Applying nuclear techniques for environmental protection: A global research network

Through the IAEA's Research Contract Programme, scientific institutes in dozens of countries are working together to study environmental problems of common interest

by Teresa Benson-Wiltschegg

Major issues concerning environmental protection today increasingly carry global dimensions. They include combatting pollution, understanding climate change, and avoiding negative effects from using pesticides and other agrochemicals. Such problems involve terrestrial and marine environments and the food cycle, and consequently affect people in all parts of the world.

In a variety of fields, scientists are applying nuclear, radiation, and isotopic techniques to studies of global environmental problems.

Nuclear analytical techniques, for example, can provide very sensitive and accurate methods to analyze trace amounts of pollutants. Radiation technology can be applied to reduce levels of certain pollutants in water and industrial emissions. Isotopes are ideally suited to answer three basic environmentally related questions: the type, pathway, and concentration of pollution; the cause of pollution; and possible remedies to avoid or remedy pollution. Compounds labelled with an isotope can be detected in very small amounts, thus making them ideal for examining various environmental processes.

To apply such techniques in environmental research, countries frequently pool their efforts through the IAEA's Research Contract Programme (RCP). The programme serves as the central co-ordinating mechanism, bringing together research centres, laboratories, universities, and scientific institutes interested in studying and solving specific problems.

About 130 co-ordinated research programmes (CRPs) presently are being carried out by the Agency's Department of Nuclear Energy and Safety; and by the Department of Research and Isotopes, through its Divisions of Life Sciences, Physical and Chemical Sciences, Joint Division of the IAEA and Food and Agriculture Organization (FAO) of Nuclear Techniques in Food and Agriculture, as well as through its laboratories at Seibersdorf and Monaco. Most of the projects relate to environmental areas. Additionally, a variety of other CRPs are being planned for implementation soon. *(See tables.)*

Ms Benson-Wiltschegg is head of the IAEA's Research Contract Section, Department of Research and Isotopes.

Research Contract Programme overview

The Agency's RCP has been designed to stimulate advances in scientific knowledge; to assist developing countries whenever possible to increase their participation in nuclear research; and to co-ordinate research between the Agency and national centres.

Each November, a detailed list of the programme's subject areas is circulated to Member States inviting them to submit research proposals. The list is drawn to reflect the detailed lines of activity for the following year as approved by the Agency's governing bodies.

Under the programme, the Agency places contracts and cost-free agreements with research centres, laboratories, universities, and other institutions in Member States to conduct research projects in relation to its scientific programmes.

Fields in which research currently is supported include protection of the environment, nuclear technology, radioisotope and radiation applications, and the protection of people against ionizing radiation. The relative emphasis given to each subject and the designation of specific topics within each area are reviewed annually within the Secretariat, with due consideration of Member State input (experts, consultants, ad-

visory groups, etc). The programme is oriented, as far as possible, towards research topics of specific interest to the developing countries. Wherever possible, contracts are awarded to institutes in developing countries.

On the basis of agreed subjects of research, CRPs are proposed by Agency scientists and reviewed within the IAEA. Following a decision to establish a CRP, the scientific staff member who developed the proposal becomes the responsible project officer. He or she is responsible for all technical matters relating to the CRP, contacting interested institutes, guiding progress, evaluating all reports, and ensuring that results are widely disseminated.

Research contract proposals may originate either within the Secretariat or at an institute, which is normally a non-profit making research organization. In either case a formal proposal must be submitted to the IAEA. Research institutes are invited to submit their proposals directly to the IAEA without going through government channels. All proposals received are carefully reviewed by the IAEA.

After a thorough examination of the proposal and a decision to contribute towards funding of the project, a lump-sum cost-sharing contract is prepared. Though the amounts awarded are small — the present average being approximately US $5000 per contract per annum — the impetus given can be far more than proportionate to the expenditure, as IAEA support often attracts substantial additional support for the project. Provision is made for specified payments in return for research results provided in accordance with a stated programme of work. Each contract with an institute is awarded on the understanding that a specific individual of the institute, named in the contract, will serve as Chief Scientific Investigator (CSI). The CSI is personally responsible for work under the contract, including co-ordination with the Agency and preparation of all required reports.

All contracts require that information and any products (e.g. plant mutants, analytical chemistry methods, instrumentation, computer codes, etc.) developed under contract be accessible to all Member States. Such contracts are normally issued for a period of one year, with a possibility of renewal for a second and third year.

As an alternative to research contracts, which always include financial remuneration, the IAEA can award research agreements. These are similar to contracts and are administered in basically the same manner; however, they do not provide funds. Under such arrangements the institute agrees to provide a technical report on a specified research topic in return for formal IAEA sponsorship and participation in exchanges of information and meetings organized by the Agency with other institutes in the CRP. Research agreements are normally awarded to institutes in developed countries. In addition to their value for other institutes in the CRP, research agreement holders profit from the access to all information used and developed in the CRP and gain an insight into important problems.

