

Technical Cooperation Report for 2016

Report by the Director General



IAEA

60 Years

Atoms for Peace and Development

Technical Cooperation Report for 2016

Report by the Director General

**GC(61)/INF/7
Printed by the
International Atomic Energy Agency
July 2017**

Preface

The Board of Governors has requested the transmission to the General Conference of the attached Technical Cooperation Report for 2016, the draft of which was considered by the Board at its June 2017 session.

The Director General is also hereby reporting in fulfilment of the request contained in resolution GC(60)/RES/11 on “Strengthening of the Agency’s technical cooperation activities” and Part B of General Conference resolution GC(59)/RES/11.

Contents

<i>Summary</i>	vii
<i>The Agency's Technical Cooperation Programme in Figures</i>	ix
A. Strengthening the Agency's Technical Cooperation Activities	5
A.1. Technical cooperation in 2016: An overview	5
A.2. Building a more efficient, more effective technical cooperation programme	18
B. TC Programme Resources and Delivery	29
B.1. Financial overview	29
B.2. Delivering the technical cooperation programme	32
C. Programme Activities and Achievements in 2016.	37
C.1. Africa	37
C.2. Asia and the Pacific	41
C.3. Europe	46
C.4. Latin America and the Caribbean	49
C.5. Interregional projects	51
C.6. Programme of Action for Cancer Therapy (PACT)	53
Annex 1. Achievements in 2016: Project Examples by Thematic Sector	61
Health and Nutrition	61
Food and Agriculture	75
Water and the Environment	86
Industrial Applications	95
Energy Planning and Nuclear Power	99
Radiation Protection and Nuclear Safety	104
Nuclear Knowledge Development and Management	118
Annex 2. Summary of GOV/INF/2016/12	121
Annex 3. TC Programme Fields of Activity	122

Figures

Figure 1: Actuals by technical field for 2016	x
Figure 2: Female project counterparts by region, 2012–2016	23
Figure 3: Female participation in training, 2012–2016.....	23
Figure 4: Trends in TC programme resources, 2007–2016	29
Figure 5: Trends in the Rate of Attainment, 2007–2016.....	30
Figure 6: Trends in extrabudgetary contributions by donor type, 2007–2016.	31
Figure 7: Actuals in the Africa region in 2016 by technical field	37
Figure 8: Actuals in the Asia and the Pacific region in 2016 by technical field.	41
Figure 9: Actuals in the Europe region in 2016 by technical field.....	46
Figure 10: Actuals in the Latin America and the Caribbean region in 2016 by technical field	49
Figure 11: Interregional actuals in 2016 by technical field	51

Tables

Table 1: TC programme resources in 2016.....	30
Table 2: Payment of National Participation Costs and assessed programme cost arrears	30
Table 3: Extrabudgetary contributions allotted to TC projects in 2016, by donor (in Euro)	31
Table 4: Government cost sharing allotted to TC projects in 2016 (in Euro) ..	31
Table 5: Delivery of outputs under the TCF: financial indicators for 2014, 2015 and 2016.....	32
Table 6: Comparison of the unallocated balance of the TCF (in Euro)	32
Table 7: Delivery of outputs: non-financial indicators for 2015 and 2016.....	33
Table 8: TC procurement in 2016	33
Table 9: Programme Reserve projects in 2016.....	34
Table 10: Voluntary contributions to the AFRA Fund, 2016 (in Euros).....	40
Table 11: Extrabudgetary contributions to PACT, 2016.....	56

Summary

The Technical Cooperation Report for 2016 responds to General Conference resolution GC(60)/RES/11 and to Part B of General Conference resolution GC(59)/RES/11. It is set out in three parts: A, Strengthening the Agency's Technical Cooperation Activities; B, TC Programme Resources and Delivery; and C, Programme Activities and Achievements in 2016. Annex 1 gives examples of project activities and achievements in specific thematic areas. Annex 2 presents a summary of the Agency's report on the specific characteristics and problems of the least developed countries (LDCs) with respect to the peaceful applications of nuclear energy. Annex 3 lists the TC Programme Fields of Activity, grouped for reporting purposes.

Part A.1 provides an overview of the Agency's technical cooperation (TC) activities in 2016, beginning with the global development context for the TC programme. It outlines where the TC programme can contribute to Member State efforts to achieve the Sustainable Development Goals, and describes IAEA participation in the global development dialogue, notably in the High-Level Political Forum on Sustainable Development, and in the Sixth Tokyo International Conference on African Development. The report then addresses how the TC programme is tailored to respond to the specific needs and priorities of each region, referring to document GOV/INF2016/12 on the characteristics and problems of LDCs with respect to the peaceful application of nuclear energy, and describing topics that require particular attention, such as the needs of small island developing States. The report outlines how the programme has responded to emergencies in 2016, and presents activities carried out in 2016 to develop human resources and build capacities through postgraduate training, support for technical cooperation among developing countries, and assistance in drafting legislation. Part A.1 also offers a summary of the discussions at the 2016 Scientific Forum. It closes with an overview of efforts to build awareness of the TC programme.

Part A.2 focuses on efforts to build a more efficient and effective TC programme, in particular on ongoing efforts to strengthen the role of the Country Programme Framework as the main strategic planning tool for the programme. Progress made in 2016 in maximizing programme impact through strategic partnerships, both with the United Nations (UN) and with other relevant international and regional organizations, is described, with a focus on partnerships in food and agriculture, health, and at the regional level. Part A.2 also presents figures on the participation of women in the TC programme, and describes activities undertaken in 2016 to improve the quality of the TC programme.

Part B presents a summary of financial and non-financial programme delivery indicators. It reviews the resources mobilized for the TC programme through the Technical Cooperation Fund (TCF), and through extrabudgetary and in-kind contributions. Payments to the TCF in 2016 totalled €78.5 million (not including National Participation Costs, assessed programme costs and miscellaneous income), or 92.9% of the TCF target set for the year. New extrabudgetary resources for 2016 came to €18.7 million and in-kind contributions were €0.8 million. Overall, implementation for the TCF reached 84.6% in 2016, and health and nutrition, safety and security, and food and agriculture were the top areas of disbursement for the programme.

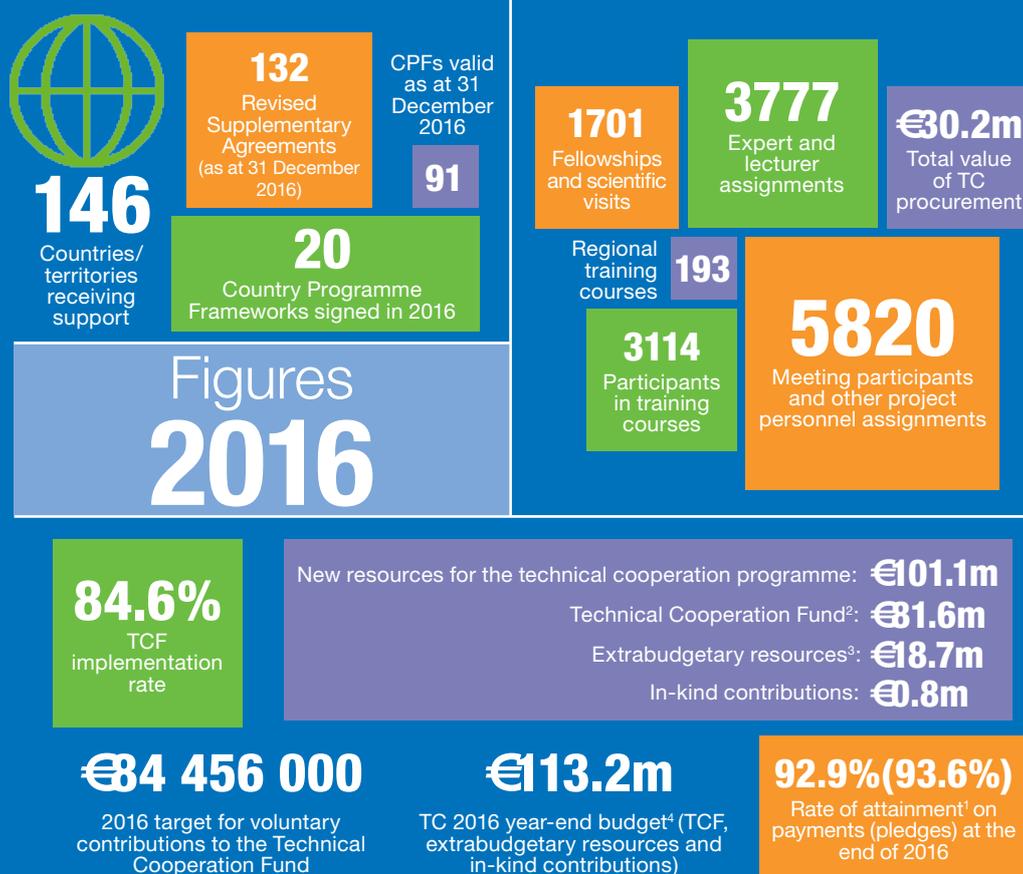
Part C highlights programme activities and achievements, and covers assistance to Member States in the peaceful, safe, secure and regulated application of nuclear science and technology. It highlights regional activities and achievements in technical cooperation in 2016, and presents an overview of the activities of the Programme of Action for Cancer Therapy (PACT).

¹ Total payments received in 2016 include €0.8 million either of deferred or of additional payments by 6 Member States. Excluding these payments, the 2016 rate of attainment on payments would have been lower by 0.9%.

Project examples are presented in Annex 1 according to thematic area, covering health and nutrition, food and agriculture, water and the environment, industrial applications, energy planning and nuclear power, radiation protection and nuclear safety, and nuclear knowledge development and management. Annex 2 presents a summary of GOV/INF/2016/12, the Director General's report on 'Addressing the Challenges Facing Least Developed Countries in the Peaceful Application of Nuclear Energy through the Technical Cooperation Programme'. Annex 3 lists the technical cooperation programme Fields of Activity

The Agency's Technical Cooperation Programme in Figures

(as at 31 December 2016)



² Including TCF payments, National Participation Costs and miscellaneous income.

³ Includes donor contributions and government cost-sharing. Please refer to Table A.5 of the Supplement to this report for details.

⁴ Year-end budget is the total value of all technical cooperation activities approved and funded for a given calendar year plus all approved assistance brought forward from previous years but not yet implemented.

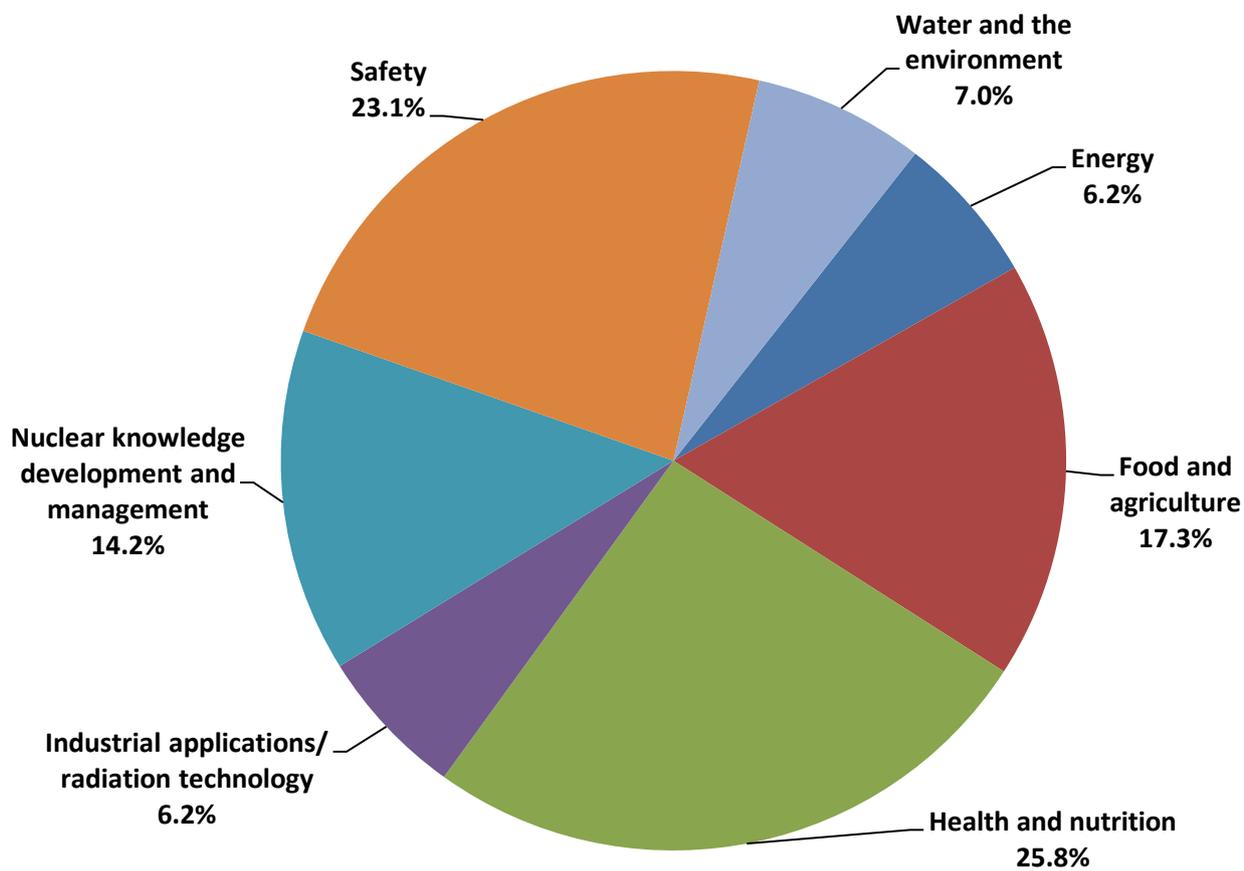


Figure 1: Actuals by technical field for 2016⁵

⁵ Throughout this report, percentages in charts may not add up to 100% exactly due to rounding.

Technical Cooperation Report for 2016

Report by the Director General

This document responds to the request by the General Conference to the Director General to report on the implementation of resolution GC(60)/RES/11, and to Part B of General Conference resolution GC(59)/RES/11.

Part A of the report provides an overview of the progress achieved in delivering the technical cooperation programme during the period from 1 April 2016 to 31 March 2017.

Part B reports on the management of financial resources and programme delivery at an aggregate level in the calendar year 2016.

Part C reports on regional activities and programme achievements during 2016.

Annex 1 provides examples of project activities and achievements in specific thematic areas.

Annex 2 responds to the request of Member States contained in GG(60)/RES/11 “to continue examining in depth the specific characteristics and problems of the LDCs with respect to the peaceful applications of nuclear energy”, containing a summary of GOV/INF/2016/12.

Annex 3 lists the technical cooperation programme Fields of Activity.



A. Strengthening the Agency's Technical Cooperation Activities

A. Strengthening the Agency's Technical Cooperation Activities⁶

A.1. TECHNICAL COOPERATION IN 2016: AN OVERVIEW⁷

Global developments in 2016: The context for the TC programme

In 2016, global efforts shifted from the achievement of the United Nations Millennium Development Goals (MDGs) towards the implementation of Agenda 2030 and its Sustainable Development Goals (SDGs), adopted by world leaders in September 2015 at the United Nations Summit. The Paris Agreement, which commits States to take ambitious steps to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so, also came into force.

Extreme climatic events, outbreaks of zoonotic disease and natural disasters such as earthquakes continued to demand responses from the international development community, directing resources away from proactive, long term programmes. These trends will add complexity to the already sizeable challenges to be overcome during the next 15 years.

The post-2015 development agenda and the Sustainable Development Goals

The SDGs provide a common international framework that will shape development cooperation and public policy decisions over the next decade and a half. The SDGs highlight the key role of science and technology in achieving sustainable development. The goals and targets are an important means through which development partners can identify co-dependencies and stakeholders to help accomplish national goals and priorities.

The Agency has identified eight Goals in addition to Goal 17 – the means of implementation and the Global Partnership for Development – that it supports through on-the-ground programme activities. By helping Member States to establish links between their national TC programme and the SDGs, as appropriate, the Agency can strengthen delivery of its mandate, deploying specialized competencies and expertise in the field of nuclear science and technology for the benefit of its Member States. The increased scope and ambition of the SDGs and the accompanying recognition of the interrelatedness of development challenges mean that the Agency's technical cooperation is more relevant than ever to the efforts of the international community and national partners to support sustainable socioeconomic development in Member States.

Achieving the SDGs requires coordinated effort to fully integrate and track the activities of development actors across the globe. At its 47th Session on 11 March 2016, the United Nations Statistical Commission approved a global indicator framework consisting of 230 global indicators, with the aim of measuring progress in the attainment of each of the

“By helping Member States to establish links between their national TC programme and the SDGs, as appropriate, the Agency can strengthen delivery of its mandate, deploying specialized competencies and expertise in the field of nuclear science and technology for the benefit of its Member States.”

⁶ Section A responds to section 2, operative paragraph 2 of resolution GC(60)/RES/11 on strengthening TC activities through the development of effective programmes and well defined outcomes; and to section 5, operative paragraph 2 on promoting TC activities supporting the self-reliance, sustainability and further relevance of national nuclear and other entities in Member States, and enhancing regional and interregional cooperation.

⁷ Section A.1 responds to section 2, operative paragraph 4 of resolution GC(60)/RES/11 on contributing to the implementation of the principles expressed in the Istanbul Declaration and the Programme of Action for the Least Developed Countries for the Decade 2011–2020, and to the attainment of internationally agreed development goals.

SDGs and targets. Development agencies and governments alike have begun to align their programmes to the new development framework. Member States and their partners will use these targets and indicators to assist their monitoring activities and to support the assessment of their progress towards the achievement of the SDGs.

Global development dialogue

High-Level Political Forum on Sustainable Development

In July, the Agency took part in the 2016 United Nations High-Level Political Forum (HLPF), which provides a platform for coordinated review and follow-up on Agenda 2030 and the SDGs. The Agency used the occasion to raise awareness of the benefits of nuclear science and technology and its contribution to the attainment of the SDGs, and hosted a side event on food security. The Agency's presence at this event helped to increase the visibility of peaceful nuclear applications within the UN community.

As part of the lead-up to the 2017 HLPF, an expert meeting, 'Readying Institutions for Integrated Approaches to the 2030 Agenda', was held in Vienna in December. The meeting examined the interlinkages among the seven SDGs that will be reviewed by the HLPF in July 2017 (poverty, hunger, health, gender, infrastructure, oceans and means of implementation), and how institutions, public and private entities, ministries and national governments can factor in these interlinkages in their implementation of Agenda 2030. The Agency joined this meeting and participated in a panel debate focusing on how to maximize the impact of SDG 9 (infrastructure and industry) on other goals and targets.

