

**GC**GC(43)/21
31 August 1999

International Atomic Energy Agency

GENERAL CONFERENCEGENERAL Distr.
Original: ENGLISHForty-third regular session
Item 17 of the provisional agenda**EXTENSIVE USE OF ISOTOPE HYDROLOGY FOR WATER
RESOURCES MANAGEMENT****Report by the Director General****I. Introduction**

1. Resolution GC(41)/RES/15 "requests the Director General to report on achievements in implementing this resolution to the Board of Governors and to the General Conference at its forty-third session under an appropriate agenda item". The present document includes the actions taken by the Secretariat with regard to a more extensive use of isotope hydrology in water resources management and achievements of the Secretariat from 1997-1999.

II. Activities undertaken 1997-1999 towards fuller utilisation of isotope techniques for water resources development and management

2. The 1997 General Conference requested the Secretariat "to continue to make efforts directed towards fuller utilisation of isotope techniques for water resources development and management in developing countries, including measures to control groundwater and surface water pollution". Strategies for a more extensive use of isotopes in the water sector were developed in a series of Advisory Group Meetings (AGMs). These meetings, focusing on the African, Latin American, Middle Eastern, and Asian countries, were held in Rabat (Morocco), Lima (Peru), Amman (Jordan), and Kozhikode (India) and included high-level representatives of national water authorities and relevant UN organisations such as UNESCO, WHO and ESCWA.

3. Based on the recommendations of the AGMs in Rabat and Amman, a regional TC project in West Asia "Isotope applications for improved groundwater utilisation - RAW/8/007" has been initiated for the 1999-2000 cycle. The project aims at improved management of groundwater aquifers affected by salinity, and assessment of the effectiveness of artificial recharge to groundwater - two of the top priority themes identified in the AGMs. The AGM in Kozhikode recommended that the formation of national co-ordination committees for increasing the awareness of isotope techniques in the hydrology community should be facilitated. A national co-ordination committee has been constituted in 1999 in one of the participating countries from the Asia-Pacific region.

For reasons of economy, this document has been printed in a limited number.
Delegates are kindly requested to bring their copies of documents to meetings.

4. Strategies for a more effective programming of TC activities in various practical fields of isotope hydrology were developed in two consultants' meetings on Thematic Planning jointly organised by the Department of Technical Co-operation and the Department of Nuclear Sciences and Applications. Priority themes in applied research and practical applications of isotope hydrology were defined and identified at these meetings.

5. More than 80% of the total of 65 TC projects in isotope hydrology operational during the 1997-1998 cycle (involving 45 Member States and a total budgetary allocation of US \$ 2.7 million) were related to field projects in water resources development and management. Out of these, 24 were completed, and a total of 28 new national projects and 6 regional projects were included in the 1999-2000 cycle (involving 48 Member States and a total budgetary allocation of US \$ 6.7 million). Highlights of the Agency's achievements in the development and application of isotopes in hydrology include the following activities.

(i) Water resources development and management

6. Two Co-ordinated Research Projects (CRPs) with 22 participating institutions were completed. These CRPs addressed the application of isotopes in high priority areas of water resources assessment and management, namely estimation of flow and pollutant transport parameters of groundwater, particularly for conditions in arid and semi-arid regions. The results achieved include (a) modelling methodologies and software which can be used routinely for practical application, and (b) an improved methodology to estimate groundwater replenishment rate in areas of water scarcity. Thus, the outcome of the CRPs has a direct impact on technical co-operation (TC) projects in isotope hydrology.

7. The first phase of the regional Model project RAF/8/022 involving four African countries was successfully completed with major impacts on water resources management practices in Ethiopia, Egypt, Morocco, and Senegal. Implementation of the Phase II of this Model project is continuing in five countries, Algeria, Mali, Niger, Nigeria and Sudan. The project aims at integrating the isotopic techniques into hydrologic investigations for water resources development and management.

8. Building on the success of the Model project RAF/8/022, a new regional TC project in southern and eastern Africa (RAF/8/029) has been initiated. The project entitled "Sustainable development of groundwater resources" involves 7 countries (Kenya, Madagascar, Namibia, South Africa, Tanzania, Uganda and Zimbabwe). The primary objective of the project is to facilitate the integration of isotope techniques with non-nuclear techniques for water resources development and management and consequently optimise the long term performance of water sector investments by governments and other donors.

9. The use of geothermal energy for electricity generation in El Salvador and Costa Rica is being facilitated by the use of isotope tools for monitoring the reservoir conditions (TC Model projects ELS/8/005 and COS/8/008). The use of isotope and geochemical tools allows the monitoring of changing temperature and pressure conditions in the reservoir as a result of electricity generation. In addition, a sufficient understanding of reservoir hydrology is obtained to protect the environment from potential pollution by re-injection of waste waters produced from electricity generation.