Once a CRP is formed, research teams from an average of 10 to 12 institutes are normally selected for participation in the programme, which lasts 3 to 5 years.

Common aspects and goals

Regardless of the field of research, each CRP involves certain common aspects. With institutes in developed countries working in close co-ordination with those in developing countries, all participants are encouraged to conduct work which will produce new research results and to apply these results to needs in their countries.

Co-operation between institutes is strongly encouraged and supported by Research Co-ordination Meetings (RCMs) which are financed by the IAEA for contractors and agreement holders and held at appropriate intervals for each CRP. At these meetings, the progress of the CRP is reviewed in detail and the future direction of work is established. At the final RCM, results are reviewed and evaluated by all participants and, where appropriate, recommendations are made for future work in the field.

Publication of the results of the work done under Agency research contracts in the open scientific literature by the contractors themselves, as well as in Agency publications, is strongly encouraged as the most direct way of bringing the results to other scientists interested in the subject. Summaries of the contractors' final reports are prepared by the Agency project officer responsible for the CRP. These findings may be included in external publications or published by the IAEA.

The IAEA may also respond to proposals from institutes for participation in the programme by awarding individual contracts not related to a CRP. A small portion of available funds is used to finance individual projects, which, although they do not fit into a CRP, deal with topics covered by the Agency's scientific programme.

Traditionally, the majority of CRPs, as well as individual contracts under the programme, have supported the promotion of research involving nuclear applications in agriculture, medicine, and physical and chemical sciences.

Currently some three-fourths of the RCP activities relate to research in these areas.

A recent United Nations Joint Inspection Unit evaluation report on the performance of UN system organizations cites the RCP as perhaps the most important co-operative activity in the system. It credits this programme for its dedication and success in solving scientifically and economically significant problems relating to the Agency's overall programme of work. This evaluation report emphasized the high quality of research proposals, the people in the research network, and the links between developing and developed country researchers who work as a team for up to 5 years on a project.

Relationship to TC programmes

Under the RCP, the IAEA assumes an active role in promoting the use of nuclear science and technology to solve problems in the developing world. The focus of this active role is to establish capabilities in existing universities and institutes in Member States. Emphasis is on developing the human resources in such institutes.

The main considerations in recommending a research contract award are the scientific merit of the project and ability of the institute and its scientific staff to successfully complete the required research. Institutes selected to participate in the programme should have the necessary facilities and staff at the time of award. The relatively small award amounts are foreseen to cover a portion of staff costs and specific smaller items of supplies or equipment to implement the project. Decisions also take into account previous research work related to the proposed project and, in particular, the compatibility of the project with the Agency's own functions and approved programmes.

CRPs carried out under the RCP concern solutions to specific problems, while activities supported under the technical co-operation (TC) programme may include training or infrastructure relating to general techniques.

While the Agency makes every effort to encourage the participation of institutes in a large number of countries, adequate care is taken to ensure that these institutes are indeed capable in principle of carrying out the research envisaged if they are given the necessary support under contract.

One subsidiary aim of the RCP is to provide "follow-on" incentive to institutes which have received assistance under the TC programme. Alternatively, the award of a research contract may, in some cases, trigger a request for technical assistance. To this end, an RCP/TC project

Co-ordinated research programme	Participating countries
Food and Agriculture	
● Radiotracer studies of behaviour of DDT in tropical environments	Indonesia, Kenya, Nigeria, Pakistan, Philippines, United Republic of Tanzania, United States of America
● Adverse effects on flora and fauna from the use of organochlorine pesticides on the African continent	Algeria, Egypt, Germany, Ghana, Nigeria, Sweden, Uganda, United Kingdom, United Republic of Tanzania, United States of America, Zambia, Zimbabwe
● Herbicide performance on grasses and hedges	Colombia, India, Indonesia, Pakistan, Philippines, Sudan, Thailand, United Kingdom, United States of America
Upcoming Programmes:	
● *The use of nuclear techniques for optimizing fertilizer applications under irrigated wheat to increase the efficient use of fertilizers and consequently reduce environmental pollution*	
● *Agroecological effects resulting from the use of persistent pesticides in Central America*	
● *Distribution, fate, and effects of pesticides on biota in the tropical marine environment, using radiolabelled tracers (Jointly carried out with the IAEA Marine Environment Laboratory, Monaco)*	
Life Sciences	
● Methodologies for comparative estimation of carcinogenicity of chemical pollutants and radiation released from fossil-fuelled and nuclear energy cycles	Austria, Hungary, Poland, United States of America
● Assessment of environmental exposure to mercury in selected human populations, studies by nuclear and other techniques	Brazil, Chile, China, Czech Republic, Hungary, India, Indonesia, Italy, Malaysia, Slovenia, Viet Nam
● Applied research on air pollution using nuclear related analytical techniques	Argentina, Australia, Belgium, Bangladesh, Brazil, Chile, China, Czech Republic, Hungary, India, Kenya, Paraguay, Portugal, Slovenia, Thailand, Turkey, United States of America
Physical and Chemical Sciences	
● Application of nuclear techniques for environment preservation in resource extraction and processing	Australia, Canada, China, Egypt, Indonesia, Poland, Portugal
● Radiation processing of combustion flue gases	Belarus, Denmark, Germany, Israel, Italy, Japan, Poland, Russia
● Nuclear analytical techniques in atmospheric and surface water pollution studies — ARCAL	Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Guatemala, Mexico, Panama, Paraguay, Peru, Venezuela
● Nuclear techniques for the evaluation of healing pathways of pollutant damage in the environment	China, India

