ. Nitrogen isotopes were also used to determine the source of increasing nitrate concentrations in groundwater. The South African study looked at cases of extreme nitrate pollution in agricultural areas due to intense rainfall events. Particular emphasis was placed on pollution caused by livestock mismanagement.

The UNZ was found to be effective in protecting groundwater from most heavy metal contaminants. Other contaminants like nitrate and chloride generally move conservatively through the UNZ. Very limited information was collected on interactions at the Saturated/Unsaturated Interface Region (SUIR), but it appears that there may be some mitigation of contaminants in this zone. There was also evidence presented that, with proper conditions, reactions involving both nitrate and ammonia can occur in the UNZ above the SUIR. When determining sources of nitrate in the UNZ, isotopes are crucial in identifying the difference between natural and anthropogenic loads. An IAEA technical document (TECDOC) containing contributions from the participants will be released in 2006.

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News in Brief

Section Staff Members Receive Awards and/or Recognition

Pradeep Aggarwal, Head Isotope Hydrology Section and Manager, Water Resources Programme and Ahmad Tanweer, Isotope Hydrology Laboratory received the Department of Nuclear Sciences and Applications award for the Best Original Research Article in 2004 for the article 'Isotope fractionation at the soil-atmosphere interface and the oxygen- 18 budget of atmosphere oxygen.' which appeared in the Geophysical Research Letters.

Manfred Groening, Head, Isotope Hydrology Laboratory, has been elected an Associate Member of the IUPAC Commission of Isotopic Abundances and Atomic Weights for the period 2006–2007.

Departing Staff Members

Mr. Cheikh Gaye left the Isotope Hydrology Section in January 2006 to return to his position at the Universite C.A. Diop in Dakar, Senegal.

Meetings

At the Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF) Advisory Meeting on Managing Aquifer Recharge, held in New Delhi, India 19–22 September 2005, Pradeep Aggarwal, from the WRP, participated as a technical expert in this meeting that explored technical challenges and responses for supporting MAR activities.

The 3rd Coordination Meeting for the IAEA Technical Cooperation Project (RAF/8/035) on 'The Use of Environmental Isotopes for Evaluation of Water Resources of the Northwestern Sahara Aquifer System (NWSAS)' was held from 5–9 December 2005, in Vienna, Austria. The purpose of the meeting was to assess progress and then to plan activities for 2006. This project has the objective to improve the technical understanding of the NWSAS and in particular to improve the aquifer model, a fundamental tool for appropriate aquifer management. The IAEA project is closely linked with the OSS/UNEP/GEF Northwestern Sahara Aquifer Programme.

The third and final research coordination meeting of the Coordinated Research Project on 'Nuclear and Isotopic Techniques for the Characterization of Submarine Groundwater Discharge (SGD) in Coastal Zones' was held from 13–16 December 2005. Numerous scientific papers have been generated from this successful initiative and the final results will be available in 2006 the form of an IAEA technical document (TECDOC).

The 2nd Coordination Meeting for the IAEA Technical Cooperation (TC) Project (RAF8/0/36) 'Sustainable Development of the Nubian Aquifer' was held from 18–19 December in order to: i.) review the progress to date and ii.) discuss next steps for the IAEA technical inputs concerning the use of isotope techniques on sampling and in the frame of both national and regional workplans for 2006. A pre-inception meeting was held from 20–21 December to inform participating countries about the progress to date in preparing the IAEA/UNDP/GEF Nubian Aquifer project which is scheduled to begin in June 2006. The IAEA TC project RAF/8/036 will be a component of the new larger initiative.

IAEA/ UNESCO Cooperation

The 2nd National Symposium of Isotope Techniques in Hydrology, was held in Gumuldur, Izmir,Turkey from 26–30 September in part, supported via the IAEA/UNESCO joint cooperation (the JIIHP programme). The meeting included topics such as isotopic composition of rainfall, surface waters, geothermal systems, surface water-groundwater interactions and groundwater dating. The meeting highlighted the excellent cooperation within Turkey amongst the isotope hydrology fraternity comprising local and regional government organisation and universities.

The IAEA WRP, participated in the 2nd Global Coordination Meeting of G-WADI- the Global Water and Development Information Network for Arid Lands, held at UNESCO, Paris 10–12 November

2005. The IAEA is partner in this initiative that is working to strengthen the global capacity to manage water resources in arid and semi-arid areas. Its primary aim is to build an effective global community through the integration of selected existing materials from networks, centres, organizations and individuals who become members of G-WADI. The meeting developed a new work programme for 2006–2007.

Regional Training Course

A training course on Isotopes and Geochemical Modelling in Groundwater Contamination was organized in Mumbai, 3 to 14 October 2005. The course was a part of activities under the regional project (RAS/8/097), 21 participants from 13 countries attended the course.