(ii) Water pollution

10. Of specific relevance to the aspects of groundwater pollution, addressed in the GC resolution, is the CRP on "The Application of Isotope Techniques to Investigate Groundwater Pollution". It was completed in 1998 and included 16 case studies in 14 countries through which the potential of isotope techniques to assess various groundwater pollution sources (domestic waste, sewage disposal, landfills, agriculture, sea water encroachment) was identified. An immediate practical impact of the CRP is related to the ongoing UNDP/RCA/IAEA project on Access to Clean Drinking Water which aims at prevention of groundwater pollution. The methodologies developed in the CRP are directly applicable to address the pollution problems encountered in the project.

11. In 1998, a TC project on surface water pollution (CHI/8/023) was successfully completed. The Chilean Atomic Energy Commission has now integrated the transferred methodologies in their routine activities, and they are being extensively used in pollution studies related to submarine disposal of sewage and waste water. Two ongoing TC projects on surface water pollution (CUB/8/016 and BOL/8/006) deal with the use of radioactive and fluorescent tracers to study pollution in rivers and aim at providing necessary data on water dynamics for the validation of water quality models needed for remedial action in highly polluted rivers. In 1999, a new TC project in Ecuador has started to use nuclear techniques to measure oxygen transfer from the atmosphere to polluted water, an important parameter for surface water pollution mitigation.

(iii) Dam leakage detection and dam sustainability

12. Through the regional project ARCAL XVIII, 6 persons from the Costa Rican Institute of Electricity were trained in the use of isotope techniques for dam leakage studies. Recently, this Costa Rican team was able to apply the isotopic techniques to identify the origin of water that caused a land slide and soil subsidence in the abutment of El Arenal dam, which endangered the stability of the dam. The gathered information allowed to take appropriate and immediate actions to stabilise the abutment, thus avoiding a catastrophe.

13. Following the success of the ARCAL XVIII project, a similar regional project on the same theme was initiated in 1997 in Africa. Twenty-two AFRA countries requested participation in this project because of existing leakages in their dams and reservoirs. Studies are being carried out in Namibia, Morocco, Algeria and Tunisia. Training is being provided to establish teams of experts who are able to solve leakage problems where they occur.

14. The use of nuclear and related techniques for dam sustainability and dam leakage investigations has been selected as a prominent area for the Thematic Planning approach for TC programmes because of the frequent occurrence of dam leakage in many Member States.

III. Co-operation with other international organisations

15. Collaborative programmes in water resources management were developed with other UN agencies. The ACC (Administrative Committee on Co-ordination) Subcommittee on Water Resources designated the Agency to lead efforts in hydrogeology for a new UN initiative on characterisation and development of mitigation strategies for polluted drinking water. The initial focus of this work is the arsenic contamination of drinking water in Bangladesh where the drinking water resources for millions of people have been threatened by arsenic poisoning. The Agency has initiated a pilot project to demonstrate the use of isotopes as an integrated tool in hydrogeologic investigations within a World Bank-financed project on arsenic mitigation in Bangladesh. This pilot project aims to facilitate mitigation efforts by using isotopes to characterise the specific mechanisms of arsenic mobilisation in groundwater and the safety of deeper aquifers as alternative sources of drinking water.

16. The Agency is collaborating with UNEP/HABITAT within the context of a UN Fund for International Partnership (UNFIP) funded project for water demand management in several African cities. Collaboration in Addis Ababa, Ethiopia involves the integration of isotopes in the assessment of water quantity and quality and in developing aquifer protection measures for the Akaki Aquifer which is to supply 40% of the water to Addis Ababa. Similar programs will be developed for other cities, such as Lusaka, Zambia and Abidjan, Cote D' Ivoire, where groundwater is the major source of water supply.

17. A new initiative called "International Program for Isotopes in the Hydrological Cycle" was launched in co-operation with other UN Organisations (WMO, UNESCO) and scientific institutes in some of the Member States. The goals of this initiative are two-fold: (1) to fully integrate isotope hydrology in water sciences at universities world-wide, and (2) to establish (through the UNESCO International Hydrological Programme) national committees on isotope hydrology to facilitate the application of isotope hydrology in the water and climate sectors of Member States. The Agency was invited to inform the Fifth Joint UNESCO/WMO International Conference on Hydrology, held from 8 to 12 February 1999, on the scope and objectives of this initiative. The initiative was presented and endorsed by the Conference.

18. A Memorandum of Understanding between IAEA and WMO (World Meteorological Organisation) to further enhance collaboration in operating the Global Network for Isotopes in Precipitation (GNIP) was signed in 1998 by the Director General and the Secretary General of WMO. The joint efforts are aimed at a wider use of the isotope data gathered through the network for scientific research and applications in hydrology and climatology. The first meeting of the GNIP-Scientific Steering Committee was held in Vienna in July 1999.

IV. Analytical facilities and services

19. In response to the request of the resolution GC(41)/RES/15, "to help Member States to obtain easy access to isotope analysis facilities by upgrading isotope hydrology laboratories to the level of regional laboratories in the near future", a number of laboratories in developing Member States were visited and proficiency tests were carried out in some of them in order to ascertain their capability for providing analytical services to TC projects in isotope hydrology. The contribution of such laboratories to analytical services has been enlarged. It should be

mentioned, however, that the number of isotope analyses performed by the Agency's Isotope Hydrology Laboratory still increased by 10% in 1998 compared to 1997.