Contributing to the achievement of the SDGs: A project example

In Chile, TC project CHI5050, 'Using Isotope Techniques to Quantify the Contribution of Agriculture in Greenhouse Gas Production', has addressed SDGs 2, 13 and 15. Through the project, the Agency has provided equipment, chemicals and training to support the application of isotopic techniques to measure greenhouse gases (GHGs), and to increase understanding of emissions from agriculture. The project was carried out with the Chilean Institute of Agricultural Development, the Chilean Office for Agricultural Studies and Policies, the Chilean Agricultural and Livestock Service and the Chilean Nuclear Energy Commission (CCHEN), with the support of the Agency.

The collection of GHG data will support the validation of Chile's emissions inventory and the identification of mitigation options for sustainable agriculture. The Chilean team is now able to collect data and information from different agroecosystems, using both nuclear and non-nuclear techniques, to find ways to reduce GHGs and enhance crop productivity.

The project has contributed to the following SDGs:

- SDG 02: Ending hunger, achieving food security as well as improved nutrition, and promoting sustainable agriculture, by increasing agricultural productivity and the incomes of small-scale food producers, as well as implementing resilient agricultural practices that increase productivity and production.
- SDG 13: Taking urgent action to combat climate change and its impacts, by integrating climate change measures into national policies, strategies and planning. The project is also helping in the implementation of international commitments made by Chile.
- SDG 15: Sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss, by promoting fair and equitable sharing of the benefits arising from the utilization of new genetic resources and promoting appropriate access to such resources, as internationally agreed.

The Sixth Tokyo International Conference on African Development (TICAD VI)

The Tokyo International Conference on African Development (TICAD) is an initiative launched by the Japanese government in 1993 to bring the world's attention to Africa's development needs and promote high-level policy dialogue between African leaders and development partners. In August, TICAD VI was held in Nairobi, Kenya – the first

time that TICAD has been held outside Japan. In three separate speaking engagements, IAEA Director General Amano highlighted the work of the Agency in making nuclear technology available for development. The TICAD VI Nairobi Declaration and the Nairobi Implementation Plan were adopted at the conference, outlining new commitments to Africa's development. The Agency is mentioned in the Implementation Plan as a non-health specialized organization with expertise to apply nuclear technologies to tackle communicable and non-communicable diseases (NCDs).



DG Amano speaks at TICAD VI in Nairobi, Kenya.

Tailoring the TC programme to Member State needs⁸

The Agency's TC programme is delivered in four regions: Africa, Asia and the Pacific, Europe (including countries in Central Asia) and Latin America and the Caribbean. Support is tailored to meet the specific needs of individual countries, sub-regions and regions. These needs are identified through Country Programme Frameworks (CPFs), national development plans, regional profiles and strategic frameworks. Interregional projects deliver TC support across national and regional boundaries and address the common needs of several Member States in different regions.

In 2016, the Agency issued GOV/INF/2016/12, 'Addressing the Challenges Facing Least Developed Countries in the Peaceful Application of Nuclear Energy through the Technical Cooperation Programme'. The document, prepared in response to Member State requests, and presented at the November meeting of the Technical Assistance and Cooperation Committee, highlights how the Agency helps countries to address these challenges and their development needs.

Small island developing States (SIDS) face unique developmental challenges, linked to geographic isolation, economies of scale and demographic changes. The Agency recognizes that a coordinated approach is required to effectively address these challenges, and in November brought together high level delegates from SIDS from both the Asia and the Pacific and the Latin America and the Caribbean regions. The meeting provided delegates, several of whom were from Member States which had only recently joined the Agency, with a unique opportunity to learn about the Agency's contribution to socioeconomic development through the application of nuclear technology. Organized visits to the Agency's nuclear applications laboratories in Seibersdorf and to the Incident and Emergency Centre allowed participants to see first-hand how SIDS can benefit from the Agency's TC programme. An interregional project that will address common challenges in areas including nutrition, cancer control, food security, climate change and radiation safety

"Support is tailored to meet the specific needs of individual countries, sub-regions and regions."

⁸ This section responds to section 3, operative paragraph 1 of resolution GC(60)/RES/11 on strengthening TC activities, including the provision of sufficient resources, based on Member States' needs and priorities, and ensuring that the components of TC projects are readily available.

is being formulated, with the goal of fostering interregional exchanges and promoting a regional approach to capacity building.

The meeting was also attended by the Assistant-Secretary General of the Caribbean Community (CARICOM) and the Deputy Director General of the Secretariat of the Pacific Community (SPC), forming the basis for strengthening future technical collaboration with the Agency in areas such as health, agriculture, water management, safety and security, disaster prevention as well as emergency preparedness and response.

In Africa, the TC programme is designed to meet the region's specific national and regional development needs and priorities, as reflected in individual CPFs and in the Regional Strategic Cooperation Framework of the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA). Food and agriculture and human health remain the highest priorities in Africa. In 2016, programmes in Congo and Djibouti were implemented for the first time.

A number of countries in Asia and the Pacific, in particular new IAEA Member States, do not have an adequate legal and regulatory framework in place for radiation safety. Most new Member States require awareness-building to establish national understanding of the established international safety standards, together with assistance to identify strategies to accelerate the establishment of an adequate radiation safety infrastructure in their countries. A comprehensive approach to establishing adequate radiation safety infrastructure at the national level was agreed in Vienna in June, at a high level seminar on building National Radiation Safety Infrastructure in Compliance with the IAEA Safety Standards. As a follow up to the seminar, radiation protection assessment missions will be organized to assist Member States as they develop action plans. In 2016, such missions took place to Cambodia, Lao People's Democratic Republic, Nepal and Vanuatu.

In the Europe region, nuclear technology is in widespread use in sectors such as energy, health, environment and industry, and as a result radiation safety is a top priority in the region. While most Member States in the region have well-functioning regulatory infrastructures, some countries have yet to bring the national framework in line with relevant IAEA Safety Standards. Several projects are specifically targeted to address gaps in this respect. Nuclear safety in the context of new nuclear power plants (NPPs) and lifecycle extensions of old NPPs is also an important area of focus for the region. In addition, the decommissioning of old research reactors and NPPs, as well as nuclear waste and remediation of old uranium mining sites, are increasingly becoming priorities for many Member States.



High Level Seminar on Building National Radiation Safety Infrastructure in Compliance with IAEA Safety Standards.

Finally, the Agency is responding to the growing challenge of cancer in close collaboration with its partners. To that end, the Agency helps low- and middle-income Member States to improve access to radiation medicine as part of a comprehensive cancer control approach. In 2016, eight Member States received integrated missions of PACT (imPACT) review missions which assessed national cancer control needs and capacities. These reviews provided Governments with recommendations on the way forward in addressing their cancer issues. Namibia and Rwanda received expert advisory assistance for the development of their national cancer control plans.

Targeted emergency response

The flexibility of the TC programme enables the Agency to respond to unforeseen needs in Member States rapidly and effectively. At the beginning of 2016, the Latin America and Caribbean Region faced an outbreak of Zika virus, with confirmed cases in 26 countries, and requested the help of the Agency in combating the problem. The Agency responded rapidly, providing training and equipment to detect the virus and exploring the application of the sterile insect technique (SIT) to control the mosquito vectors. Two regional training courses were conducted in Seibersdorf in 2016 to enhance capacity for rapid detection of the Zika virus using a nuclear derived technique, reverse transcription-polymerase chain reaction (RT-PCR). A total of 31 medical doctors and laboratory technicians received training in the use of RT-PCR, and equipment and materials were purchased for eight countries to conduct RT-PCR diagnostic tests.

The Agency also provided key emergency support to Haiti under the TC project HAI5007, 'Strengthening National Capacities for the Early and Rapid Detection of Zika Virus Infections'. Haiti received the necessary equipment and consumables for serological detection of the Zika virus circulation, as well as for molecular detection of the virus. This equipment together with the provision of training is enabling Haiti to react quickly to the Zika epidemic.

The Zika virus outbreak was also identified in the Marshall Islands in early 2016, and the Agency, in collaboration with the World Health Organization (WHO) Western Pacific Regional Office, set up a Programme Reserve project MHL5001, 'Strengthening National Capacities for the Early and Rapid Detection of Zika Virus Infections in the Marshall Islands'. This immediate IAEA support provided equipment and training for the implementation of the RT-PCR technique, and supported its integration into regular disease control programmes.

Longer term support to Member States affected by the Zika virus outbreak will include supporting the establishment of regional facilities with capacities for the application of the SIT. For the Latin America and the Caribbean region, this has been put in place through an off-cycle regional project RLA5074, 'Strengthening Regional Capacity in Latin America and the Caribbean for Integrated Vector Management Approaches with a Sterile Insect Technique Component, to Control Aedes Mosquitoes as Vectors of Human Pathogens, particularly Zika Virus', which was approved by the Board of Governors in March. Through this project, the Agency is providing technical assistance in the collection of entomological baseline data, vector surveillance, mosquito release and trapping systems, mass-rearing of vector mosquitoes, sex separation strategies, irradiation procedures, and radiation safety and security. In other TC regions (Africa, Asia and Europe) as well, an Interregional project is ongoing, focusing on capacity building and the collection of baseline data in the participating Member States.

The regional project RER9137, 'Enhancing National Capabilities for Response to Nuclear and Radiological Emergencies', although focused on enhancing Member States' capacities to prepare for and respond to radiation emergencies, includes a special emphasis on improving the participation of veterinary authorities in the national coordination mechanism in order to enhance food safety. In November a workshop was held to address lumpy skin disease (LSD), a highly infectious cowpox virus that can cause significant economic losses to farmers. The workshop was co-sponsored by the United States Department of

“The flexibility of the TC programme enables the Agency to respond to unforeseen needs in Member States rapidly and effectively.”



RER9137: The participants at a presentation on infectious diseases.

Agriculture (USDA)/Animal and Plant Health Inspection Service (APHIS). The goal was to provide the participants with an in-depth understanding of emerging infectious diseases in animals, with a special focus on the current outbreak of LSD in the Europe region, and to update their knowledge about the implementation of early notification systems for LSD, techniques for detection, planning and response to the LSD threat. The special session was dedicated to the advanced nuclear and nuclear derived techniques applicable for early detection of LSD infections. The workshop also included presentations on the perspectives of international organizations including the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health and the Agency. Affected Member States now have trained professionals with more extensive knowledge of infectious animal diseases at their disposal, who are prepared to support appropriate reactions to current and potential future outbreaks of LSD and similar diseases.

The Agency's TC programme also responded to an emergency request for assistance made by the Government of Ecuador in 2016, in order to address the impact of the earthquake that took place in the country on 16 April. The Agency, with support from Japan, sent medical and radiological equipment to the affected areas (four digital mobile X-ray systems, including complementary power generators, one emergency diagnostic kit and 24 personal detectors). Technical advice was also given to Ecuador for the development of an action plan for the application of nuclear techniques, such as non destructive testing (NDT) methods, which will be used with Agency support to test the integrity of critical buildings and structures damaged as a result of the earthquake.

“3777 expert and lecturer assignments were carried out, 5820 persons participated in meetings and workshops, 3114 participants took part in 193 interregional and regional training courses and 1701 benefited from fellowships and scientific visits.”

Developing human resources and building capacities⁹

The TC programme builds sustainable capacities in Member State in the peaceful, safe and secure application of nuclear science and technology. A combination of activities in support of capacity building, knowledge sharing, networking and partnership ensures the long term sustainability of TC projects. Throughout 2016, the TC programme continued its focus on improving human health; supporting agriculture and rural development; advancing water resources management; advising on sustainable energy planning and development, including the option of nuclear power for electricity generation; addressing environmental challenges; and promoting nuclear safety. Consequently, 3777 expert and lecturer assignments were carried out, 5820 persons participated in meetings and workshops, 3114 participants took part in 193 interregional and regional training courses and 1701 benefited from fellowships and scientific visits.

⁹ This section responds to section 2, operative paragraph 1 of resolution GC(60)/RES/11 on facilitating and enhancing the transfer of nuclear technology and know-how among Member States.

In the Africa region in 2016, ten young scientists from ten African Member States completed their Masters' degree programme in nuclear science and technology at the University of Alexandria, Egypt and the Graduate School of Nuclear and Allied Sciences of the University of Ghana. Both countries host AFRA regional designated centres for higher and professional education. These studies were supported by RAF9056, 'Strengthening Education and Training in Radiation Safety and Sustaining Human Resources Development and Nuclear Knowledge Management (AFRA)', which supports training for a new generation of nuclear scientists in Africa.

Also in Africa, assistance was provided in 2016 under RAF0047, 'Promoting the Sustainability and Networking of National Nuclear Institutions for Development, Phase II', to build the sustainability of national nuclear institutions (NNIs) so that they can contribute to the socioeconomic development of their countries. Managers and heads of atomic energy commissions, research facilities and laboratories received training on intellectual property, technology transfer licensing and sustainability and on the implications of intellectual property policies for the management of innovation, technology transfer and market competition.

As a result of RAF5067, 'Establishing a Food Safety Network through the Application of Nuclear and Related Technologies', and its successor RAF5078, 'Establishing a Food Safety Network through the Application of Nuclear and Related Technologies, Phase II', 31 countries in Africa are now part of the African Food Safety Network, and are sharing knowledge, experiences and analytical methods with each other. The two projects supported the launch of a strategy for effective knowledge exchange through scientific exchanges: trainees and laboratory personnel visit each other's laboratories to train colleagues or benchmark their testing capabilities and national monitoring programmes. Laboratory bench fees in a number of cases are waived by the host institutions. This concept is gradually contributing to reducing needs for training abroad, and is enabling the formation of a cohort of technically competent personnel that are able to apply nuclear/isotopic techniques to food safety. Increasingly, former trainees are now resource persons in subsequent training courses. Thirteen of the 31 countries are now applying radio receptor assay tools to test for various food contaminants.

The Strategic Capacity Building Approach introduced in the Asia and the Pacific region in 2015 has contributed to a more cost-effective and better managed capacity building process. In 2016, Sri Lanka, for example, has hosted two activities on NDT and animal production; the Philippines has hosted one group fellowship activity on isotope hydrology; and Indonesia has hosted one group fellowship activity on plant mutation breeding and one group fellowship on radioactive waste management infrastructure for newcomer countries. Jordan has also hosted a group fellowship on groundwater hydrology.

The First School of Radiation Emergency Management for Member States in the Asia and the Pacific region took place August – September 2016 in Chiba, Japan, supported by regional project RAS9076, 'Strengthening of National Capabilities for Response to Nuclear and Radiological Emergencies'. In collaboration with the Government of Japan, through the National Institute of Radiological Sciences, the school was designed to deliver a comprehensive training course on nuclear or radiological emergency preparedness and response (EPR). Specialists from Bahrain, Bangladesh, Indonesia, Islamic Republic of Iran, Jordan, Kuwait, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Pakistan, Papua New Guinea, Philippines, Palau, Qatar, Thailand, United Arab Emirates, Vanuatu and Yemen participated. The school contributed to the creation of a cadre of managers capable of developing and managing sustainable EPR programmes, based on IAEA Safety Standards, technical guidelines, tools and training material.

In the area of radioactive waste management infrastructure, comprehensive capacity building support was provided to participants from 15 Member States in the Asia and the Pacific region through TC project RAS9062, 'Promoting and Maintaining Regulatory Infrastructures for the Control of Radiation Sources'. Practical, hands-on training at the regional course, 'Search for Orphan Sources and Post-discovery Activities', in the



RAS9076: Practical sessions during the First School of Radiation Emergency Management for Member States from the Asia and the Pacific region, Japan 2016.

Philippines in October provided participants with the necessary knowledge and practice to perform orphan source searches in a safe and secure manner, thus strengthening the regulatory inspection regime of participating countries.

In the Europe region, developing human and institutional capacities is a priority across all thematic areas. In the health sector, for example, the national project POL6010, 'Supporting the Network of Nuclear Medicine Centres for Cooperation in the Application of Positron Emission Tomography in Oncology', supports a network of 16 nuclear medicine centres in Poland. Some 800 to 900 new cases of Hodgkins lymphoma are diagnosed annually in the country, but for about 30–40% of the patients, morphological imaging is unsuitable, and for an additional 20–30% of patients, standard chemotherapy is not sufficient for cure. Positron emission tomography–computed tomography (PET CT) at staging and early interim PET is becoming a powerful tool for proper staging at the beginning and early identification of patients with poor outcomes following standard treatment. The Agency has supported a network database and has arranged expert missions. The project has contributed to the quality of the health care system by improving cooperation and networking among PET centres, leading to better treatment for cancer patients, including lymphoma patients, using PET CT technologies.

In Latin America and the Caribbean, a new regional project, RLA0057, 'Enhancing Nuclear Education, Training, Outreach and Knowledge Management', was initiated in 2016. The four year project will contribute to enhanced education and training in the fields of nuclear science, engineering and technology, in a region where knowledge transfer and preservation are critical for the development of the peaceful application of nuclear technology. Building on previous TC projects, the Agency is providing continuous support in the following areas: capacity creation, nuclear knowledge management basics, the use of e-learning and other pedagogical tools for the development and preservation of nuclear education, outreach material, as well as in the provision of equipment and software to establish virtual classrooms. The project also supports and fosters networking and collaboration through the Latin American Network for Education in Nuclear Technology (LANENT).

The Programme of Action for Cancer Therapy (PACT) continues its work to support the efforts of Member States to provide comprehensive and sustainable cancer services. For example, health professionals from 35 African Member States have strengthened their abilities to collect high quality cancer data in support of informed decision-making for cancer control planning. Medical professionals from 16 Member States have enhanced their skills through fellowships in medical physics, radiation oncology and cancer registries. Eighty medical professionals were trained at the Association of Medical Physicists in

the Russian Federation, six at the Korea Institute of Radiological and Medical Sciences (KIRAMS) and three at the Cancer Registry of Côte d'Ivoire.

Building competence through postgraduate training

The Postgraduate Educational Course (PGEC) in Radiation Protection and Safety of Radiation Sources build the capacities of the personnel of national regulatory bodies, enhancing their capacity to perform regulatory functions, and building a cohort of young professionals who are expected to become, in time, senior regulators, senior decision makers, radiation protection experts or trainers.

The directors of the PGECs hosted in all IAEA regional training centres in Africa, Asia and the Pacific, Europe and Latin America and the Caribbean met in August in Vienna. The results of the evaluation of the impact of the PGEC on the professional career of participants and on the radiation safety infrastructures of Member States were analysed.

In Africa, a PGEC in Radiation Protection and the Safety of Radiation Sources was delivered in English, French and Portuguese to 40 professionals from national regulatory authorities and bodies in 2016, helping to increase the number of qualified radiation protection officers in Africa, and enhancing the delivery of technical services. Assistance was also provided to Member States to develop their national strategies for education and training in radiation, transport and waste safety.

In the Asia and the Pacific region, the 13th PGEC in Radiation Protection and the Safety of Radiation Sources was held in Malaysia in November. Supported through the project RAS9081, 'Providing Education and Training in Radiation Safety in the Asia-Pacific Region', the PGEC hosted 32 young professionals from 16 Member States who are working in the field of radiation protection and the safety of radiation sources.