New Developments

A new continuous flow mass spectrometer has been installed at the Isotope Hydrology Laboratory, with the intent of extending the Lab's analytical capabilities to the analysis of micro amounts of water for both oxygen and hydrogen, for example for air moisture analyses.

The Water Resources Programme is developing an Isotope Hydrology Atlas containing thematic maps, plots and basic statistical treatment of isotope and hydrochemical data compiled under previous and on-going IAEA Technical Cooperation (TC) Projects in the African Member States. The publication is based on the information stored in ISOHIS (Isotope Hydrology Information System), which contains the all the GNIP records as well as a large isotope database compiled from more than 100 TC projects in Africa during the past decades. The publication is scheduled towards the end of 2006. A second volume reporting the isotope data in Latin America will follow.

Announcement

IAEA Water Resources Programme

UNESCO-IHE Institute for Water Education

Opportunities for Advanced Studies in Isotope Hydrology through an IAEA/UNESCO Joint Programme

The IAEA and UNESCO, as part of their Joint International Isotopes in Hydrology Programme (JIIHP), have initiated a Masters Programme in Isotope Hydrology with the UNESCO IHE Institute for Water Education in Delft, Netherlands.

A limited number of fellowships will be awarded to qualified applicants from developing countries to work towards a Masters degree with a thesis on specific national water resource management issues.

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The Moldovan Artesian Basin (MAB)

Isotopes will be used in the hydrological investigation of the Moldovan Artesian Basin in order to contribute to the sustainable management of the water resource.

Typical large diameter well used for domestic water supply in the Republic of Moldova. (Photo Credit: Alan Welch)

Moldovan groundwaters

Groundwater is crucial in the Republic of Moldova for domestic water supply, agriculture, irrigation and industry. The largest and most important water resource is the Moldova Artesian Basin (MAB) covering most of the central part of the country. This aquifer is in a sedimentary basin and is recharged mainly from the eastern, and partly in the central and western areas.

Moldovan water authorities are creating a development plan for the future of national groundwater resources in general, and for the MAB in particular. The first phase (2005–2006) in this process will be in the southern and eastern territory of Moldova.

An IAEA Technical Cooperation (TC) Project (MOL/8/003) will use isotope techniques to characterize the water resource, identify the different end-members in the system, recharge and discharge zones as well as protection zones.

A synthesis of the collected groundwater data will provide valuable information for understanding the resource, and this work will eventually contribute to the establishment of a management strategy for the MAB.

The project is being implemented by the IAEA in collaboration with the Moldavian Hydrogeology Expedition: the Institute of Geophysics and Geology of the National Academy of Science will also be involved in the project.

Hydrogeology

The MAB groundwater is located in the Neogene sedimentary sequences which mainly comprise clay, sand and carbonaceous rocks. A carbonaceous coral reef deposit lies in the middle of the sediments, in a NNE–SSW direction.

East of the reef, clay and sandy layers dominate, mixed with carbonaceous rocks. On the western side of the reef, clay dominates the sediments. The sedimentary sequence increases in depth to the south and west.

The groundwater body on the eastern side of the reef contains excellent drinking water and is thought to be recharged mainly by water from the River Nistra on the border of Ukraine to the East.

However, the water in the western part is heavily contaminated by nitrate and fluorite. The nitrate probably stems from uncontrolled use of agriculture fertilizers in the past. The fluorine, on the other hand, is considered to be a natural phenomenon.

Previous studies, from the 1970s, suggested that there is little or no interaction between the groundwater in the western part and the River Prut, which is on the border to Romania in the West. This area receives

most of the rainfall (300–400 mm/y) and the landscape is characterized by large landslides. These cover almost 20% of the nation and are concentrated in hilly areas. They are related to disturbances between the sandy and silty layers of the Neogene sediments from the old Tethys Sea. These areas are very important from the agricultural point of view, with fruit orchards and vineyards being especially important.

Republic of Moldova's Water Programme

Most of the domestic water supply comes from large diameter wells, which are found all over the country. Such wells do not always provide best quality water; moreover, they are vulnerable to contamination.

Moldova's water programme therefore aims to exploit the deeper parts of the MAB. The main challenges will be to characterize the aquifer system to enable sustainable use of the groundwater, and to identify reserves and protection zones.

Environmental isotopes will be very useful tools in delineating the recharge zones and identifying protection zones.

The IAEA assistance will be an important contribution for the future development and management of the MAB. Besides analytical services, the capacity building programme comprises training in isotope hydrology and laboratory equipment.