Note: Tables list only CRPs related to environmental areas

Co-ordinated research programme	Participating countries
IAEA Seibersdorf Laboratories	
● Development and selection of analytical techniques and procedures for measuring accidentally released radionuclides in the environment	Brazil, Canada, China, Hungary, Sweden, Syrian Arab Republic, Ukraine
IAEA Marine Environment Laboratory	
● Sources of radioactivity in the marine environment and their relative contributions to overall dose assessment from marine radioactivity	Australia, Canada, China, Denmark, France, Germany, India, Italy, Philippines, Poland, Portugal, Romania, Sweden, United States of America
● The application of tracer techniques in the study of processes and pollution in the Black Sea (Jointly carried out with the Division of Physical and Chemical Sciences)	Bulgaria, Romania, Russian Federation, Turkey, Ukraine
Upcoming Programmes:	
● *Distribution, fate and effects of pesticides on biota in the tropical marine environment, using radiolabelled tracers (Jointly carried out with the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture)*	
● *Use of nuclear and isotopic techniques in retrospective studies of coral reefs — implications to climate research, global environmental change, and coastal pollution*	
Nuclear Safety	
Upcoming Programmes:	
● *The radiological impact of the Chernobyl accident on countries neighbouring the Commonwealth of Independent States*	
● *Radionuclide transfer to man in tropical and sub-tropical environments*	
Nuclear Fuel Cycle and Waste Management	
● Validation of models for the transfer of radionuclides in terrestrial, urban, and aquatic environments	Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Poland, Romania, Russian Federation, United Kingdom, Ukraine, United States of America
Upcoming Programme:	
● *Decontamination, environmental restoration, and management of the resulting waste*	

Note Tables list only CRPs related to environmental areas

link has been established within the Agency to ensure that activities of both programmes are as closely co-ordinated as possible.

In particular, the training of scientists under the TC programme relates directly to the support and guidance given to scientists participating in the RCP. TC activities, including the awarding of fellowships, participation in training courses, and provision of expert services, often represent a first step in the co-operation of some institutes with the IAEA, which continues with involvement in the RCP. Once training is completed or advice received under the TC programme, institutes often find themselves in a position to participate in the Agency's RCP. Thus, the expertise gained via the initial TC programme participation can prepare research institutes to further benefit through research endeavours carried out within the framework of the RCP. Conversely, completion of a research contract can result in a request for further training under a TC programme aimed at enabling an institute to conduct more sophisticated research and ensure application of the findings of this research.

The relationship between the two programmes is also complementary in respect of the provision of equipment and establishment of laboratories. The establishment of a laboratory contributing to a Member State institute's ability to carry out certain research can represent the necessary prerequisite for participation in the RCP. Later, that participation could result in a request under the TC programme for a large piece of equipment which is required to continue with work begun under a research contract. In a broader sense, individual research contracts, as well as CRPs, often form part of TC regional and interregional projects, offering an additional avenue for participation of institutes in these projects.

In the last 10 years, the Agency has financed from its regular budget RCP activities in Member State institutes totalling US $32.7 million. In addition to regular budget funds that were made available, an increase in the amount of extrabudgetary funds received from Member States for specific projects has enabled the programme to grow substantially during a period of zero real growth in the IAEA's regular budget. In 1992, over US $5.3 million in regular budget and extrabudgetary funds were used to carry out RCP activities at institutes in 96 Member States. Evaluations carried out on 11 CRPs completed last year indicate substantial achievements under this programme, with all the information and knowledge generated widely disseminated to Agency Member States.

New CRPs are announced in each issue of the *IAEA Bulletin* and institutes in all Member States are invited to submit their proposals for participation in these programmes. In addition to the CRPs mentioned here, it is expected that several new CRPs concerned with environmental issues will be approved and initiated by the Agency during 1993. ❐