In the Europe region, a PGEC delivered in Russian began in Minsk, Belarus in October 2016. The course will continue until April 2017, enabling 11 young professionals to acquire a sound basis in radiation protection and the safety of radiation sources. The course also aims to provide the necessary basic tools for those who intend to become qualified experts in radiation protection in later years and to be involved in education and training in radiation protection in their home countries.

Fifteen participants from thirteen Member States of the Latin America and the Caribbean region participated in a six-month long PGEC hosted by the Regional Training Centre in Buenos Aires, Argentina in 2016. In addition, 15 radiation protection specialists from twelve Member States were provided with theoretical knowledge and practical skills to serve as trainers of radiation protection officers in their countries through a regional 'train the trainers' workshop in Honduras in May. This activity aims for a multiplier effect in strengthening trainers' capacities in radiation protection.

Technical cooperation among developing countries and networking

The Agency's regional TC programmes are essential tools to promote technical cooperation among developing countries (TCDC), address common challenges efficiently and effectively, foster the exchange of best practices, and encourage networking. In Africa, much of this work is done through AFRA. AFRA projects RAF0038, 'Promoting Technical Cooperation Among Developing Countries (TCDC) in Africa through Triangular Partnerships', and RAF0046, 'Promoting Technical Cooperation among Developing Countries through Triangular Partnerships and Sustaining Regional Ownership of the AFRA Programme', have supported TCDC initiatives in the area of triangular partnerships. For example, the effective use of radiotracers in industry was promoted through triangular partnerships between Morocco, as a more advanced country in the use of this technology, with Egypt, Kenya, Sudan and Zimbabwe. Côte d'Ivoire and Morocco are collaborating in using radioisotopes in conservation agriculture. Ghana and Tunisia are working together to establish digital radiography in NDT. Cooperation between Algeria and Burkina Faso

“The Agency's regional TC programmes are essential tools to promote technical cooperation among developing countries (TCDC), address common challenges efficiently and effectively, foster the exchange of best practices, and encourage networking.”

has resulted in the calibration of several instruments used in occupational exposure control in Burkina Faso.

Indonesia and Malaysia have become the first developing countries in the Asia and the Pacific region to contribute to the Peaceful Uses Initiative (PUI) to support capacity building in the region, thereby promoting TCDC. Indonesia's contribution has supported capacity building and activities under the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture. Malaysia's contribution has supported the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) projects and the PUI Project on Supporting the Preparation and Recovery of Civil Structures in case of Natural Disasters in Asia and Pacific Region.

“Bilateral legislative assistance was provided to 20 Member States in the form of written comments and advice on drafting nuclear legislation, and through the conduct of national workshops and legislative assistance missions to advise on the development and revision of national legal frameworks.”

Legislative and drafting assistance

The Agency supports Member States in the establishment of adequate and comprehensive national legal frameworks for the safe, secure and peaceful uses of nuclear energy and ionizing radiation. Throughout 2016, legislative assistance to Member States was delivered through regional projects for Africa (RAF0048, 'Establishing National Legal Frameworks in African Member States'), Asia and the Pacific (RAS0071, 'Providing Legislative Assistance on Establishing and Upgrading the Legal Framework for Safe, Secure and Peaceful Use of Nuclear Energy'), Europe (RER0038, 'Establishing National Legal Frameworks'), and Latin America and the Caribbean (RLA0051, 'Establishing National Legal Frameworks').

Two Sub-Regional Workshops on Nuclear Law were supported under RAS0071, one in Singapore in June, and the second in Jordan in December, bringing together over sixty people in all. Participants were trained in developing work plans for the provision of legislative assistance that may be required to enhance the national legal framework.

The sixth session of the Nuclear Law Institute took place in Baden, Austria, attended by 58 participants from 51 Member States from the four regions. The Institute provided a two-week intensive training in all areas of nuclear law and in drafting corresponding national legislation.

Bilateral legislative assistance was provided to 20 Member States in the form of written comments and advice on drafting nuclear legislation, and through the conduct of national workshops and legislative assistance missions to advise on the development and revision of national legal frameworks. Scientific visits to Agency Headquarters were also organized, allowing fellows to gain practical experience in nuclear law.



RAS0071: Participants at the workshop in Singapore, 2016.

A number of Schools for Drafting Regulations (radiation safety stream and nuclear safety stream) were once again organized in 2016 under TC projects RER9141, 'Improving National Infrastructures for Safety', RER9111, 'Establishing a Sustainable National Regulatory Infrastructure for Nuclear and Radiation Safety', and RLA9079, 'Enhancing Governmental and Regulatory Safety Infrastructure to Meet the Requirements of the New IAEA Basic Safety Standards', which support Member States in upgrading their radiation and nuclear safety infrastructure.

Scientific Forum: Nuclear Technology for the Sustainable

Development Goals

The 2016 Scientific Forum focused on the role of nuclear technology in helping countries achieve their development goals. The topic was particularly relevant following the adoption of the SDGs in September 2015, which highlight the essential role that science, technology and innovation play for development. Technical cooperation activities to transfer knowledge on peaceful nuclear technology have helped Member States acquire significant expertise, thereby contributing to food security, healthy lives and the safe use of nuclear power as a measure to combat climate change.



Mr. Andrew Wheatley, Minister of Science, Energy and Technology of Jamaica, speaks at the 2016 IAEA Scientific Forum 'Nuclear Technology for the Sustainable Development Goals', at the 60th IAEA General Conference. Photo: IAEA.

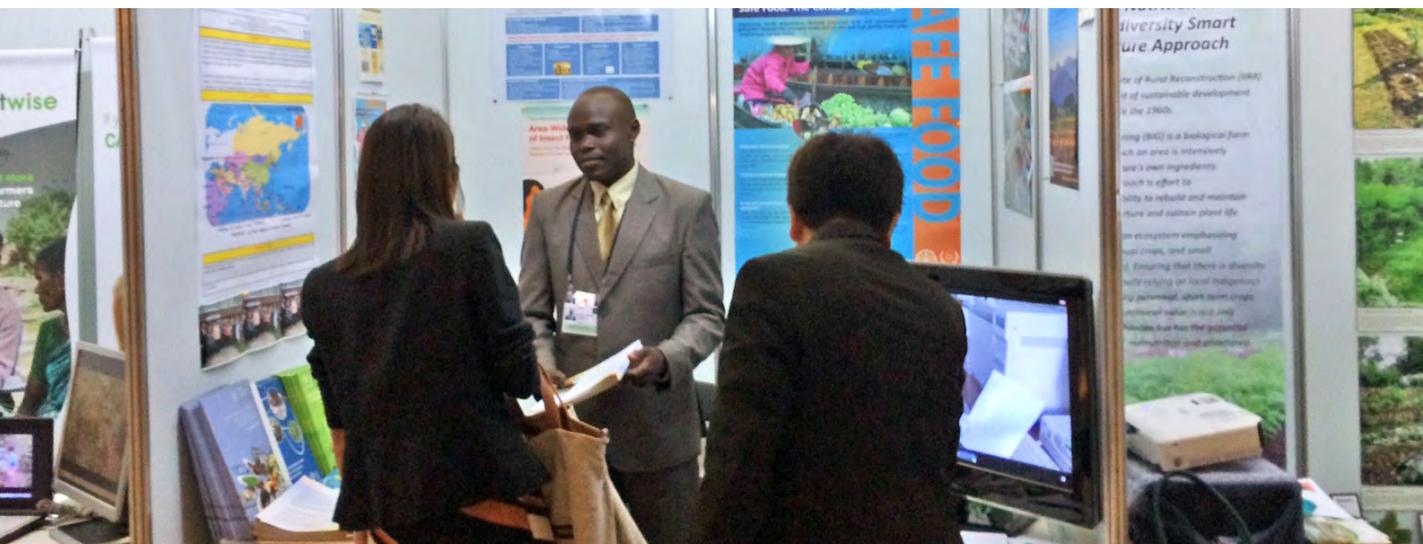
Building awareness of the TC programme

Outreach to Member States, current and potential partners, donors, the international development community and the general public continues to be an important focus for the Agency. Exhibitions focusing on TC activities were organized at the European Development Days, the Asian Development Bank (ADB) Food Security Forum and the TICAD VI, among others, and at the 60th IAEA General Conference. The TC programme's achievements were showcased in six side events, including, for example, the pilot initiative to introduce nuclear science and technology in secondary schools in the Asia and the Pacific region developed through the regional TC project RAS0065, 'Supporting Sustainability and Networking of National Nuclear Institutions in Asia and the Pacific Region.' Member States also highlighted achievements and best practices at the side event 'Panel Discussion

on the Deliverables and Effectiveness of the Technical Cooperation Programme in Africa'. Further side events presented the contribution of nuclear techniques to obtaining accurate information on breastfeeding practices, a new app that helps physicians to provide better care to patients with gynaecological cancer, and an initiative to enhance the value of learning activities through the IAEA Curricula for Nuclear Medicine Professionals.

The Agency participated in the ADB Food Security Forum in Manila, Philippines, in June. With the slogan 'Safe, Nutritious and Affordable Food for All', the Forum provided an opportunity for the Agency to share its work in building capacities in its Member States in the application of nuclear techniques in food safety, quality and security. The Agency also participated in the Techno Show, presenting irradiation techniques that are used to ensure food integrity and safety, as well as technologies used for food traceability and contaminant control.

The Agency also participated in the fifth Responsible Business Forum on Sustainable Development, co-organized by UNDP, which took place in Singapore in November, with the delivery of a keynote statement in a plenary discussion panel on 'Technology,



IAEA stand at the Techno Show at the Food Security Forum, Manila, 2016.

Innovation and Sustainable Growth'. The statement emphasized the role the Agency plays in contributing to global development through building and enhancing Member State capacities in the peaceful applications of nuclear technology.

The Agency participated in selected, high-level global health events with a focus on cancer to raise awareness about the Agency's role in fighting cancer. Agency activities resulted, for example, in the inclusion of health technologies in the 'Kampala Declaration 2016', to which African Ministers of Health committed at the 5th African Palliative Care International Conference in Uganda. Also, the Agency contributed to the formulation of the Istanbul Declaration by the First Ladies of the Organization of Islamic Cooperation (OIC) Member States, at a special session on cancer control held at the 13th OIC Summit in Turkey. In addition, the Agency's role in supporting Member States in comprehensive cancer control was promoted at the World Health Summit in Berlin, Germany, the 10th Stop Cervical, Breast and Prostate Cancer in Africa Conference of African First Ladies in Addis Ababa, Ethiopia, and at the World Cancer Leaders' Summit and the World Cancer Congress in Paris, France.

The Annual Seminar on Technical Cooperation for Permanent Missions in Vienna, designed to provide Permanent Missions with a comprehensive overview of the programme, was held in October in Vienna, and attended by 40 participants. The seminar

“The Agency participated in selected, high-level global health events with a focus on cancer to raise awareness about the Agency’s role in fighting cancer.”

provided comprehensive information on the TC programme, its policy basis, programming mechanisms and management systems, and was particularly designed for new delegates.

The Agency also posted targeted outreach material of relevance to specific 'UN Days', including World Cancer Day, World Day to Combat Desertification and World Health Day, using social media and the web to promote relevant TC activities.



Participants at the Annual Seminar on Technical Cooperation for Permanent Missions, Vienna.

The corporate visual identity for the TC programme was updated in 2016, and applied across various outreach channels, including printed material and social media platforms. The TC web site was updated with 72 web articles, 6 photo essays and 18 videos during 2016, and now has some 8500 visitors a month. With the Agency's move to a new web content management system, TC site content has also been assimilated into many more pages on the main IAEA web site, enhancing programme visibility.

More than 770 tweets were sent out from the @IAEATC Twitter account, which now has over 3000 followers. The LinkedIn TC Alumni Group now has over 1400 members. A number of new outreach products were issued, including a new TC brochure and leaflet, and a brochure on TC in Africa. Particular efforts were made to place TC stories on the main page of the IAEA website, resulting in greatly increased visibility for the programme. The stories covered topics such as nuclear medicine in Sri Lanka, agriculture in Sudan, tissue banks in Peru, Agency efforts to combat Zika virus disease, and many more.

The first international conference on the TC programme, *International Conference on the IAEA Technical Cooperation Programme: Sixty Years and Beyond – Contributing to Development*, will take place 30 May – 1 June 2017. The goal of this conference is to raise awareness of the achievements and potential of the Agency's TC programme, and to create and strengthen partnerships with Member States, sister UN organizations, and a range of other relevant partners. Considerable efforts are being made to reach out to potential audiences through the TC web site and social media.

A.2. BUILDING A MORE EFFICIENT, MORE EFFECTIVE TECHNICAL COOPERATION PROGRAMME¹⁰

Revised Supplementary Agreements, Country Programme Frameworks and UN Development Assistance Frameworks¹¹

Revised Supplementary Agreements Concerning the Provision of Technical Assistance by the IAEA (RSAs) govern the provision of technical assistance by the Agency. By the end of 2016, the total number of Member States with a signed RSA was 132. Recent signatories included the Central African Republic and Vanuatu.¹²

Country Programme Frameworks (CPFs) provide a frame of reference for technical cooperation between a Member State and the Agency, defining mutually agreed development needs and priorities that can be supported through TC programming. CPFs help to ensure that projects are effectively focused on agreed needs and priorities, identifying where nuclear technologies can be used to address national development priorities. The CPF underpins effective, sustainable implementation of TC assistance in line with relevant national developmental priorities, for the greatest socioeconomic impact.

Efforts continued throughout 2016 to further strengthen the role of the CPF as the main strategic planning tool for the development of national TC programmes for Member States, including enhancing the connection between TC interventions and national and sectoral development plans and priorities as well as other key development frameworks. Some recently developed CPFs have already established linkages between the Agency's TC programme and the SDGs. In 2016, 20 CPFs were signed by Member States, and at the end of the year, 91 CPFs were still valid. 42 CPFs are currently under development or being updated.

The United Nations Development Assistance Framework (UNDAF) is a medium-term framework for coordinated UN system action in support of national development goals and priorities. In 2016, the Agency remained focused on greater involvement in the development and implementation of UNDAFs in relevant countries. This process has enabled the Agency to raise awareness about its work, facilitated access to the main national development coordination and planning bodies, helped the Agency align with national development priorities, and assisted in coordination and collaboration with UN system organizations and other partners.

CPFs signed in 2016

Burkina Faso	Nepal
Burundi	Niger
China	Oman
Costa Rica	Poland
Ecuador	Qatar
Estonia	Senegal
Ghana	Seychelles
Malawi	Singapore
Malaysia	Uzbekistan
Myanmar	Zambia

UNDAFs signed by the Agency in 2016

Albania	Lao People's Democratic Republic
Azerbaijan	Mongolia
Bangladesh	Montenegro
Georgia	Tajikistan
Honduras	United Republic of Tanzania

¹⁰Section A.2. responds to section 3, operative paragraph 1 of resolution GC(60)/RES/11 on strengthening TC activities, including the provision of sufficient resources, based on Member States' needs and priorities, and ensuring that the components of TC projects are readily available.

¹¹This section responds to section 4, operative paragraph 11 of resolution GC(60)/RES/11 on the mechanism to share CPFs and footnote-a/ project details.

¹²This paragraph responds to section 1, operative paragraph 1 of resolution GC(60)/RES/11 on adhering to the Statute and document INFCIRC/267; and to operative paragraph 2 on the importance of RSAs.

“Efforts continued throughout 2016 to further strengthen the role of the CPF as the main strategic planning tool for the development of national TC programmes for Member States.”

Maximizing programme impact through strategic partnerships¹³

The Agency works in close partnership with Member States, United Nations agencies, research organizations and with civil society in order to maximize the contribution of nuclear science and technology to the achievement of development priorities, thus also contributing to the achievement of SDG 17, 'Strengthen the means of implementation and revitalize the global partnership for sustainable development'. The goal is to add value to Agency activities, and to take advantage of synergies to optimize the impact of Agency support. By advancing partnerships, the Agency promotes improved project identification, design, implementation, monitoring and impact, encourages the sharing of resources, and mobilizes resources in support of Member State goals.

In 2016, the Agency and the United Nations Industrial Development Organization (UNIDO) hosted a meeting of the European Regional Directors of UN agencies for the first time. This strengthened collaboration with the United Nations Development Programme (UNDP), FAO, the United Nations Economic Commission for Europe (UNECE), WHO and others.

A new delegation agreement was negotiated and signed in 2016 with the European Commission (EC) paving the way for continued work with the EU to support the implementation of regional and interregional projects to address the development needs of IAEA Member States in the area of nuclear safety.

In June, the Agency participated in the 2016 European Development Days (EDD) – a key forum for development practitioners and international cooperation in Brussels. The Agency organized an Interactive Lab Debate under the EDD topic 'Planet', focusing on the interlinkages between global challenges, sustainable development and nuclear technologies. The debate raised awareness amongst potential partners of the development related work of the Agency and how this can support the implementation of the SDGs. The Agency also participated in the EDD Global Village, demonstrating three projects conducted through the Agency's TC programme and its Joint FAO/IAEA Programme on Nuclear Techniques in Food and Agriculture.

A quadripartite meeting between the four regional/cooperative agreements, AFRA, Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA), Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) and RCA, took place in September during the 60th regular session of the Agency's General Conference, under the chairmanship of ARCAL. Members agreed to develop a plan of action to operationalize collaboration modalities between the Regional/Cooperative Agreements, as defined in a concept paper that established a Quadripartite Forum. These efforts will be supported by the Agency, with the goal of assisting the Quadripartite Forum to share information, best practices and experiences, as well as to explore common areas of inter-agreement collaboration.

A cooperation agreement with the International Renewable Energy Agency was signed with the aim of supporting cooperation in the area of energy planning to enhance capacity building efforts. Cooperation activities include joint capacity building, training events and exchange of experts in the field of energy planning.

Partnerships in food and agriculture

In October, the Agency attended the Fifteenth session of the Committee for the Review of the Implementation of the Convention (CRIC15) of UNCCD in Nairobi, Kenya. Following

"A new delegation agreement was negotiated and signed in 2016 with the European Commission (EC) paving the way for continued work with the EU to support the implementation of regional and interregional projects."

¹²This section responds to section 5, operative paragraph 1 of resolution GC(59)/RES/11 on consultations and interactions with interested States, the UN system, multilateral financial institutions, regional development bodies and other relevant intergovernmental and non-governmental bodies; and section 5, operative paragraph 3 on developing and facilitating cost-sharing, outsourcing and other forms of partnership in development.

this, the Agency was invited to join the new UNCCD Knowledge Hub and share science-based data on soil and water management, and feedback from capacity-building initiatives. It is expected that the Knowledge Hub will expand the depth and reach of knowledge on desertification, land degradation, drought and sustainable land management and make this more accessible to country parties, other scientists, planners and decision makers. This will also raise visibility of the work of the Agency and expand dissemination of knowledge products to stakeholders.