A liquid scintillation counter was recently installed for tritium measurements and a field sampling training course was organized by the IAEA and hosted at the Moldavian Hydrogeology Expedition in Chisinau.

Sampling of river water, groundwater and rainwater was initiated during 2005. The groundwater has been sampled from four major sites (see map) for isotope analyses.

Specific tasks of the project are:

• Characterize the MAB isotopically and identify the end-members in the system.

Sampling sites for the groundwater investigation

• Determine the interactions between the River Nistra and the MAB.

• Delineate the major recharge and discharge zones.

• Identify protection zones.

Preliminary results obtained to date from the isotope analyses confirm that the groundwater in the eastern part of the MAB is recharged from the River Nistra, whereas the water in the western part of the aquifer, which is slightly isotopically different, is most likely recharged by local rain.

Further investigations are in progress.

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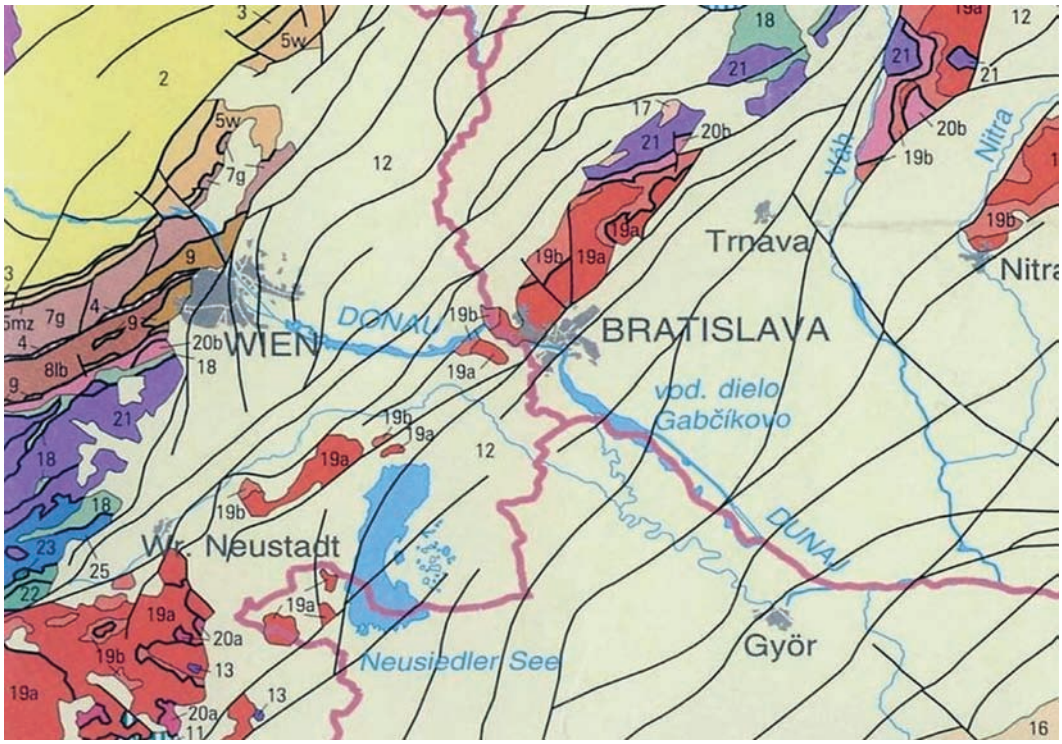
The Use of Isotopes in the Danube Aquifer: Austrian, Slovak and Hungarian Transboundary Collaboration



Geological map of the target region of "Porta Hungarica". (Credit: Geological Survey of Slovak Republic, Bratislava)

A new IAEA initiative is to consider the application of isotopes in the management of shallow aquifers along the Upper and Middle Danube between Vienna, Bratislava, Gyor and Sopron (region of Porta Hungarica).

This is a region of a very diverse mixture of groundwater bodies and crucial importance for local and regional groundwater supplies.

Although data sources for this activity are numerous, due to social and political differences in the past they are mostly only to be found in national studies.

Six specialists from water research and management institutions in the Danube region participated at a meeting held in Vienna 24–25 October 2005 and outlined the contents of a guidebook that will compile and map isotopic (stable water isotopes and tritium) and geochemical data from surface water and shallow groundwater the target area.

It will usefully complement the existing set of transboundary hydrogeological maps DANREG (Danube Region Environmental Geology Programme), prepared by the National Geological Services of Austria, Hungary and Slovakia. In addition, it will help regional water research and management communities to answer questions such as:

- Where is the interface between groundwater derived from Danube infiltration and local recharge?

- Where do groundwater streamlines cross national boundaries? and

- Where do water quality problems result from transboundary groundwater movement?