20. The isotope laboratories in El Salvador, Egypt, and Algeria, established or upgraded with the Agency's support, are being tapped as regional isotope laboratories to serve the analytical requirements of the Member States in Central America and Africa. This regional collaboration is a direct result of the achievements in implementing Model TC projects in these areas.

21. The Agency's Isotope Hydrology Laboratory issued 5 new reference materials in 1998 for stable and radioactive isotope analysis [IAEA-C7, IAEA-C8: oxalic acid for ^{14}C , RM8562, RM8563, RM8564: CO_2 gas in glass ampoules for ^{13}C and ^{18}O]. A total of 38 isotopic reference materials are now managed by the Agency. During 1997-1999, nearly 1000 samples of these reference materials were distributed to laboratories world-wide upon their request. This number is the highest ever, and indicates the increasing demand to be met by the laboratory with regard to the supply of reference materials.

22. State-of-the-art analytical techniques for radioactive (tritium and ^{14}C) and stable isotope analyses and related Quality Assurance requirements were the main topics of two training courses held in Vienna. A total of 54 participants from 41 countries attended these interregional and regional training courses. A computer-based laboratory information management system, expected to assist in the improvement of data processing and data consistency, was introduced and provided to the participants by the US Geological Survey.

23. A second inter-laboratory comparison exercise was conducted for analytical laboratories engaged in the routine analyses of hydrogen and oxygen stable isotopes. Eighty seven laboratories, representing a substantial portion of the entire analytical community engaged in this type of measurements, participated in this exercise, resulting in a greater confidence in the compatibility of isotopic results being produced around the world.

24. Inter-laboratory comparison among 15 laboratories for chemical analyses of water samples was completed within the regional geothermal project in Asia, RAS/8/075, composed of China, Indonesia, Philippines and Thailand. This resulted in an assessment of the quality of the analyses and will lead to an improvement of the methodologies employed in the laboratories. A subsequent inter-comparison of chemical results was conducted including 38 laboratories providing services to the geothermal industry and 50 laboratories in Asia, Latin America, Middle East and Africa involved in drinking water resources investigations.

V. University curricula and training

25. Six volumes of teaching material in isotope hydrology were prepared under a joint IAEA-UNESCO activity. In December 1998, the final drafts of these volumes were reviewed during a meeting at UNESCO in Paris. The teaching material will be published in 1999 in a UNESCO series named "Technical Reports in Hydrology". This will ensure a wide distribution to participants of Agency training courses in isotope hydrology as well as to teaching institutes and universities world-wide.

26. The development of a practical guide and self-learning tool for isotope hydrology was initiated. The objective is to develop a CD-ROM based, interactive software that will allow hydrologists with minimal training in isotopes to be able to understand the basic principles of isotope hydrology and to analyse their data for solving problems related to surface and ground water resources. This is expected to facilitate the integration of isotopes in hydrologic investigations.

27. To enable efficient manpower development for the application of isotope techniques in geothermal power generation, the Agency is publishing a field instruction manual on "Isotopic and Chemical Techniques in Geothermal Exploration, Development and Use".

VI. Information dissemination

28. A quarterly newsletter named "Water and Environment News" was launched in 1997 to improve the exchange of information between scientists participating in co-ordinated research activities, counterparts of TC projects, and the scientific community involved in isotope hydrology. So far, 7 issues of the newsletter have been published and sent to about 700 addressees in the Member States.

29. An isotope hydrology database ("Isotope Hydrology Information System", ISOHIS), was developed to facilitate data exchange between counterparts of TC projects and the Agency and will represent, after a substantial amount of data has been entered, a global database in isotope hydrology accessible through the Internet. The software for using ISOHIS can be obtained electronically from the FTP-server of the IAEA. The distribution is free of charge and is open to all interested users.

30. An Internet Web Site on Development and Management of Water Resources was opened in 1998. This site includes Water and Environment News and links to other relevant databases such as the GNIP (Global Network for Isotopes in Precipitation) and ISOHIS databases. By July 1999, the GNIP home page and database have been visited more than 4000 times by outside users.

31. Regional collaboration within TC project RAS/8/075 has accelerated the exchange of experience through the concept of TCDC in the four participating countries, China, Indonesia, Philippines and Thailand, where geothermal energy is being used for electricity generation. Efforts are being made to extend this collaboration to include countries in Central America through an inter-regional TC project.

32. The 10th International symposium on "Isotope Techniques in Water Resources Development and Management" was held at the Agency's Headquarters from 10-14 May, 1999. This symposium is organized by the Agency at regular intervals of four years, the first symposium being held in 1963 in Japan. The 10th symposium was sponsored by UNESCO, WMO and International Association of Hydrological Sciences (IAHS). A total of 201 participants from 69 Member States and three international organizations attended the symposium where 48 oral and 72 poster presentations were made. The symposium provided an international forum for review and exchange of information on the status and recent advances of isotope methodologies applied to water resources development and management.

The symposium proceedings will soon be published by the Agency as a CD-ROM. The future research and development needs in isotope hydrology and the role of the IAEA both in support of research and applied work was also considered during a round table discussion organized during the symposium.