A successful pilot project supported by the Agency, in partnership with FAO, has been expanded to benefit over two thousand small farmers in the Kassala region of Sudan. Under RAF5071, 'Enhancing Crop Nutrition and Soil and Water Management and Technology Transfer in Irrigated Systems for Increased Food Production and Income Generation (AFRA)', isotopic techniques have been used to monitor soil-water interaction and to support the application of drip irrigation in vegetable cultivation. Crop productivity has improved, and the initial pilot project has been scaled up by the Sudanese Red Crescent (SRC) and the United Nations High Commission for Refugees (UNHCR) as part of their efforts to help farmers adapt to climate change and ultimately to improve livelihoods and relieve poverty in the country.

The Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture is supporting Agency technical cooperation projects that help Member States to use the SIT to control pests that affect crops and livestock. The Dominican Republic, for example, has regained access to export markets in January 2016 that had been closed (resulting in costs of roughly \$40 million in lost exports) due to an outbreak of Mediterranean fruit fly. This achievement was made possible thanks to the coordinated efforts of several organizations, including the Moscamed Programme in Guatemala/Mexico, the USDA, FAO, the IAEA, the Inter-American Institute for Cooperation on Agriculture (IICA), the International Regional Organization for Plant and Animal Health (OIRSA) and the Ministry of Agriculture of the Dominican Republic. These coordinated efforts have prevented the fly from spreading to other Caribbean and mainland countries, including Mexico and the US, thus avoiding large economic losses in the region.

In the Latin America and the Caribbean region, strategic partnerships between the Commission for the Eradication and Prevention of the New World Screwworm, USDA/APHIS, the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, OIRSA and several Member States in the region have been built under project RLA5067, 'Supporting Capacity Building for Evaluation of Feasibility of a Progressive Control Programme for New World Screwworm', to ensure a coordinated response. The project has delivered substantial assistance, including a number of impact and feasibility assessments, as well as harmonized procedures for baseline information collection and analysis, and capacity building through technical training and the provision of expert advice. Continued efforts are needed to protect the current screw worm-free areas and to start pest control in Member States where the pest is present. A recent outbreak in the Florida Keys, which was a screw worm-free area, has shown the importance of a coordinated strategy to contain and eventually eradicate the pest.

Partnerships in health

The Agency has signed a Practical Arrangement with the Islamic Development Bank (IDB) and the Organization of Islamic Cooperation (OIC) to further enhance collaboration between the three organizations to support their common Member States in their fight against cancer. The IDB is currently assisting Côte d'Ivoire, Djibouti and Niger in their development of radiotherapy centres. This support, facilitated by the Agency, which combines soft loans, grants and the provision of technical assistance, is expected to be made available to additional joint member states of the IDB, OIC and the Agency.

The Agency has launched the IAEA Curricula for Nuclear Medicine Professionals (ICNMP) with the aim of providing sustainable and standardized training in the field

"The Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture is supporting Agency technical cooperation projects that help Member States to use the SIT to control pests that affect crops and livestock."

of nuclear medicine. The ICNMP offers medical professionals in IAEA Member States the opportunity to maintain a high level of competence in the evolving fields of nuclear cardiology, hybrid imaging, therapeutic nuclear medicine and other specialized fields. The Curricula programme thus far covers six thematic areas within the nuclear medicine discipline. Two Practical Arrangements (PAs) in support of ICNMP were concluded in 2016 with Osaka University Graduate School of Medicine and Osaka University Hospital, Osaka, Japan, and Dubai Health Authority, Dubai Hospital, Department of Nuclear Medicine, Dubai, United Arab Emirates. The PAs will facilitate collaboration through the ICNMP platform to train nuclear medicine professionals, organize meetings and workshops on clinical nuclear medicine and related disciplines, exchange data and experiences, and promote the success and availability of the IAEA Curricula.

The Agency and the Association of Medical Practitioners of Spain cooperate through a Practical Arrangement to improve radiation medicine in countries in the Latin America and the Caribbean region, and to promote the use of nuclear science and technology in the field of human health. A number of activities were held in 2016 with the support of this association, such as the development of online training material in the area of radiation medicine, including nuclear medicine, diagnostic imaging, radiation oncology, radiation biology and medical physics, as well as nutrition and health related environmental studies.

Partnerships by region

In 2016, the Agency brought together the national coordinators of the Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC) to explore the rejuvenation of PATTEC and to develop a new action plan for the continent.

The Agency and the Intergovernmental Oceanographic Commission (IOC) of United Nations Educational, Scientific and Cultural Organization (UNESCO) are cooperating under TC project RAS7026, 'Supporting the Use of Receptor Binding Assay (RBA) to Reduce the Adverse Impacts of Harmful Algal Toxins on Seafood Safety'. This project supports Member States in the Asia and the Pacific region in strengthening monitoring programmes to control and mitigate the negative socioeconomic impact of toxic harmful algal blooms (HABs). The collaboration between the Agency and the IOC-UNESCO has focused on the preparation of a manual and guide for designing and implementing a plan to monitor toxin-producing microalgae. The manual will be published in 2017.

Two Agreements were signed in 2016 and implemented between the Agency and the European Association of Nuclear Medicine (EANM) and the European Society for Radiotherapy and Oncology (ESTRO). EANM and ESTRO provide operational and administrative arrangements for the conduct of training courses, and the TC programme sponsors participation from Europe region Member States. This increases efficiency



Physicists, chemists, and nuclear medicine engineers from Mexico's National Institute of Nuclear Research who have received support from the TC programme as fellows, scientific visitors and training course participants.

in relevant TC activities and facilitates networking among Member States, professional associations and partner organizations such as WHO.

In the Latin American and the Caribbean region, the Agency is collaborating with the FAO through the interregional project INT5154, 'Improving Food Safety through the Creation of an Interregional Network that Produces Reliable Scientific Data Using Nuclear and Isotopic Techniques'. The Agency also undertakes regular activities in collaboration with PAHO, in particular in the area of radiation protection of patients. In addition, a multi-year project to combat Zika in the region was launched in 2016 in partnership with FAO and WHO. The project will utilize the SIT developed by the Joint FAO/IAEA Programme as a component of integrated vector control.

Female participation in the TC programme¹⁴

Women are encouraged to participate in every aspect of the TC programme. In 2016, 4370 women from all regions participated in the programme as counterparts, fellows, scientific visitors, meeting and training course participants and international experts and lecturers. There are also currently nine women on the Director General's Standing Advisory Group on Technical Assistance and Cooperation (SAGTAC), out of a total of 21 members. In 2016, the TC programme supported the participation of 17 women in the Women in Nuclear Global Annual Conference.

Ensuring the continual improvement of the TC programme¹⁵

In early 2016, the process for the development of the TC programme was thoroughly reviewed and improvements were subsequently made to the process for the development of the 2018–2019 programme cycle. These were: (1) A streamlined Programme Note phase; (2) An extended Project Design phase with the goal of providing the Secretariat and Member States enough time for consultation in order to ensure good quality of projects designs; (3) A more rigorous technical and quality review process, to provide comprehensive input for the feedback to Member States, to support their decision making with respect to the programme under development.¹⁶

Preparations for the 2018–2019 TC cycle started in 2016 with the issuance of the Note Verbale and revised Guidelines for the Planning and Design of the IAEA 2018–2019 Technical Cooperation Programme. As part of ongoing efforts to enhance the quality of the TC programme, the Agency continued to provide support to Member States throughout the year to ensure that the projects developed for the 2018–2019 cycle are of high quality and have measurable, attainable and timely objectives.

Around 30 workshops, training events and programme briefings were organized for some 600 TC stakeholders, including project counterparts, NLOs and National Liaison Assistants (NLAs), PMOs and Technical Officers. These activities provided support for the effective use of the logical framework approach (LFA) for the design of new projects, and were organized both in-house and in Member States.

All guidance documents relating to the quality assurance of the TC programme have been revised and updated, and are available to Member States and Agency staff on

¹⁴ This section responds to section 2, operative paragraph 3 of resolution GC(60)/RES/11 on promoting gender equality and advancing gender balance in the TC programme.

¹⁵ This section responds to section 3, operative paragraph 1 of resolution GC(60)/RES/11 on strengthening TC activities, including the provision of sufficient resources, based on Member States' needs and priorities, and ensuring that the components of TC projects are readily available; to section 3, operative paragraph 3 on optimizing the quality, the number and the impact of TC projects; to section 3, operative paragraph 4 on providing Member States with information on project development according to the LFA; to section 3, operative paragraph 5 on submission and guidance of reporting; to section 3, operative paragraph 6 on the results of efforts to implement outcome monitoring; to section 3, paragraph 7 on the two-step mechanism in monitoring the quality of TC projects; and to section 3, operative paragraph 8 on enhancing adherence with the central criterion and all the TC requirements.

¹⁶ This paragraph responds to section 2, operative paragraph 9 of resolution GC(60)/RES/11 on PCMF implementation, and making it simpler and user-friendly for effective use.

"In 2016, 4370 women from all regions participated in the programme as counterparts, fellows, scientific visitors, meeting and training course participants and international experts and lecturers."

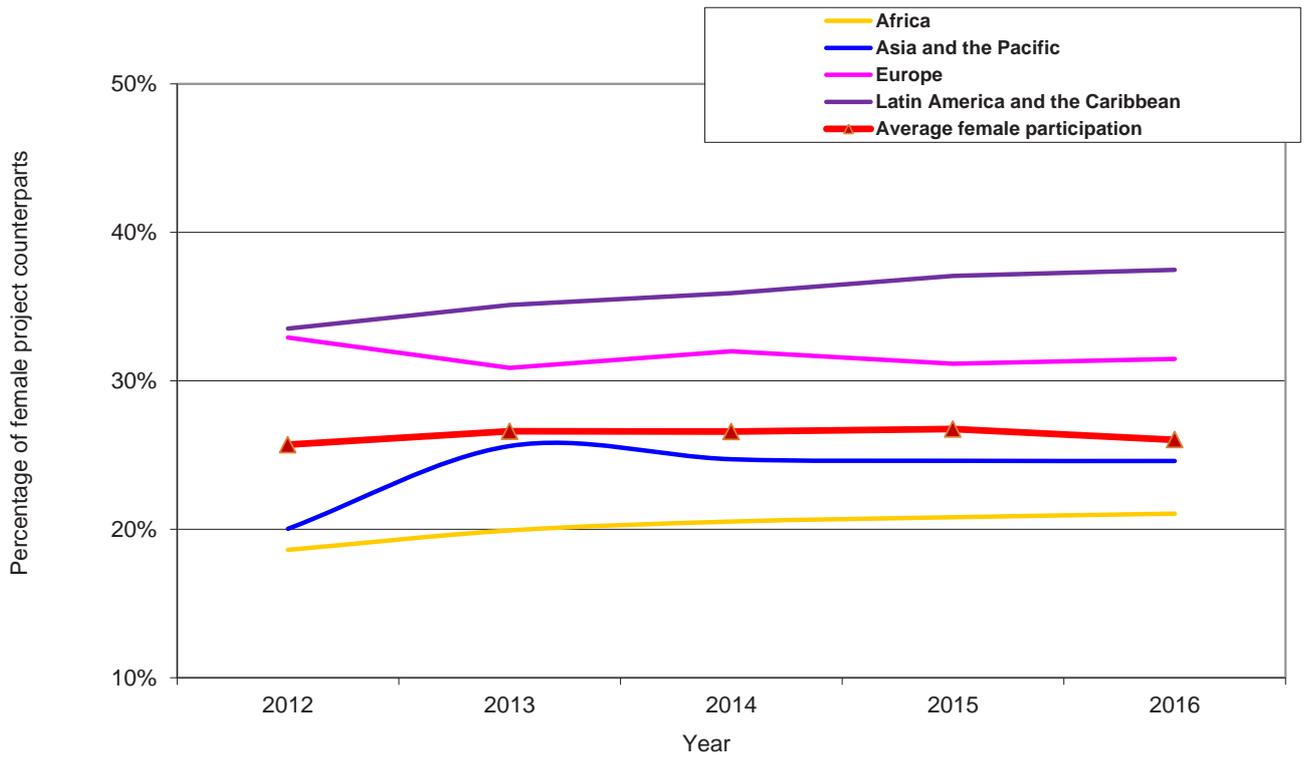


Figure 2: Female project counterparts by region, 2012–2016.

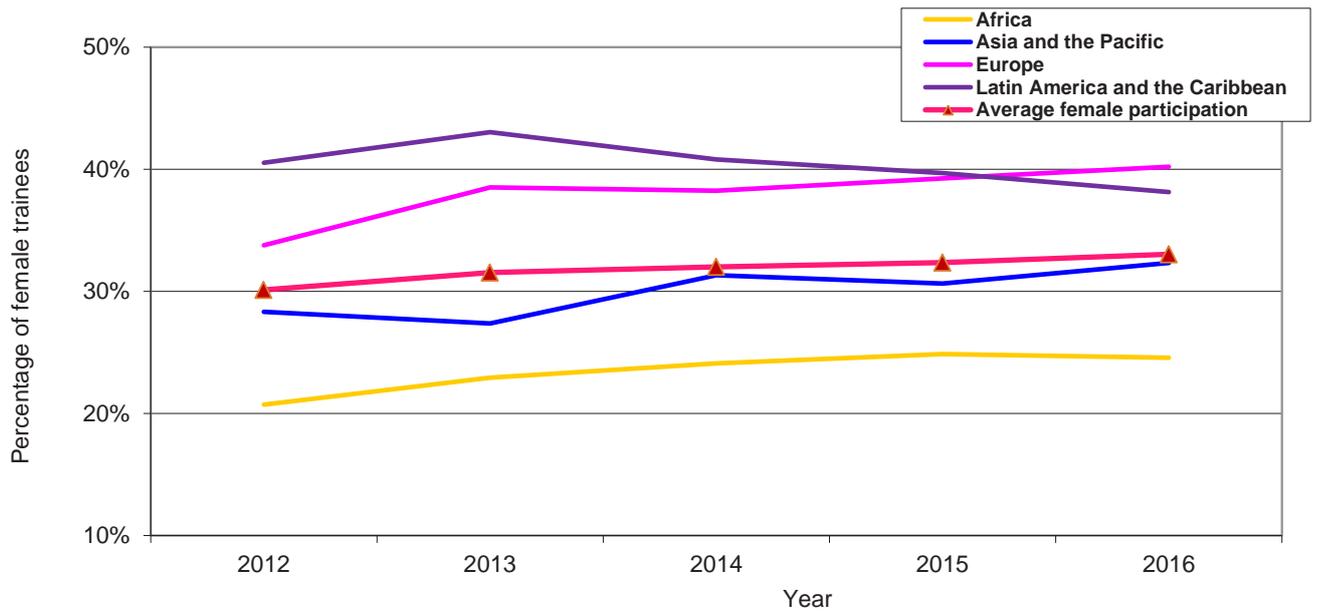


Figure 3: Female participation in training as fellows, scientific visitors, training course participants, meeting participants and other project personnel, 2012–2016.



Newly-appointed NLOs and NLAs visit the Seibersdorf Laboratories.

National Liaison Officers from Latin America and the Caribbean attended a comprehensive training session in Vienna in August 2016. Photo: IAEA.

the Programme Cycle Management Framework (PCMF) Reference Desk. The revised documents include the TC Programme Quality Criteria, and the TC Programme Planning and Design Glossary. Together with a new Quality Checklist for Programme Management Officers (PMOs), National Liaison Officers (NLOs) and counterparts, these documents help project teams to ensure that the requirements related to project design quality, application of the logical framework approach, and preparation of the project work plan are met.

The first assessment of the quality of draft project designs submitted by Member States through the PCMF platform for the 2018–2019 TC programme cycle took place in November 2016. The review aimed to provide sound and constructive feedback on the draft project documents, in compliance with the TC Programme Quality Criteria and the Guidelines for the Planning and Design of the IAEA 2018–2019 TC Programme, and thus to contribute to the preparation of better quality TC projects. Review feedback was made available to all project team members on the PCMF platform. An additional quality enhancement exercise will take place in the first half of 2017, to provide further support to Member States and project teams in optimizing the quality of their TC project documents during the last stage of project planning and design.

A range of complementary monitoring instruments, such as Project Progress and Assessment Reports (PPARs), Field Monitoring Methodologies and Self-Evaluations, have been developed in recent years, including, in 2016, an innovative electronic monitoring and reporting system for TC projects. In addition, a pilot version for e-PPARs and Project Achievement Reports submission was released in December 2016. The new system will enable quicker and more relevant reporting by Member States, and for the Secretariat, will significantly facilitate the aggregation and interpretation of PPAR data.

In 2016, field monitoring missions were implemented in three Member States (Botswana, United Arab Emirates, and Uruguay). The purpose of these missions was to strengthen the capacity of national TC stakeholders to effectively apply result-oriented monitoring and evaluation tools and to monitor the progress of on-going projects using participatory assessment, in order to ensure that expected output results are achieved and lead to planned outcomes.

The Department of Technical Cooperation works closely with the Office of Internal Oversight Services (OIOS) to support effective and efficient implementation. As part of their audit, evaluation and management services reports, OIOS made 16 recommendations to the management of the Department in 2016. The same number of recommendations from previous years were either closed or considered implemented in 2016.¹⁷

¹⁷ This paragraph responds to section 3, operative paragraph 10 of resolution GC(60)/RES/11 for OIOS and external auditors to evaluate TC projects.



Participants at the Regional Design Workshop, 31 October – 4 November 2016, Vienna, Austria. Photo: IAEA.

B. TC Programme Resources and Delivery



B. TC Programme Resources and Delivery

B.1. FINANCIAL OVERVIEW

Resources for the technical cooperation programme¹⁸

At the end of 2016, €79 million of the €84.5 million target had been pledged for the 2016 Technical Cooperation Fund (TCF), and €78.5 million in payments had been received. Total TCF resources including National Participation Costs (NPCs), assessed programme costs (APCs) arrears, and miscellaneous income amounted to €81.6 million (€78.5 million TCF, €2.8 million NPCs, €0.02 million APCs arrears and €0.3 million miscellaneous income). New extrabudgetary resources for 2016 came to €18.7 million and in-kind contributions amounted to €0.8 million.

The rate of attainment on pledges, as at 31 December 2016, was 93.6% and the rate of attainment on payments, as at 31 December 2016, was 92.9% (Fig. 5). Total payments received in 2016 include €0.8 million either of deferred or of additional payments by six Member States. Excluding these payments, the 2016 rate of attainment on payments would have been lower by 0.9%.