This initiative is expected to be a valuable pilot study for the assessment of other transboundary shallow aquifers.

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Keeping International Water References Alive

The primary water reference materials used for calibration in all isotope hydrology laboratories worldwide are being replaced by newly produced successors.

The two primary reference materials used for calibration of δ^2H and $\delta^{18}O$ measurements worldwide are VSMOW (Vienna Standard Mean Ocean Water) and SLAP (Standard Light Antarctic Precipitation) kept both at the IAEA and at the National Institute of Standards and Technology (NIST) in the USA.

Both water reference materials were prepared nearly 40 years ago in quantities of about 70 litres each.

Despite all efforts to preserve these materials as long as possible, the remaining stock is nearly exhausted and supply will finish in less than one year.

In an international effort involving several reputable laboratories and scientists, a replacement for VSMOW was prepared at the IAEA from carefully calibrated natural raw waters in a quantity of about 300 litres.

Tests on this material performed by three laboratories indicate an excellent matching between its isotopic composition and that of VSMOW. Residual offsets amount only to much less than 0.01 ‰ for $\delta^{18}O$ and to about 0.1 ‰ for δ^2H.

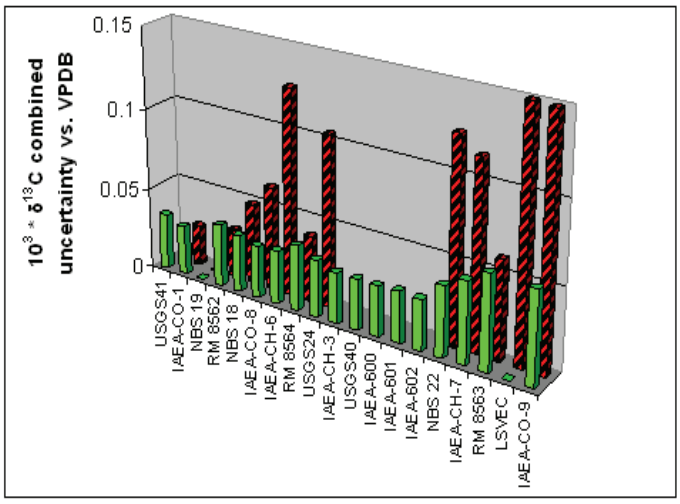
The final bottling of this new material in flame sealed glass ampoules has been started and will be followed in spring 2006 by a rigorous evaluation of its isotopic composition versus VSMOW by a few carefully selected laboratories. The second step is the preparation of a successor material for SLAP, which is ongoing.

Consistency of $\delta^{13}C$ data for carbon reference materials considerably improved

A re-calibration of the existing 13 carbon stable isotope reference materials was carried out in 2004 with the participation of four experienced laboratories (USGS, Reston – USA; MPI-BGC, Jena – Germany; UFZ, Leipzig – Germany; CIO, Groningen – Netherlands). At the same time, 6 new materials were calibrated for the first time for $\delta^{13}C$ to make them available for international use.

The data evaluation revealed an unprecedented accordance of raw data from different laboratories for the 19 different reference materials included in this study.

Normalization of those $\delta^{13}C$ data by assigning a fixed $\delta^{13}C$ value to a second reference material further improved the data consistency (see figure below).



Graphical display of combined uncertainties of recommended $\delta^{13}C$ values for existing carbon reference materials as achieved during the calibration exercise (green columns in front) versus the former uncertainties (red striped columns in back). Considerable improvement is indicated by much smaller uncertainties.
Note: For NBS19 and LSVEC uncertainties are zero per definition/convention of the VPDB scale.

LSVEC lithium carbonate was therefore assigned an $\delta^{13}C$ value of –46.60‰ exactly and the following recommendation adopted by the IAEA group of experts:

It is recommended that $\delta^{13}C$ values of all carbon-bearing materials be expressed C values within analytical uncertainty for the same sample (see table on page 14).

Name	Description	$\delta^{13}C \times 10^3$ VPDB
USGS41	L-glutamic acid	+37.63
IAEA-CO-1	calcium carbonate	+2.49
NBS 19	calcium carbonate	+1.95
RM 8562	carbon dioxide	-3.72
NBS 18	calcium carbonate	-5.01
IAEA-CO-8	calcium carbonate	-5.76
IAEA-CH-6	sucrose	-10.45
RM 8564	carbon dioxide	-10.45
USGS24	graphite	-16.05
IAEA-CH-3	cellulose	-24.72
USGS40	L-glutamic acid	-26.39
IAEA-600	caffeine	-27.77
IAEA-601	benzoic acid	-28.81
IAEA-602 *	benzoic acid	-28.85
NBS 22	oil	-30.03
IAEA-CH-7	polyethylene	-32.15
RM 8563	carbon dioxide	-41.59
LSVEC	lithium carbonate	-46.60
IAEA-CO-9	barium carbonate	-47.32