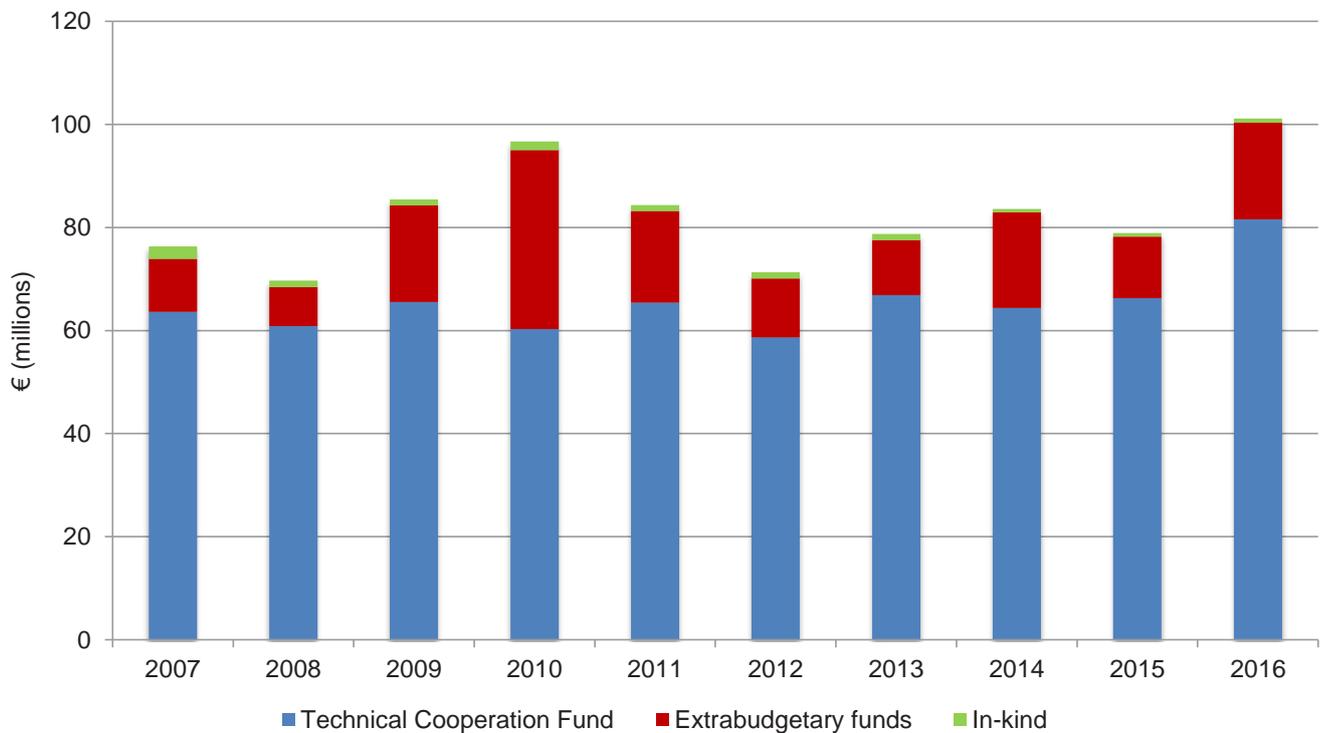


Figure 4: Trends in TC programme resources, 2007–2016.

¹⁸ This section responds to section 4, operative paragraph 2 of resolution GC(60)/RES/11 on the payment of TCF contributions and NPCs, and payment of APC arrears; and to section 4, operative paragraph 5 on timely payments to the TCF.

Table 1: TC programme resources in 2016	
2016 target for voluntary contributions to the TCF	€84.5 million
Technical Cooperation Fund, NPC, miscellaneous income	€81.6 million
Extrabudgetary resources ¹⁹	€18.7 million
In-kind contributions	€0.8 million
Total new resources for the TC programme	€101.1 million

Table 2: Payment of National Participation Costs (NPCs) and assessed programme cost (APC) arrears		
	Received in 2016	Outstanding payments
NPCs	€2.8million	€0.8 million
APCs	€0.02 million (\$0.02 million)	€0.98 million (\$1.03 million)

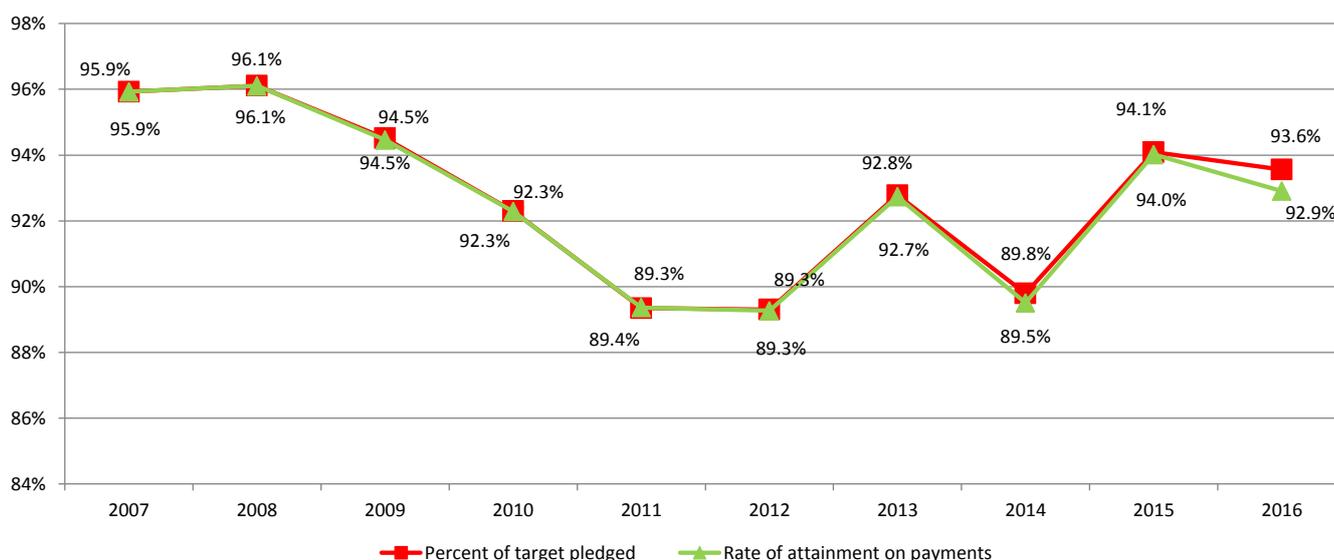


Figure 5: Trends in the Rate of Attainment, 2007–2016.

Extrabudgetary and in-kind contributions²⁰

Extrabudgetary contributions from all sources in 2016 (donor countries, international and bilateral organizations, government cost sharing) accounted for €18.7 million. More detail is contained in Table 3 (extrabudgetary contribution by donor) and Table 4 (government cost sharing). In-kind contributions accounted for €0.8 million in 2016. Of the total extrabudgetary contributions, €10.2 million was received through the PUI mechanism.

¹⁹ Please refer to Table A.5 of the Supplement to this report for details.

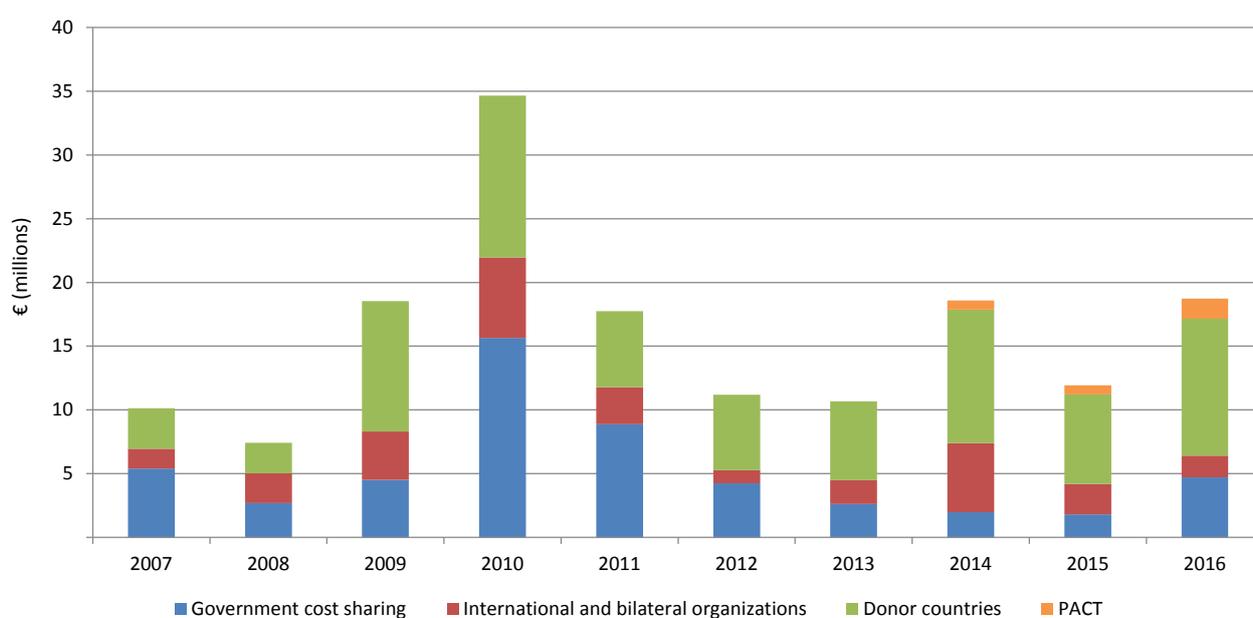
²⁰ This section responds to section 4, operative paragraph 8 of resolution GC(60)/RES/11 on seeking resources to implement footnote-a/ projects; to section 4, operative paragraph 9 on voluntary contributions and the implementation of footnote-a/ projects; and to section 4, operative paragraph 10 on extrabudgetary contributions, including the PUI.

Table 3: Extrabudgetary contributions allotted to TC projects in 2016, by donors (in euros)

Argentina	32 940	Korea, Republic of	709 923
Australia	16 390	Norway	105 208
Chile	14 548	Spain	110 000
China	143 780	Switzerland	100 000
Czech Republic	55 238	United States of America	6 900 765
Indonesia	50 555	AFRA Fund	741 376
Iraq	49 058	European Commission	952 249
Japan	2 453 176	For PACT ²¹	1 591 281

Table 4: Government cost sharing allotted to TC projects in 2016 (in euros)

Algeria	10 000	Malaysia	55 310
Colombia	101 364	Pakistan	17 940
Costa Rica	30 000	Paraguay	49 566
Estonia	1 538 393	Philippines	597 980
Ethiopia	200 000	Qatar	110 000
Ghana	44 600	South Africa	205 679
Indonesia	208 806	Sri Lanka	60 000
Iran, Islamic Republic of	330 000	United Republic of Tanzania	100 000
Israel	281 500	Turkey	98 000
Jordan	138 161	Uganda	88 822
Lesotho	181 980	Uzbekistan	248 940
Lithuania	10 000		

**Figure 6: Trends in extrabudgetary contributions by donor type, 2007–2016**²¹ For breakdown by donor country, please see Table 11.

B.2. DELIVERING THE TECHNICAL COOPERATION PROGRAMME

Financial implementation

TC programme delivery is expressed in both financial and non-financial terms. Financial delivery is articulated in terms of actuals²² and encumbrances. Non-financial delivery (i.e. outputs) can be expressed numerically in terms of, for example, experts deployed or training courses conducted.

Financial implementation for the TCF, measured against the budget for 2016 as on 31 December 2016, reached 84.6% (Table 5).

Table 5: Delivery of outputs under the TCF: financial indicators for 2014, 2015 and 2016

Indicator	2014	2015	2016
Budget allotment at year end ²³	€77 075 529	€80 024 103	€93 737 513
Encumbrances + actuals	€60 126 727	€67 896 353	€79 294 249
Implementation rate	78.0%	84.8%	84.6%

Unallocated balance

By the end of 2015, the total unallocated balance²⁴ had been brought down to €0.0. The unallocated balance for 2016 as at 31 December 2016 amounted to €4.2 million. In 2016, €8.6 million were received as advance payments for the 2017 TCF. Some €1.9 million of cash is held in currencies which are difficult to use in the implementation of the TC programme.

Table 6: Comparison of the unallocated balance of the TCF (in euros)

Description	2015	2016
Total unallocated balance	0	4 186 904
Advance payment in 2015 and 2016 for TCF for following year	6 874 950	8 578 255
Non-convertible currencies that cannot be utilized	13 688	14 067
Currencies that are difficult to convert and can only be used slowly	2 914 774	1 934 046
Adjusted unallocated balance	9 803 412	14 713 272

Human resources and procurement

Human resource indicators show the non-financial delivery of the TC programme. Regarding procurement, a total of 1714 purchase orders were issued in 2016, to a value of €30.2 million.

At the end of 2016, 914 projects were active, and an additional 450 projects were in the process of being closed. During 2016, 417 projects were closed, of which four were cancelled in consultation with the relevant Member State.

²² Terminology has changed with the implementation of the Agency-wide Information System for Programme Support (AIPS/Oracle). Actuals are the equivalent of disbursements.

²³ 2016 budget allotment at year end includes carry-over from previous years of €5.9 million, already allocated to projects.

²⁴ Total funds not allocated to TC projects.

Table 7: Delivery of outputs: non-financial indicators for 2015 and 2016			
Indicator	2015	2016	Increase/(decrease)
Expert and lecturer assignments	3477	3777	300
Meeting participants and other project personnel	5126	5820	694
Fellowships and scientific visitors in the field	1852	1701	(151)
Training course participants	2722	3114	392
Regional and interregional training courses	175	193	18

Table 8: TC procurement in 2016			
Division	Requisitions	Purchase orders issued	Value
TCAF	664	713	€10 773 666
TCAP	348	352	€4 872 571
TCEU	196	209	€6 779 976
TCLAC	388	410	€6 787 613
PACT	5	30	€976 642
Total	1601	1714	€30 190 468

Programme Reserve projects

Nine national and two regional Programme Reserve projects were implemented in 2016, at the request of Costa Rica, El Salvador, Guatemala, Haiti, Honduras, Marshall Islands, Nicaragua, Panama, Swaziland and the Latin America and Caribbean region.

Table 9: Programme Reserve projects in 2016

Project	Actuals end 2016	Encumbrances end 2016	Total
COS5034 - Strengthening national capacities for the early and rapid detection of Zika virus infections in Costa Rica	€42 000	€0	€42 000
ELS5013 - Strengthening national capacities for the early and rapid detection of Zika virus infections in El Salvador	€41 448	€0	€41 448
GUA5020 - Strengthening national capacities for the early and rapid detection of Zika virus infections in Guatemala	€42 000	€0	€42 000
HAI5007 - Strengthening national capacities for the early and rapid detection of Zika virus infections in Haiti	€40 865	€0	€40 865
HON5008 - Strengthening national capacities for the early and rapid detection of Zika virus infections in Honduras	€42 000	€0	€42 000
MHL5001 - Strengthening national capacities for the early and rapid detection of Zika virus infections in the Marshall Islands	€38 248	€0	€38 248
NIC5010 - Strengthening national capacities for the early and rapid detection of Zika virus infections in Nicaragua	€42 000	€0	€42 000
PAN5026 - Strengthening national capacities for the early and rapid detection of Zika virus infections in Panama	€42 000	€0	€42 000
RLA5072 - Strengthening regional capacities for the early and rapid detection of Zika virus infections in Central America and the Caribbean	€36 896	€0	€36 896
RLA5073 - Strengthening regional capacities for the early and rapid detection of Zika virus infections in South America	€36 573	€0	€36 573
SWA0001 - Supporting Human Resources Development and Nuclear Technology through the establishment of a comprehensive and needs-based Technical Cooperation Programme	€14 056	€0	€14 056



C. Programme Activities and Achievements in 2016

C. Programme Activities and Achievements in 2016²⁵

C.1. AFRICA

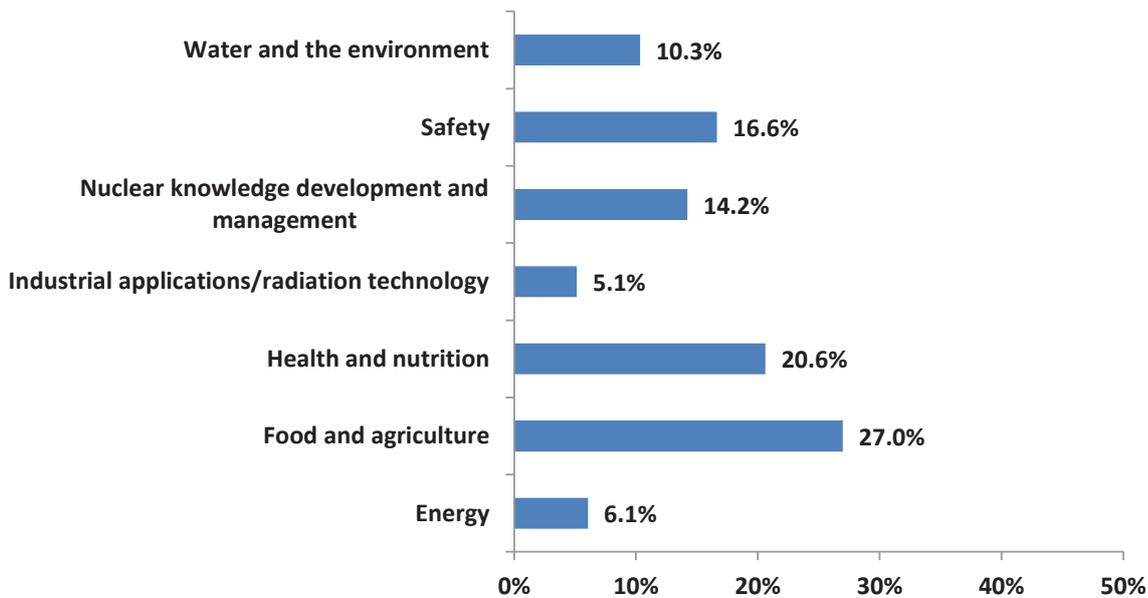
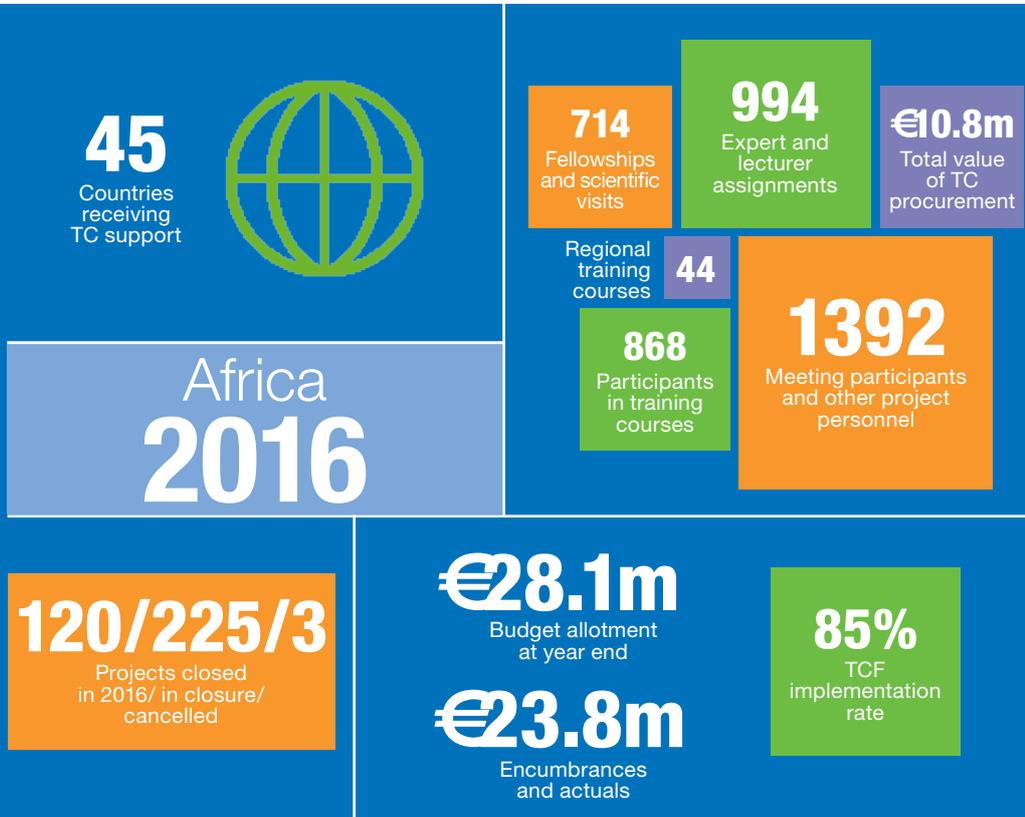


Figure 7: Actuals in the Africa region in 2016 by technical field.

²⁵ Section C responds to section 2, operative paragraph 1 of resolution GC(60)/RES/11 on facilitating and enhancing the transfer of nuclear technology and know-how among Member States; to section 2, operative paragraph 2 on strengthening TC activities through the development of effective programmes and well defined outcomes; and to section 5, operative paragraph 2 on promoting TC activities supporting the self-reliance, sustainability and further relevance of national nuclear and other entities in Member States, and enhancing regional and interregional cooperation.

Regional highlights in Africa, 2016

The Agency worked with 45 Member States in the Africa region, of which 26 are least developed countries (LDCs), to build human and institutional capacity for the sustainable application of nuclear technology for development, and to build partnerships, mobilize extrabudgetary resources and strengthen regional cooperation. The programme achieved an implementation rate of 85%, despite a number of challenges, including the security situation in a number of countries.

CPFs signed in Africa in 2016	
Burkina Faso	Niger
Burundi	Senegal
Ghana	Seychelles
Malawi	Zambia

The development of CPFs remained an important focus of attention throughout the year. Eight new CPFs were signed for Burkina Faso, Burundi, Ghana, Malawi, Niger, Senegal, Seychelles and Zambia in 2016.

The Agency actively participated in formulating the UNDAF for Algeria, Malawi, Morocco, Sudan and Zimbabwe, the UN Development Assistance Plan II for the United Republic of Tanzania and the Strategic Partnership Cooperation Framework 2017–2021 for Eritrea. By the end of 2016, the Agency was involved in the UNDAF process in 19 countries in Africa.



Signature of the CPF for Senegal. Photo: IAEA.

Project highlights

In Tunisia, the Agency is supporting the safe use of radioactive sources for cancer treatment with training and knowledge transfer. Agency experts have conducted training for radiopharmacists and medical physicists to improve quality control and the safe use of radiation medicine and equipment. Tunisia now has 17 radiotherapy machines for its population of 10 million, placing it above most countries in Africa. Since 2013, the Tunisian Government, with Agency support, has established radiotherapy centres in Tunis, Sousse and Sfax, which are equipped with a new generation of linear accelerators (linacs). These accelerators are most commonly used to treat patients by delivering very precisely localized, high-energy X-ray irradiation to tumours. The Agency is also providing specialized fellowships and scientific visits in medical physics and radiotherapy.

The TC programme, supported by the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, has greatly enhanced the capacities of Morocco's national veterinary laboratories to detect veterinary drug residues and animal diseases. The project, initiated in January 2014, was designed to support the work of Morocco's National Office of Food Safety (ONSSA). Today, the Moroccan government is able to better implement its national drug residue monitoring plan using high level analytical standards that meet international guidelines and those of major trade partners. This has enhanced food safety levels in the Moroccan market and will support plans to export poultry products. In the field of animal health, the awareness of laboratory analysts regarding quality assurance and quality control in molecular biology analysis has been greatly improved. The analysts participated in the diagnosis of the first outbreak in Morocco of H9N2, a type of avian influenza at the human-animal interface, that is, a variety of the virus commonly known as 'bird flu', which happened in early 2016.

In Namibia, collaboration and technical cooperation was initiated between the Government of Namibia through the Ministry of Agriculture, Water and Forestry and the Agency, with the support of the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture in 2008 in order to combine mutation breeding and integrated soil-water-nutrient management practices to optimize crop productivity and food security in drought-prone environments in the country. Today, combined soil and water management practices such as conservation agriculture (linking land productivity with the environment) are being used to evaluate the interactive effects of crop rotations, soil organic matter additions, and nutrient and water use on the soil quality and productivity of the mutants. With support from projects such as NAM5012, 'Developing High Yielding and Drought Tolerant Crops through Mutation Breeding', mutation breeding has been successfully used, and advanced, drought tolerant and early maturing mutant lines in cowpea, sorghum and pearl millet have been developed; these breeds have yield 10 to 20% higher than local varieties.

Building on field work carried out between 2013 and 2016, RAF7011, 'Integrated and Sustainable Management of Shared Aquifer Systems and Basins of the Sahel Region', has provided a first, broad overview of groundwater in the Sahel Region. This is a significant achievement given the vast area studied. The thirteen participating countries (Algeria, Benin, Burkina Faso, Central African Republic, Chad, Cameroon, Ghana, Mauritania, Mali, Nigeria, Niger, Senegal and Togo) have produced five transboundary aquifer/basin reports detailing the hydrological questions addressed, and highlighting major findings and recommendations on improving water resource management. These reports have also identified gaps in the required hydrogeological information.

Member States from the Africa region have used the IAEA-developed Self-Assessment of Regulatory Infrastructure for Safety (SARIS) methodology to develop and implement national action plans for the improvement of their national regulatory bodies. With Agency support, countries have enhanced their capacities to conduct national self-assessments on a regular basis to support the continuous improvement of regulatory performance. Action plans for the improvement and further development of regulatory infrastructure and processes were also produced. All participating African Member States have both conducted a self-assessment of the core functions and responsibilities of their regulatory body using SARIS, and have prepared an action plan to address identified gaps.

Research reactors play an important role in training. For countries without such facilities, online information technologies such as the Internet Reactor Laboratory (IRL) represent a great learning opportunity. The IRL is a two-way online video system, connected to a real-time research reactor where the operators perform experiments that are followed by the students. In 2016, through RAF1005, 'Strengthening the Capacity of Research Reactors Safety and Applications in Africa', this system has been installed in Tunisia and the United Republic of Tanzania, connecting with the ISIS reactor in Saclay, France, and offering distance training services for Tunisia and the United Republic of Tanzania.

“The TC programme, supported by the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, has greatly enhanced the capacities of Morocco's national veterinary laboratories to detect veterinary drug residues and animal diseases.”

Several activities were organized under RAF0047, 'Promoting the Sustainability and Networking of National Nuclear Institutions for Development, Phase II', to build the capacities of managers, high ranking decision-makers and strategic planners responsible for developing and implementing the Strategic Action Plans of their NNIs. With the assistance provided, NNIs are increasingly demonstrating their relevance through their contribution to sectoral activities for national development, by aligning their core business with the specific targets of national development plans. Through the project, Member States in Africa have been able to sustain their national nuclear infrastructure and capabilities by including peaceful nuclear technologies in efforts to address national development objectives, improving managerial practices, and facilitating partnership building with end-users for growth and development.

Regional cooperation

AFRA remains the principal framework for promoting TCDC in Africa and for enhancing regional cooperation among its 41 State Parties. In July, Egypt hosted the 27th AFRA Technical Working Group Meeting in Sharm El Sheikh. Participants reviewed and adopted concrete measures to enhance the implementation of AFRA regional projects and the management of its cooperative activities.

A panel discussion on the Deliverables and Effectiveness of the Technical Cooperation Programme in Africa was held during the 60th regular session of the IAEA General Conference. The panellists examined the progress achieved with the assistance of the TC programme in Africa over the past 10 years, particularly in regard to capacity building. The 26th Meeting of AFRA Representatives also took place during the 60th General Conference. Participants adopted, among others, the AFRA Annual Report 2015, the updated AFRA Guidelines and Indicators for the sustainability of nuclear institutions and the Charter of the Regional African Network of National Nuclear Institutions. The meeting also adopted the 2016–2030 Regional Strategy for enhancing the sustainability of nuclear medicine in Africa, and the Concept Paper for the Quadripartite Forum (AFRA, ARCAL, ARASIA and RCA) to promote collaboration between the regional/cooperative agreements.

Contributions to the AFRA Fund

In 2016, the total contribution of AFRA State Parties to the AFRA Fund was €841 376, of which €741 376 was allocated to TC projects. The remaining €100 000 was transferred to the Renovation of the Nuclear Applications Laboratories (ReNuAL) project, in support of the construction of the new laboratories at Seibersdorf.

Table 10: Voluntary contributions to the AFRA Fund for TC activities, 2016 (in euros)

Algeria	444 888	Lesotho	2635
Botswana	9396	Mauritius	13 250
Burkina Faso	3396	Morocco	54 652
Cameroon	11 112	Namibia	7228
Côte d'Ivoire	4079	South Africa	230 446
Democratic Republic of the Congo	6012	Uganda	6895
Kenya	40 773	Zimbabwe	6614

C.2. ASIA AND THE PACIFIC

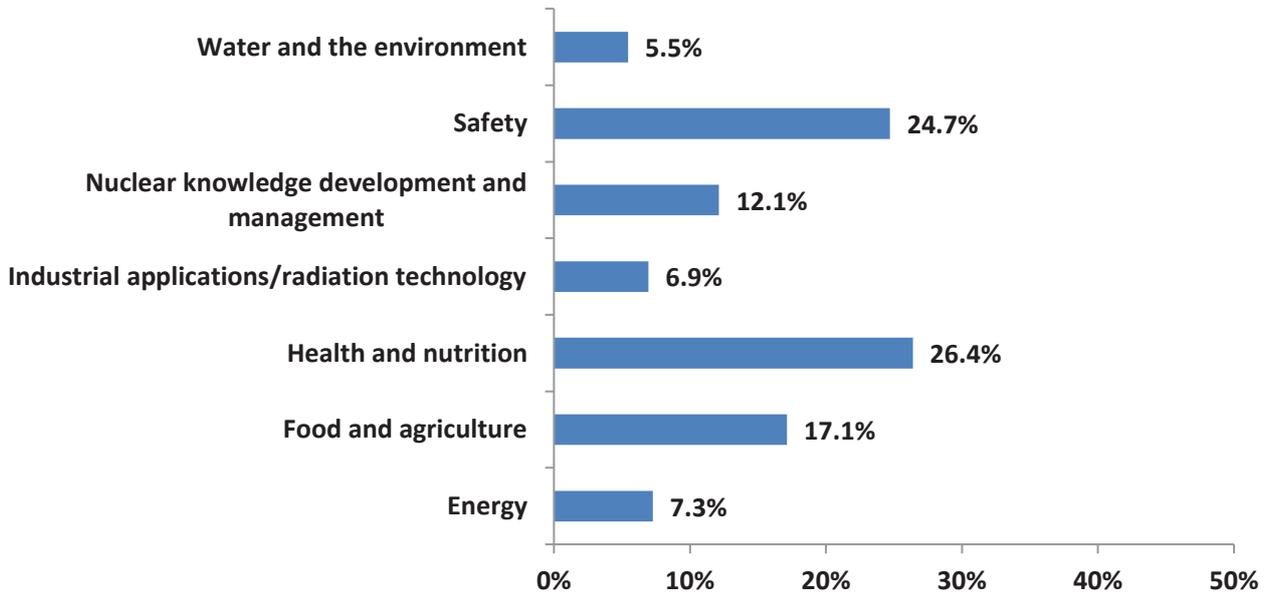


Figure 8: Actuals in the Asia and the Pacific region in 2016 by technical field.

Regional highlights in Asia and the Pacific, 2016

The TC programme provided support to 41 countries and territories in the Asia and the Pacific region in 2016, of which nine are LDCs and eight are SIDS (three countries are both LDCs and SIDS). In 2016, the Agency supported 290 national and 80 regional TC projects in the region. The programme achieved an implementation rate of 82.9%.

The TC programme for the Asia and the Pacific region is designed to meet the respective strategic priorities of the region’s Member States, in line with their national development plans. National programmes are tailored according to the national development priorities set out in the CPFs, and are aligned, where appropriate, with the SDGs. In 2016, CPFs were signed by seven Member States: China, Malaysia, Myanmar, Nepal, Oman, Qatar and Singapore.

CPFs signed in Asia and the Pacific in 2015	
China	Oman
Malaysia	Qatar
Myanmar	Singapore
Nepal	

In 2016, the Agency co-signed the UNDAF for Bangladesh (2017–2020), and the Lao PDR United Nations Partnership Framework (2017–2021). The Agency has also continued to contribute to the implementation of Nepal’s UNDAF for 2013–2017, focusing in particular on increasing government capacities to develop and establish infrastructure to ensure

radiation safety in compliance with international standards, and to use nuclear technologies in key development sectors including human health, food and agriculture, environment and water resources, industry and minerals exploration and energy planning.

The Agency also participated actively in the dialogue of the United Nations Country Team (UNCT) for developing Viet Nam’s One Strategic Plan 2017–2021. This is now in its final stage of preparation. The Agency has also closely worked with the UNCT of Indonesia in the development of the United Nations Partnership for Development Framework (UNPDF 2016–2020). Agency TC activities have been reflected, where relevant, in the UNPDF and the Agency co-signed the document with UN partners and the Government of Indonesia in early 2016. The Agency also participated in the discussion of the new reporting, monitoring and evaluation mechanism.

A meeting of NLOs and National Representatives from the Asia and the Pacific region was held in Vienna in February. The meeting discussed the challenges, opportunities and the way forward for the regional programme, and the Regional Programme Framework



Signature of the CPF for China. Photo: IAEA

(2018–2028) was developed and endorsed. The Framework is a working document that will guide the programming of non-Agreement regional projects in the Asia and the Pacific region over the next ten years.

Project highlights

The Jordan Research and Training Reactor (JRTR), with a capacity of 5 MW, was inaugurated on 7 December 2016. JRTR is stationed at the Jordan University for Science and Technology. The research reactor is intended to be utilized for training, research and radioisotope production for medical uses, as well as industrial application. The Agency assisted in the preliminary design of the neutron imaging facility and the high resolution neutron powder diffractometer facility for the JRTR through JOR1006, 'Building Capacity for the Construction, Commissioning, Safety and Utilization of the Jordan Research and Training Reactor (Phase II)'. The Agency has also supported the development of human capabilities for the JRTR, particularly in safety, including an Integrated Safety Assessment

“The Jordan Research and Training Reactor (JRTR), with a capacity of 5 MW, was inaugurated on 7 December 2016.”



JOR1006: Inauguration ceremony of the JRTR, December 2016.
Photo: Jordan Atomic Energy Commission.



IAEA peer review team in discussion with Jordanian experts during the IAEA INSARR mission to Jordan. Photo: Jordan Atomic Energy Commission.

of Research Reactors (INSARR) peer review mission carried out in December on the results of the commissioning programme as well as for the preparation of the routine operation of the reactor.

In the United Arab Emirates, the national project UAE9011, 'Strengthening the National Programme on Patient Radiation Safety and Dosimetry', has helped to enhance the radiation safety and dosimetry capacities of participating hospitals to ensure radiation protection for patients and workers in diagnostic and interventional radiology and nuclear medicine. Over 200 medical professionals (of whom 50% are women), including radiologists, nuclear medicine physicians, medical physicists, radiographers, nuclear medicine technicians and regulators, have enhanced their knowledge of radiation safety and dosimetry in the fields of radiology and nuclear medicine. An upgraded patient radiation protection procedure is now in place. This has strengthened the application of the IAEA international Safety Standards for the radiation protection and safety of radiation sources at the national level to control patients' radiation exposure. Additionally, a quality management system (QMS) for image quality and optimization of patient doses is now operational in the participating hospitals.

The Agency has helped Kuwait to establish a unique facility for conducting large scale ocean acidification experiments under K UW7003, 'Addressing Ocean Acidification and Carbon Export in Marine Waters', which has enhanced national capabilities to use nuclear techniques to study the effects of ocean acidification on various organisms. The project has



produced some remarkable datasets. Kuwait has also developed a water quality monitoring programme for in situ monitoring of key water quality parameters.

Under the TC project MHL7001, 'Developing a National Radioactivity Monitoring Capacity', the Agency has provided emergency support to the Marshall Islands to establish monitoring capabilities for PCBs and trace metals. Immediate assistance was provided in response to a report identifying high rates of contamination. Working with WHO, the Agency provided assistance to the Marshall Islands in the form of equipment and training, enabling the establishment of analytical capacities to ensure food safety for the population.

In Cambodia, through project KAM6001, 'Improving Access to Radiotherapy and Establishing a Plan for Nuclear Medicine Services', the Agency is supporting the establishment of the country's first National Cancer Centre (NCC), in a joint undertaking with the Royal Cambodian Government. From the first ground-breaking for the NCC, the Agency has supported the Centre with design, equipment, training and expert advice to create a modern medical facility offering comprehensive cancer care. The Agency is contributing to both nuclear medicine and radiotherapy by supporting the training of key medical professionals. In addition, dosimetry, radiation protection and immobilization items provided through the project will contribute to the safety of patients and personnel during imaging and treatment procedures. The NCC project is expected to be inaugurated mid-2017.

By supporting the selection of superior breeding stock, the TC project MYA5022, 'Improving Animal Productivity through the Use of DNA-Based Technology and Artificial Insemination', has assisted Myanmar in improving livestock productivity. National capacity in the use of molecular and related technologies for raising the genetic quality of local and adapted livestock breeds has been enhanced. In addition, a genetic laboratory has been set up, and the staff have been trained on basic DNA molecular techniques and on devising detailed procedures for the genetic characterization of local breeds. The Agency has also conducted a training course on techniques and organization of artificial insemination field services. This project has primarily benefited small holder farmers and livestock owners in rural regions. The improvement of livestock productivity and the resulting strengthening of food security have also benefitted the wider population of Myanmar.

The Agency is providing technical assistance through regional project RAS9085, 'Enhancing the Radioactive Waste Management Infrastructure in the Asia - Pacific Region',



RCA Board of Representatives annual meeting in Mongolia 2016.



ARASIA regional meeting, Jordan, 2016.

for the development of Malaysia's mobile hot cell, which will be used for the management of high activity radioactive waste both nationally and regionally.