Table 1. Recommended $\delta^{13}C$ Values of carbon references materials
** IAEA-602 is listed here for information purposes only. It is not recommended for routine carbon isotopic calibration because it is enriched in ^{17}O and ^{18}O and its ^{17}O /^{18}O ratio no longer reflects that of natural terrestrial materials.*

Tritium Interlaboratory Comparison 2004–2005 (TRIC2004)

The 7th IAEA tritium interlaboratory comparison exercise, TRIC2004, was carried out in 2004–2005. Recently the final results were evaluated. The response rate of the laboratories was the highest ever: 69 out of 74 laboratories.

This confirms the usefulness of the new approach to request the interested laboratories to submit all relevant information before getting the samples shipped.

The evaluation report will be submitted to the participating laboratories in electronic format and later on be made available on the Water Resources Programme's website.

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Consultants Meeting: Isotope Techniques for Understanding the Water Quality Impacts of Wetlands

Wetlands are a key link between land and water ecosystems. Apart from being of aesthetic value, they provide a number of environmental services, such as wildlife habitats, flood protection for lowland areas, and natural filters to retard and remove nutrients in agricultural landscapes.

Clearly hydrological processes are a key factor in wetland maintenance. However, it is not well understood how anthropogenic changes to hydrological balances affect water quality within (and to) water bodies around wetlands.

Wetlands are especially vulnerable to anthropogenic alteration of the water cycle because they are either at the top of the groundwater table, or at the receiving end of surface water catchments.

In collaboration with the IAEA staff, a team of consultants during a meeting held in Vienna 17–20 October 2005, defined the scope and nature of project areas that will form the basis of a coordinated research project (CRP) scheduled to start in 2006 on "Isotope techniques for understanding the water quality impacts of wetlands".

Isotope hydrology provides a unique toolkit that can examine both the water balance and the impacts on solute and nutrient fluxes and transformations. In particular, the special role that isotopes play in integrating spatial and temporal variability will be addressed.

The CRP, which will begin in 2006 will also focus on less studied wetlands in tropical and sub-tropical regions.

For further information, please contact:
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Consultants Meeting: Development of Guidelines for the Use of Compound Specific Isotope Analysis (CSIA) in Assessing Bioremediation

Contamination of groundwater due to industrial pollution is an immense problem throughout the world. Knowledge of the fate of contaminants, and their rates of movement, is required to provide sound and defensible management decisions on remediation strategies.

Natural or augmented bioremediation of contaminants can reduce cleanup costs enormously if the rate at which contaminant is being degraded can be reliably determined. Recent advances in the integration of gas chromatography and mass spectrometry into analytical approaches has allowed rapid and relatively easy measurement of the isotopic composition of specific compounds, allowing just such an analysis to be made.

The isotopic composition of carbon (^{13}C) in many organic compounds changes in a systematic way with increasing biodegradation. Therefore if one can measure both the so-called free product (initial contaminant) and the residual of that contaminant sampled from boreholes, then the fraction of contaminant degraded can be estimated.

If we also know something about groundwater flow rates, or know the time fame when a spill occurred, we can estimate the rate of biodegradation.

A consultants meeting - "Development of guidelines for the use of compound specific isotope analysis (CSIA) in assessing bioremediation" was convened at the IAEA, 27–28 October 2005 to provide specific and precise guidelines and protocols for applying these techniques in many common situations (e.g., gasoline spills, light and heavy insoluble organic liquids, etc).

The guidelines will focus on four main:

- Ensuring data quality and reliability
- Protocols for conducting field studies
- Interpretation of data, including case studies, and
- Application of the tools to differentiate sources.

The guidelines – in the form of a manual - will help to provide non-specialists with information on how to best to apply the techniques and how to judge whether the data are meaningful to their specific problem.

The guidelines are expected to be released in the second half of 2006.

For further information, please contact:
a.herczeg@iaea.org

A New Communication Approach for the IAEA Water Resources Programme

In 2005, great effort was devoted to developing a comprehensive communications approach for the IAEA Water Resources Programme. While the Programme's growth and significant achievements are increasingly recognized, it was realized that a consistent, structured approach was needed to effectively reach key target audiences; IAEA Member States and in particular their water resource professionals, need to know about the WRP as well as about the science and technology– isotope hydrology– that the WRP promotes. A 'sub-brand' was developed for the WRP that fits within the IAEA's visual identity. A new folder and a brochure were produced as well as the first of what will become a continuous series of 4 page 'Fact Sheets' on activities, projects, applications etc. This WRP newsletter was revised to fit within the approach. In 2006 efforts will be devoted to enhancing the WRP's web page.