Regional cooperation

The ARASIA Board of Representatives Meeting was held in April at the Middle East Scientific Institute for Security in Amman, Jordan. The four-day meeting provided a platform for deliberations on strategic and policy issues pertaining to the management of ARASIA and its future programme, with the goal of ensuring that ARASIA cooperation has real and sustainable impact. As a step towards mutual learning among ARASIA countries to accelerate development in the area of nuclear technology, agreement was reached on the modalities, procedures and a concrete timeframe for the designation of ARASIA regional centres.

At the ARASIA meeting held on the margins of the 60th IAEA General Conference, delegates agreed upon a plan of action to build on existing strengths, to explore opportunities, to alleviate risks and to address weaknesses with the aim of supporting the implementation of the ARASIA Medium Term Strategy for 2018–2027.

The RCA held two policy meetings in 2016. The 38th Meeting of the National RCA Representatives took place in Ulaanbaatar, Mongolia in May, and the RCA General Conference Meeting took place in September in Vienna, Austria. Three Working Groups (WGs) were established in preparation for the execution of the RCA Medium Term Strategy (MTS) 2018–2023: the WG on Financial Gap Analysis and Resource Mobilization, the WG on Human Resource Development, and the WG on MTS 2018–2023 Coordination.

Within the frame of regional TC project RAS9073, 'Improving the Regulatory Framework for the Control of Radiation Sources in Member States', a four week training course for new regulators and Member States who are in the process of establishing nuclear regulatory bodies was organized in collaboration with the RCA Regional Office (RCARO) and the Korea Institute of Nuclear Safety. The training course, funded by RCARO, supported the build-up of the competencies and expertise required to establish and operate an adequate regulatory programme for the safety and security of radiation sources.

C.3. EUROPE

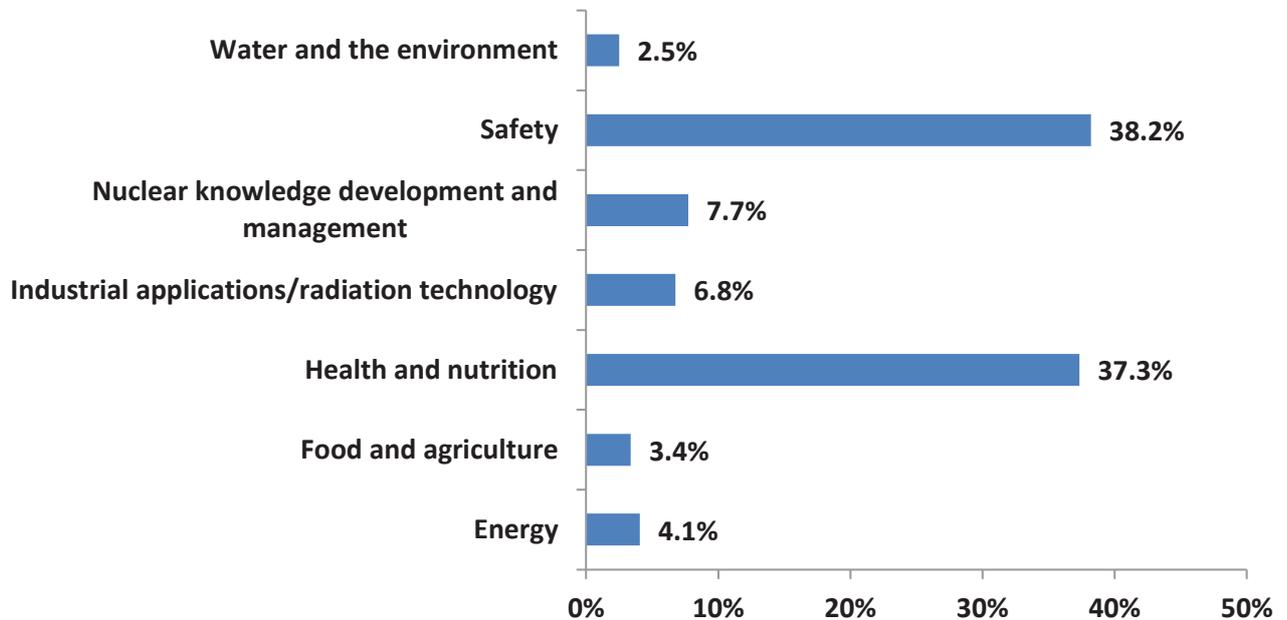
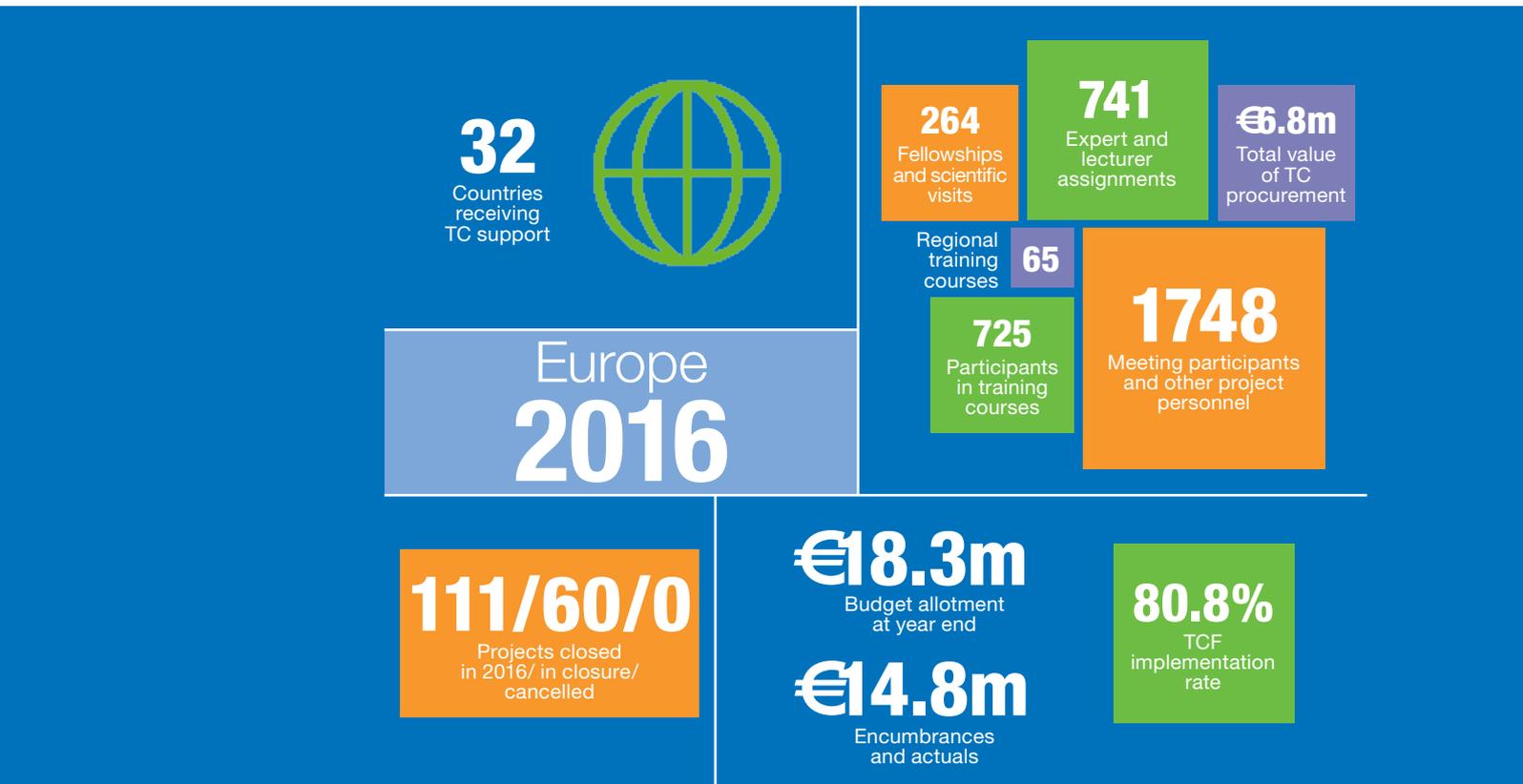


Figure 9: Actuals in the Europe region in 2016 by technical field.

Regional highlights in Europe, 2016

In 2016, 32 Member States in the Europe region (which includes Central Asia) received support through a total of 158 projects, of which 34 were regional and 124 national. Of the 158 projects, 108 were initiated in the 2016–2017 cycle. All 32 Member States in the region are participating in regional projects, and 28 countries have active national TC projects. The programme in the region achieved a TCF implementation rate of 80.8%

During 2016, three CPFs were signed, with Estonia, Poland and Uzbekistan. UNDAFs were co signed by the Agency for Albania, Azerbaijan, Georgia, Montenegro, and Tajikistan, and programme activities were carried out according to commitments in 12 further UNDAFs.

CPF signed in Europe in 2016

Estonia

Poland

Uzbekistan

Project highlights

In Europe, the regional project RER6033, 'Strengthening Knowledge of Radiation Therapy Professionals (Radiation Oncologists, Medical Physicists and Radiation Therapy Technologists)', has provided training opportunities on advanced treatment modalities for a total of 233 radiotherapy practitioners in 2016. These training courses were implemented in partnership with ESTRO and Inholland University. With a financial contribution from the Russian Federation, the project enabled the organization of four regional training courses for Russian-speaking medical physicists to help improve skills and knowledge in medical radiotherapy physics, including one on Quality Assurance Teams for Radiation Oncology, and another on Status and Quality of Radiotherapy Services.

With Agency support under AZB6008 'Introducing Cyclotron and Positron Emission Tomography/Computed Tomography (PET/CT) in Clinical Practice', Azerbaijan has been able to establish a cyclotron and PET-CT facility, housed in the newly founded nuclear medicine centre in Baku under the auspices of the National Centre for Oncology. The combination of PET and CT, thanks to state-of-the-art multimodality scanners, provides both functional and anatomical information with great advantages over conventional equipment. IAEA technical officers and experts supported project implementation, and provided project monitoring and multidisciplinary expert advice. The Agency also assisted the National Centre for Oncology of Azerbaijan in the timely review of documents, provided necessary help in obtaining regulatory permissions, and conducted the final audit of the completed facility. Agency support included knowledge transfer: the technical staff of the centre received training to ensure the provision of services to cancer patients, and to support safety and the protection of patients, staff and the public from ionizing radiation. The centre is now appropriately equipped to address the health needs of the population, and in particular the needs of cancer patients. It supports early detection, staging and disease management, and thereby improves the life expectancy of patients. The staff trained under this project are expected to contribute significantly to the operation, management and further implementation of PET technology in the country.

In 2016, the technical cooperation programme supported an innovative cross-Atlantic learning activity for young professionals for the second time. This activity, the Intercontinental Nuclear Institute (INI) brought together 27 fellows from 13 European countries in a learning journey across continents. The INI programme provides experiential learning to promising graduate students and young professionals in the fields of nuclear science and technology who will be the future experts leading the nuclear power industry. The programme is designed to leverage existing expertise and to create a network of young professionals who will bridge the technology and knowledge gaps in the nuclear power sector. Hands-on activities and technical visits are the bedrock of INI's design, which started in 2015 as a pilot programme. The four-week programme, held in 2016 from 27 June to 22 July, is a joint initiative between the U.S.-Czech Civil Nuclear Cooperation Centre in Prague and the University of Massachusetts at Lowell. The INI 2016 offered fellows opportunities for capacity building, technical engagement and global dialogue in the fields

“ In 2016, the technical cooperation programme supported an innovative cross-Atlantic learning activity for young professionals for the second time.”

of nuclear science and power reactor technology. The programme included trips to the Pilgrim nuclear power plant in Plymouth, Massachusetts, the Seabrook nuclear power plant in New Hampshire and the Temelin Nuclear Power Station in the Czech Republic, where participants saw how nuclear power plants operate.

A TC Europe regional meeting was held during the 60th IAEA General Conference, at which the topics 'Decommissioning, Waste Management, Environmental Remediation: A thematic and regional overview', and 'Animal Health with a particular focus on Lumpy Skin Disease in Cattle: Recent Developments and Actions' were discussed.

C.4. LATIN AMERICA AND THE CARIBBEAN

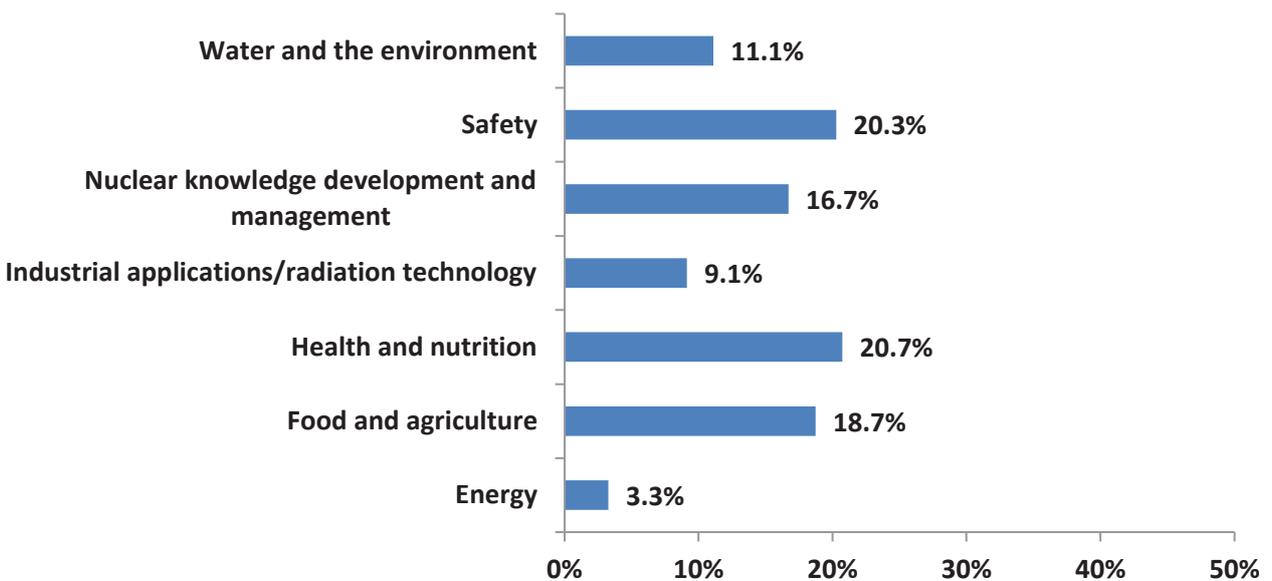
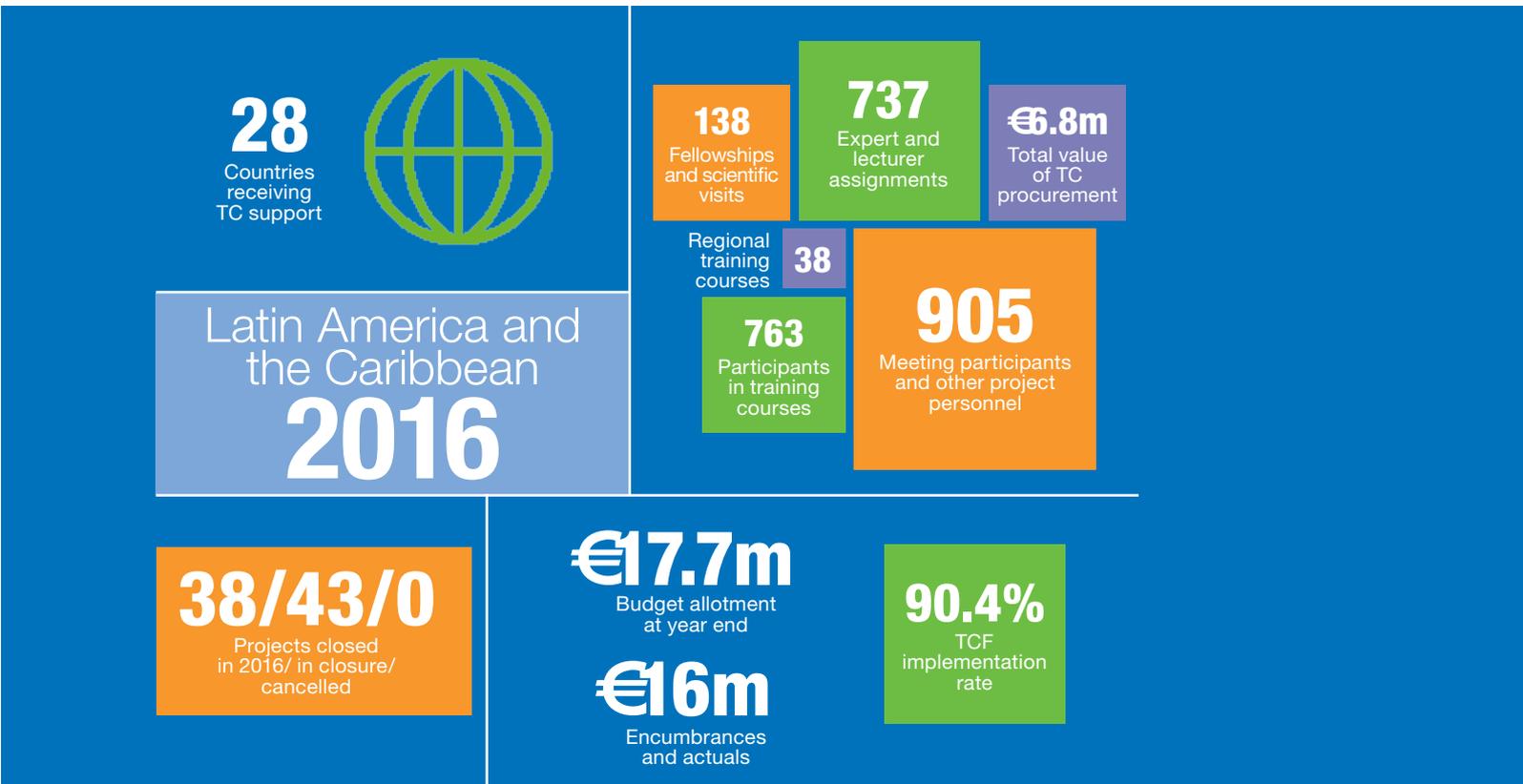


Figure 10: Actuals in the Latin America and the Caribbean region in 2016 by technical field.

Regional highlights in Latin America and the Caribbean, 2016

In 2016, the TC programme continued to provide support and technical cooperation to Member States in the Latin America and the Caribbean region to build human and institutional capacities for the sustainable and safe application of nuclear technology.

CPFs signed in Latin America and the Caribbean in 2016

Costa Rica

Ecuador

Monitoring project implementation and the progress made in achieving the expected project results in the region was a priority.