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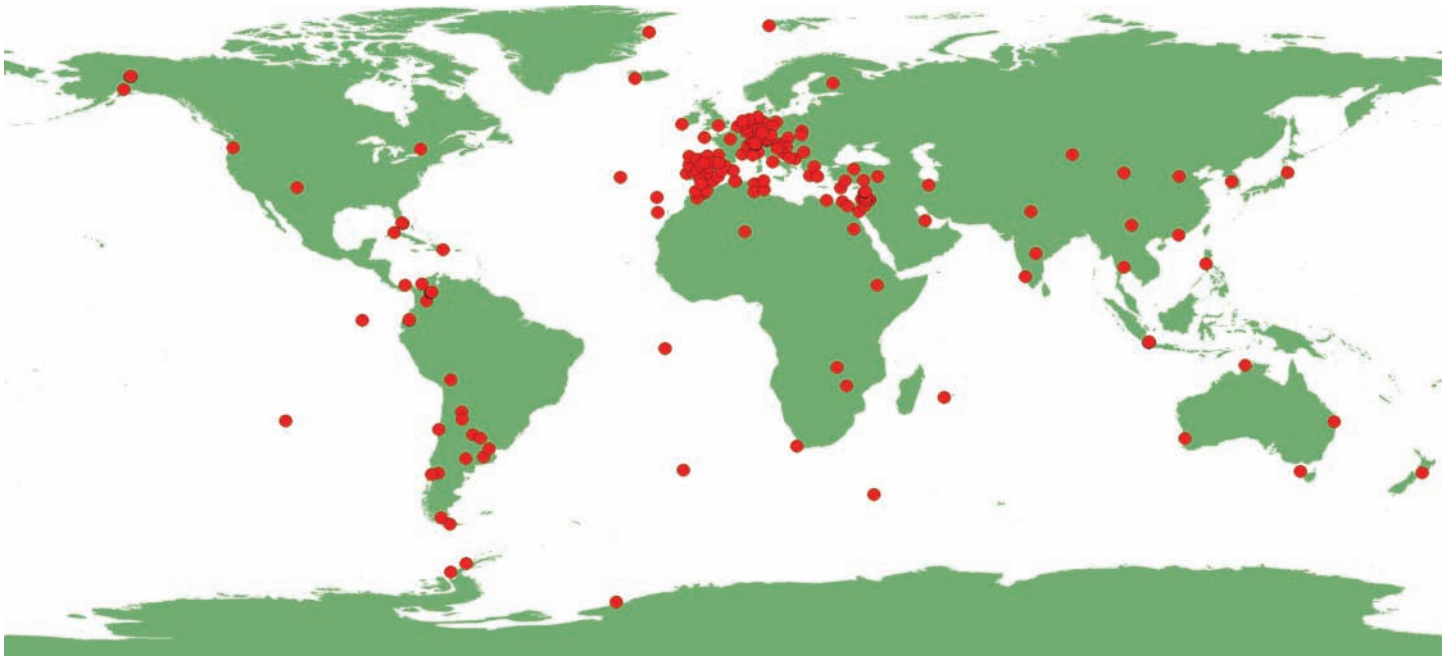
a.garner@iaea.org or k.m.kulkarni@iaea.org

GNIP Update – New Inputs and Initiatives

Increasing effort is being made to enhance the joint IAEA / WMO Global Network of Isotopes in Precipitation (GNIP) due to growing demand by scientist in various fields.



There is a high and increasing demand for good quality data on isotopes in the water cycle. These data are of high value to professionals working in the fields of water resources management, climate change and ecology.

In response to this demand the Water Resources Programme of the IAEA organised two technical meetings in Vienna during November 2005 to consolidate and strengthen isotope monitoring initiatives.

The value of these monitoring activities has been internationally recognised, and the GNIP programme has been included as one of the main parameters under the Global Terrestrial Network – Hydrology (GTN-H), sponsored by WMO and a number of international Organizations.

A Consultant's Meeting on the establishment of national networks for monitoring isotope contents in precipitation took place from 7–9 November 2005.

It was designed to support the reactivation or establishment of networks, mainly in areas poorly covered by GNIP stations in terms of spatial coverage, length of record and/or value for hydrological, climatological or ecological studies.

As a result of this meeting, some isotope data not previously submitted to the IAEA will be compiled and included in the global database. Additionally, new stations in 9 countries will be included or will be reactivated in the near future.

The fourth meeting of the Scientific Steering Committee of GNIP was held on 10–11 November 2005. Scientists representing different communities contributing to or using isotope data reviewed the Programme's operations and analyzed the challenges faced in ensuring that it serves the needs of a growing number of scientific disciplines using GNIP data.

As a result of the meetings, overall value of the isotope data sets collected by the Water Resources Programme is expected to improve.

Water and climate change professionals and institutions interested in participating in the GNIP network can contact Mr. Luis Araguas for further details.

For further information, please contact:
l.araguas@iaea.org

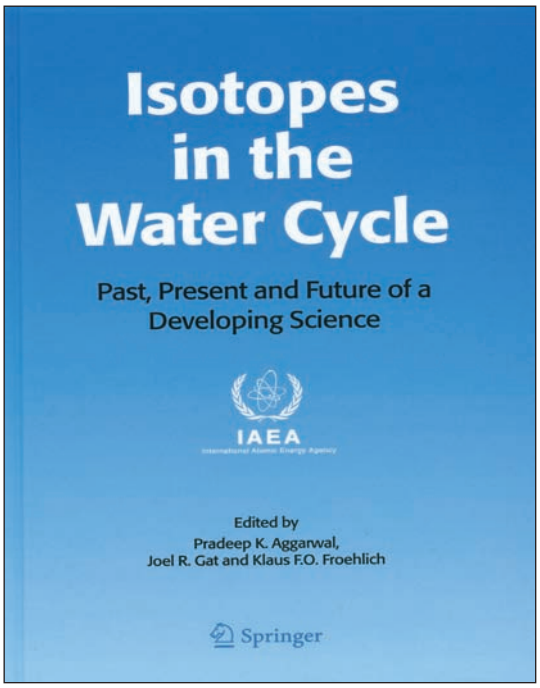
Meetings held in 2005

- Consultants Meeting to review drafted version and final editing to the French version of the UNESCO / IAEA books on Isotope Hydrology, Vienna, 14–17 June 2005.
- Consultants Meeting to finalize the list of invited speakers and programme of a workshop on evaporation processes to be held in 2006, Vienna, 17–18 October 2005.
- Consultants meeting on Isotope techniques for understanding the water quality impacts of wetlands, Vienna, 17–20 October 2005.
- Consultants Meeting on the use of isotopes in the assessment of river aquifer interactions: A case study of the tri-country Austrian-Slovak-Hungarian part of the Danube basin, Vienna, 24–25 October 2005.
- Consultants Meeting on the review of operational aspects of the IAEA - WMO Global Network of Isotopes in Precipitation, Vienna, 7–9 November 2005.
- Consultants Meeting on the Establishment of National Networks for monitoring Isotope contents in precipitation, 7–9 November 2005.
- Consultants Meeting of the Scientific Steering Committee of GNIP (Fourth Meeting), Vienna, 10–11 November 2005.
- Consulation Meeting with representatives of the Organization of America States (OAS) on enhancing cooperation on water activities in Latin America, Vienna, 15–16 November 2005.
- Project Coordination Meeting of the IAEA Guarani Aquifer project (RLA/8/036) with the OAS/World Bank/GEF Guarani Aquifer project staff, Vienna, 16–18 November 2005.
- Research Coordination Meeting on application of isotopes to the assessment of pollutant behaviour in the unsaturated zone for groundwater protection, Vienna, 21–25 November 2005.
- Research Coordination Meeting on the design criteria for a network to monitor isotope compositions of runoff in large rivers, Vienna, 28 November–2 December 2005.
- Project Coordination Meeting of the IAEA Northwest Sahara Aquifer project (RAF/8/035), Vienna, 5–9 December 2005.
- Research Coordination Meeting to develop nuclear and isotopic techniques for characterization of SGD, Vienna, 13–16 December 2005.

Meetings Planned for 2006

- Research Coordination Meeting on Isotopic age and composition of streamflow as indicators of groundwater sustainability, Vienna, 8–12 May 2006
- Coordination Meeting on Nubian Sandstone Aquifer System (NSAS) Technical Baseline Meeting (IAEA project RAF /8/036), Vienna, 8–12 May 2006
- Technical meeting on World-wide Hydrological Mapping and Assessment Programme (WHYMAP), meeting held jointly with UNESCO, Vienna, 22–24 May 2006
- Consultants Meeting on trends in water resources: Developing tools for application of isotopes for management of water resources for the next century, Vienna
- Consultants Meeting on the Development of a $^{3}H/^{3}He$ Guidebook, Vienna
- Research Coordination Meeting on isotope techniques for understanding the water quality impacts of wetlands, Vienna
- Consultants Meeting on Danube pilot study, Vienna
- Research Coordination Meeting on isotope methods for study of water and carbon cycle dynamics in the atmosphere and biosphere, Vienna
- Research Coordination Meeting on Geostatistical analysis of spatial isotope variablity to map the sources of water for hydrology and climate studies, Vienna
- Research Coordination Meeting on Optimization of irrigation water use efficiency by using isotope techniques, Vienna
- Technical Meeting of laboratory managers active in external analysis network (Isotope Hydrology Analysis Network, IHAN), Vienna
- Consultants Meeting on data evaluation for oxygen reference material calibration, Vienna

Recent Publications



Isotopes in the Water Cycle

Past, Present and Future of a Developing Science - Aggarwal, Pradeep K., Gat, Joel R., Froehlich, Klaus F.O. (Eds.) 2005, XV, 381 p., Hardcover ISBN: 1-4020-3010X

About this book

Environmental isotope and nuclear techniques provide unmatched insights into the processes governing the water cycle and its variability under past and present climates.

This monograph is recommended to advanced students and specialists and presents historical perspective, state-of-the-art applications and new developments of isotopes in hydrology, environmental disciplines and climate change studies.

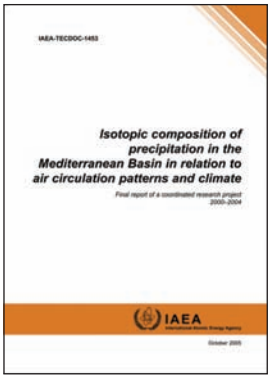
The spectrum of isotope applications addressed in this monograph ranges from the assessment of groundwater resources in terms of recharge and flow regime, identification of palaeogroundwater, water balance of river basins and lakes, to studies of the past and present global environmental and climate changes.

The contributions are written by renowned specialists in the various application fields.

Written for :

Advanced students and specialists dealing with the integration of environmental isotope techniques in hydrological cycle and related environmental studies including past and present climate change and water resources assessment and management.

For further information, please contact :
o.azucena@iaea.org



Isotopic Composition of Precipitation in the Mediterranean Basin in Relation to Air Circulation Patterns and Climate

IAEA TECDOC Series No. 1453

This publication compiles the results obtained under an IAEA Coordinated Research Programme undertaken from 2000 to 2004.
The isotopic composition of precipitation is closely connected to the rain formation conditions such as temperature and the origin of the air masses.
Stable isotopes are, therefore, powerful tools for investigating precipitation and formation conditions and changes in the composition can be correlated to observed climatic changes.
The material in this book represents a collaborative effort to integrate isotopes into climate studies at regional and national levels.
Hydrologists, hydrogeologists and meteorologists investigating precipitation stable isotopes and simulating the hydrologic cycle in climate models will find this book an important resource.

IAEA-TECDOC-1453, 2005, ISBN 92-0-105305-3, 222 pages, English. 15.00 Euro. Date of Issue: 18 November 2005.

The book is available for free download at:
http://www-pub.iaea.org/MTCD/publications/PDF/te_1453_web.pdf
Hard copies can be ordered from: sales.publications@iaea.org

International Symposium on Advances in Isotope Hydrology and its role in Sustainable Water Resources Management

21–25 May 2007, Vienna, Austria

The quadrennial IAEA Symposia provide an international forum for a comprehensive review of the state-of-the-art and recent advances in isotope hydrology as well as a basis for identifying further research and development needs. This will be the 12th symposium in the series on the first one in the UN Decade for Action "Water for Life" 2005–2015.

Adoption of nuclear techniques, facilitated by the IAEA, is increasingly enhancing availability and effective use of isotopes to address water resources management. The 2007 Symposium will address the major themes by featuring keynote speakers on topics followed by plenary discussions. The majority of contributed papers will be in the form of poster presentation. It is envisaged that all contributions will be published as 4-page papers in a proceedings.

The Symposium will cover a multi-disciplinary spectrum of research and applications of isotope techniques. Isotope specialists, hydrologists, hydrogeologists, geochemists, environmental scientists and water managers are expected to participate.

The following themes will be covered:

- Analytical Developments and Research Frontiers
- Moisture Isotopes in the Biosphere and Atmosphere (MIBA)
- Rivers and surface water
- Development of deep groundwater resources
- Isotope hydrology and ecosystems
- Urbanisation and water resource management
- Water management in dryland agriculture and irrigation systems
- Integration with economic, social, cultural aspects

It is expected that the Symposium will stimulate the international exchange of information and ideas that will contribute to greater accessibility and enhanced use of isotope techniques in local, regional and global water resources investigations.

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IAEA International Atomic Energy Agency

Water and Environment News No. 20 March 2006

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

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Wagramer Strasse 5, P.O. Box 100,
A-1400 Wien, Austria

Printed by the IAEA in Austria,
March 2006

06-08471