Three Member States had national programmes for the first time. Of the 28 Member States in the region, 25 have national TC projects, and one is a LDC. A total of 165 projects were active during the course of the year. One hundred and twenty-six were national projects and 39 were regional. Of the regional projects, 19 projects were initiated as part of the 2016–2017 TC cycle. Additional projects were also created to counter the Zika outbreak. The programme in the region achieved a TCF implementation rate of 90.4%.

Two CPFs were signed in 2016: Costa Rica and Ecuador. The most recent UNDAF co-signed by the Agency in the Latin American and Caribbean Region is for Honduras.

Project highlights

In addition to traditional support for capacity building in various thematic fields, the Agency paid particular attention to the Zika outbreak in Latin America and the Caribbean in 2016. Altogether, seven national and three regional programme reserve projects were approved to address this outbreak. The projects aimed to enhance capacities to diagnose patients with the Zika virus early and fast. In addition, the Agency provided support to Ecuador in the aftermath of the terrible earthquake that occurred in April, by providing government institutions with medical and radiological equipment.

The regional project RLA5070, ‘Strengthening Fruit Fly Surveillance and Control Measures using the Sterile Insect Technique in an Area Wide and Integrated Pest Management Approach for the Protection and Expansion of Horticultural Production (ARCAL CXLI)’, supported several initiatives to strengthen the capacities of the participating countries during the year. These included training courses and the provision of equipment and materials to enhance national fruit fly programmes and national capacities to apply integrated fruit fly management, including the SIT, in fruit producing areas.

Support continued to be provided to the Dominican Republic throughout 2016 to assist with the outbreak of the Mediterranean fruit fly. The presence of fruit flies and the expansion of the pest would have restricted exports of fruits and vegetables from the island, and there would have been a high risk of pest introduction to Mexico and the USA. Area-wide eradication actions were successfully coordinated and implemented in Punta Cana and other infested areas in the Altagracia Province. Assistance included operations to suppress and eradicate the pest as well as to establish a surveillance programme.

Regional cooperation

ARCAL continues to contribute to the sustainable development of the Latin American and Caribbean region, supporting cooperation among countries and promoting the peaceful uses of nuclear science and technology to address priorities and needs in the region.

During 2016, ARCAL prepared terms of reference for the monitoring and evaluation of TC projects, providing a methodology that will enhance the implementation of regional projects and strengthen their connection to the ARCAL Regional Strategic Profile for Latin America and the Caribbean (RSP) 2016–2021 (IAEA-TECDOC-1763), a key programmatic reference document that establishes priority areas for the regional TC programme.

“In addition to traditional support for capacity building in various thematic fields, the Agency paid particular attention to the Zika outbreak in Latin America and the Caribbean in 2016.”

C.5. INTERREGIONAL PROJECTS

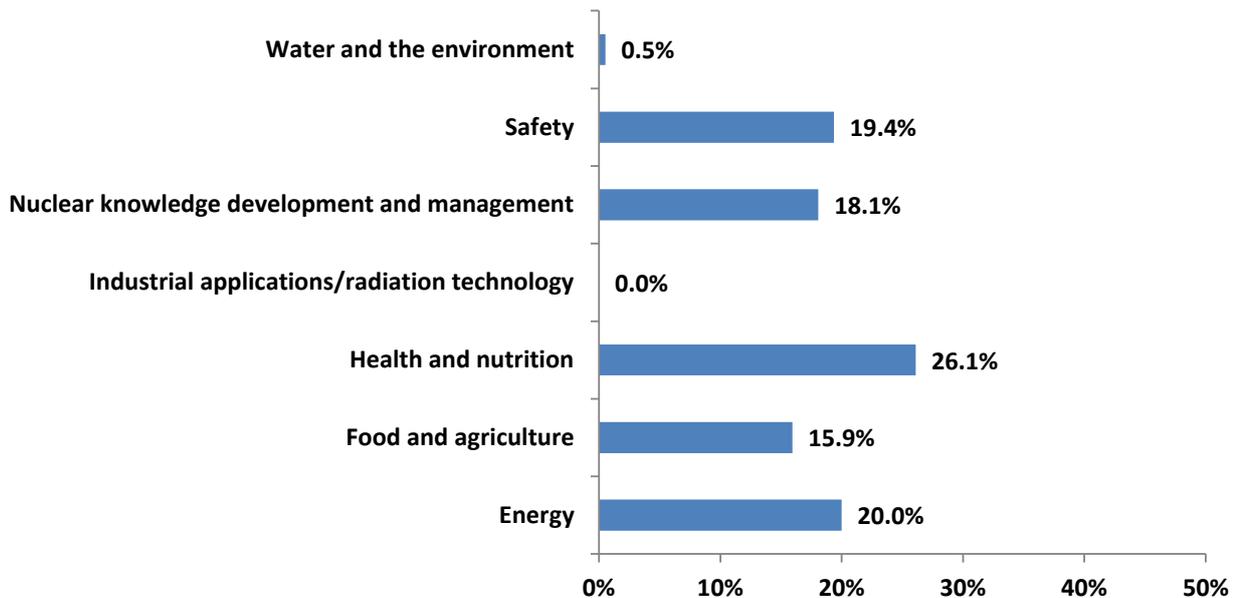


Figure 11: Interregional actuals in 2016 by technical field.

Interregional projects deliver TC support across national and regional boundaries and address the common needs of several Member States in different regions. In 2016, actuals under interregional projects totaled €5.6 million. At the end of December 2016, 16 interregional projects were active, with a further five in closure. One interregional project was closed during the course of the year.

The interregional project INT5155, 'Sharing Knowledge on the Sterile Insect and Related Techniques for the Integrated Area-Wide Management of Insect Pests and Human Disease Vectors', has built capabilities in control strategies for dengue and malaria vectors. By supporting training for relevant managers and scientists in regional facilities or international centres, networking with National Health Organizations to exchange knowledge and expertise on control strategies against disease-transmitting mosquitoes, and the sharing of knowledge on the management of area-wide integrated pest management (AW-IPM), the project has created awareness and increased technical and managerial capacity on AW-IPM programmes. The project has also helped to integrate the environmentally friendly SIT with other insect control methods to address existing major crop pests as well as livestock/human vectors. Moreover, the project has contributed to the scientific field, with findings improving existing knowledge with respect to the bio-ecology characteristics of the pests and vectors, particularly their ability to adapt to climatic conditions arising from global warming. On the whole, the project has also assisted participating Member States in achieving their development goals.

The Agency is supporting a Master of Medical Physics Programme (MMP) through interregional project INT6057, 'Establishing a Joint IAEA/ICTP International Post-Graduate Medical Physics Education Programme' and relevant national or regional TC projects. The MMP consists of one year of training at ICTP and Trieste University, and a second year of full-time clinical training in a hospital in Italy. The first group of students began clinical training on 1 January 2016. The students come from Member States that lack adequate post-graduate education programmes or clinical training opportunities in medical physics, in particular low and middle income countries in Africa, Asia, Eastern Europe and Latin America. A second group of 21 students has begun a Master of Medical Physics Programme (MMP) in the International Centre for Theoretical Physics (ICTP) and Trieste University on 13 January 2016. The MMP was prepared with the assistance of the Agency and is based on the IAEA Training Course Series No. 56 'Postgraduate Medical Physics Academic Programmes'. The

clinical training is conducted in selected Italian hospitals who have agreed to follow the IAEA clinical training guides in medical physics (TCS-37 for radiation oncology physics, TCS-47 for radiology physics and TCS-50 for nuclear medicine physics). A collaborative agreement has been signed between the Agency and ICTP to support the MMP.

Sustainable uranium production is critically important for uranium fuel security, notably in nuclear 'newcomer' countries, some of which are seeking to source fuel from their own uranium resources. Activities

to integrate efforts to achieve SDGs into the

uranium production cycle and build business models that adapt to a wide range of local conditions are supported under INT2019 'Deploying Technology and Management of Sustainable Uranium Extraction Projects'. In 2016, the Agency supported a meeting to share experiences with the in situ leaching method. In addition, a training course was carried out to introduce the practical application of United Nations Framework Classification–2009 (UNFC–2009, developed by the UN Economic Commission for Europe) in classifying resources such as uranium, thorium, coal and oil and gas.

The on-going interregional capacity building project, INT2018, 'Supporting Knowledgeable Decision-making and Building Capacities to Start and Implement Nuclear Power Programmes', has successfully developed additional expertise and competencies in participating countries introducing or expanding their nuclear power programmes. With 42 participating Member States, the project is extensive in scale. It has primarily aimed to enhance and coordinate capabilities for the introduction of nuclear power in newcomer countries, and to assist in establishing a global network and forum for the exchange of information to new and expanding nuclear power programmes. Training and capacity building was delivered to Member States through training courses, fellowships, expert missions and workshops. Topics included the licensing process for new or expanding nuclear power programmes, integrated management systems and the development of safety culture, and support to nuclear power infrastructure capacity building was also provided. The training has been valuable in enabling participating Member States to create capacities to support informed decision-making in launching or expanding nuclear power programmes.

The interregional project INT0086, 'Building Human Capacity for the Construction, Operation and Use of SESAME,' has been completed, and INT0092, 'Building Human Capacity for the Construction, Operation and Use of Synchrotron-Light for Experimental Science and Applications for the Middle East', has been initiated in continuation. The projects focused on building capacities in support of the International Centre for Synchrotron Light for Experimental Science and Applications in the Middle East (SESAME). As the region's first major international research centre, SESAME will contribute to regional scientific, technical and economic development and will be a focal point through which scientific collaboration will be strengthened. The project enabled the training of SESAME staff and interactions with experts at different synchrotron light sources in Australia, Europe and USA.



INT6057: Students attending clinical training.

C.6. PROGRAMME OF ACTION FOR CANCER THERAPY (PACT)²⁶

PACT highlights in 2016²⁷

In 2016, the Agency, through PACT, continued to support the efforts of low and middle income countries (LMICs) to strengthen national cancer control capacities.

*imPACT reviews*²⁸

Eight Member States received imPACT review missions, during which cancer experts assessed national cancer control needs and capacities. The findings and recommendations resulting from such review missions focus on strengthening these capacities, facilitate evidence-based decision-making and help governments to prioritize interventions and investments for cancer control. They also form the basis for dedicated follow-up support by the Agency in cooperation with partners.

Belarus: imPACT review mission 4–9 April 2016. Belarus delivers cancer services of a high standard, particularly in the areas of diagnostics and treatment. At the same time, cancer remains the second leading cause of death in the country. Recommendations focus on further strengthening the effectiveness of current cancer services as well as the coordination and communication between different facilities and programmes related to cancer control.

Belize: imPACT review mission 5–9 December 2016. Belize's national plan to address NCDs includes some priority actions in cancer control which are not yet implemented. Cancer treatment services are very limited and radiotherapy is not available at all. In general, access to cancer treatment requires travel abroad. Preliminary recommendations focus on developing a national cancer control programme, establishing a population-based cancer registry to determine the actual cancer burden, improving access to cancer treatment in the short and long-term, and establishing an adequate radiation safety infrastructure.

Honduras: imPACT review mission 16–20 May 2016. While implementation of Honduras' cancer control programme was discontinued a few years ago, several important actions continue to be undertaken to strengthen and expand prevention, early detection and cancer registration. Recommendations focus on renewing strong national leadership for cancer control, expanding access to cancer treatment, building corresponding human resources capacities and establishing an adequate radiation safety and nuclear security infrastructure.

Kenya: imPACT review mission 22–26 August 2016. Kenya has made significant progress in developing cancer control services, policy and legislation since the last imPACT review in 2010. The Government now plans to further expand and decentralize access to public health services for the early detection and treatment of cancer, and, based on the information from the review mission, has initiated the development of the new National Cancer Control Strategy 2017–2022. imPACT recommendations focus on strengthening the legal framework for the national cancer registry system, developing an essential package for cancer control services at all levels of health care, and formulating a long term cancer workforce development plan to meet the requirements of the planned infrastructure.

imPACT review missions in 2016

Belarus	Kazakhstan
Belize	Liberia
Honduras	Paraguay
Kenya	Sierra Leone

“Eight Member States received imPACT review missions, during which cancer experts assessed national cancer control needs and capacities.”

²⁶ Section C.6. responds to section B, operative paragraph 1 of resolution GC(59)/RES/11 on the development and deployment of systems for the radiation treatment of cancer patients; operative paragraph 4 on the integrated and actionable framework for collaboration with the WHO and the IARC; and to operative paragraph 20 on reporting on the implementation of this resolution (GC(59)/RES/11).

²⁷ This section responds to section B, operative paragraph 8 of resolution GC(59)/RES/11 on establishing integrated and comprehensive national cancer control plans.

²⁸ This section responds to section B, operative paragraph 3 of resolution GC(59)/RES/11 on the follow up on the outcomes and recommendations of the high-level meetings on the prevention and control of NCDs.

Kazakhstan: imPACT review mission 14–18 November 2016. Kazakhstan has a good network of screening services at the primary health care level, a balanced distribution of hospital services and strong commitment to training and education of the health workforce. The Government has initiated an update of the current national cancer care development programme (2012–2016). Preliminary imPACT recommendations focus on strengthening the existing cancer registry as part of the national health information system, regularly reviewing cancer diagnostic and treatment guidelines in terms of new global evidence and cost-effectiveness, and enhancing existing training programmes in line with the latest international good practices.

Liberia: imPACT review mission 27 June–2 July 2016. imPACT recommendations focus on re-establishing the national cancer registry and re-building and training the depleted health workforce, establishing a public cancer centre with provisions for surgical, medical and radiation oncology, providing adequate palliative care in view of the fact that currently 80% of cancer cases are diagnosed at an advanced and incurable stage, and establishing an adequate radiation safety infrastructure.

Paraguay: imPACT review mission 19–23 September 2016. Complementing an imPACT mission in 2011, experts observed progress in the implementation of cancer prevention, early detection, treatment and palliative care activities. There is also progress towards establishing a dedicated unit at the Ministry of Health in charge of cancer control and drafting a national cancer control programme. Preliminary recommendations focus on strengthening the nascent cancer control unit at the Ministry of Health, operationalising the nuclear medicine service created through a national TC project, and improving access to radiotherapy in the public sector.

Sierra Leone: imPACT review mission 28 November–2 December 2016. Like many other countries in the region, cancer has emerged as one of the leading causes of death. Preliminary imPACT recommendations focus on cancer prevention, strengthened access to early detection, diagnostic and treatment services, as well as on palliative care, re-building and training the depleted health workforce, and the need to establish an adequate radiation safety infrastructure.

PACT Model Demonstration Sites (PMDS)

In the United Republic of Tanzania, an OPEC Fund for International Development (OFID) funded project to strengthen palliative care services at the Ocean Road Cancer Institute (ORCI) and in four regional hospitals was completed. Important results include the training of 200 medical doctors, nurses and community volunteers in palliative care, the procurement of 10 beds for cancer patients at ORCI and the provision of 125 palliative care kits for volunteers. In addition, national policy guidelines for palliative care were finalized for the Ministry of Health's endorsement and distribution to health workers.

The Oncology Ward of the Korle Bu Teaching Hospital in Accra, Ghana, was provided with equipment for paediatric cancer patients which will improve the care of around 150 young cancer patients annually. The project was funded through the United Nations Women's Guild (UNWG) in Vienna.

In 2016, the National Cancer Centre of Mongolia received radiotherapy treatment-related immobilization devices, funded by Japan. These complement a Treatment Planning System at the same centre co-funded by Japan and Monaco in 2015.

Support in the area of cancer care and control has continued to be provided to Viet Nam and Nicaragua through projects funded by OFID, the UNWG in Vienna and the United Nations Federal Credit Union (UNFCU).

*Virtual University for Cancer Control and Regional Training Network (VUCCnet)*²⁹

The VUCCnet – an eLearning platform – offers health professionals high quality, contextualised and free training programmes in several areas of cancer control. Following the successful pilot phase in four sub-Saharan African countries, a plan to expand VUCCnet across the African region has been developed in response to the request of Member States. Dedicated resource mobilization efforts have been conducted to support the expansion. In addition, a Master’s level course for Clinical Oncology has been developed and is expected to become available in 2017.

Advocacy, partnership building and resource mobilization³⁰

*Partnership building and outreach*³¹

The Agency engaged intensively with partners to enhance collaboration on cancer control matters. A Practical Arrangements Agreement was concluded with OIC and IDB.

The Agency’s role in supporting Member States efforts in cancer control was highlighted to the global health community and potential new partnerships were explored through well-targeted participation in major international health and cancer-related events. This resulted for example, in the inclusion of health technologies in the ‘Kampala Declaration 2016’, to which African Ministers of Health committed at the 5th African Palliative Care International Conference in Uganda. In addition, the Agency contributed to the formulation of the Istanbul Declaration by the First Ladies of the Organization of Islamic Cooperation (OIC) Member States, at a special session on cancer control held at the 13th OIC Summit in Turkey. The Declaration affirms the First Ladies’ commitment to promote cancer awareness and advocacy programmes, and to advocate for the prioritisation of cancer prevention and control in health agenda at both national and international level through a multi sectoral approach.

Three thousand delegates at the 10th Stop Cervical, Breast and Prostate Cancer in Africa Conference of African First Ladies in Addis Ababa, Ethiopia, were informed of the Agency’s cancer control activities in Africa, and the Agency’s contribution to the SDGs.

During the World Health Summit in Berlin, Germany, where 735 organizations from 80 countries were represented, the IAEA’s Director General delivered a key note speech on ‘The Role of Nuclear Technology and the IAEA Contribution to Expanding Access to Quality Health Care in Developing Countries’. In addition, potential funding and partnership opportunities were explored during the Summit.

Dedicated cancer control sessions and an exhibition on the Agency’s work in cancer control raised awareness of the Agency’s role and of the need for strategic partnerships against cancer at the World Cancer Leaders’ Summit and the World Cancer Congress in Paris, France.

On the occasion of World Cancer Day 2016, the Agency organized a public lecture featuring two leading oncologists, a panel discussion on joining forces fight cancer, an

“ The Agency engaged intensively with partners to enhance collaboration on cancer control matters.”

²⁹ This section responds to section B, operative paragraph 14 of resolution GC(59)/RES/11 on the expansion of the VUCC.

³⁰ This section responds to section B, operative paragraph 5 of resolution GC(59)/RES/11 on advocating and building support for the Agency’s work on cancer control; to operative paragraph 7 on harmonizing approaches to help MSs to develop their financial proposals to mobilise resources; to operative paragraph 15 on seeking, strengthening and facilitating the Agency’s involvement in international partnerships, to further pursue, develop and implement PACT; to operative paragraph 16 on the continued implementation of PACT’s fundraising and resource mobilization strategy; and to operative paragraph 18 on providing adequate financial support for the implementation of PACT.

³¹ This section responds to section B, operative paragraph 19 of resolution GC(59)/RES/11 on raising awareness about the global cancer burden and the crucial role of radiation medicine in cancer diagnosis and treatment.

exhibition showcasing the Agency's cancer-related assistance to Member States, and a campaign about key facts on cancer that included social media posts and visual projections.

A side event at the 60th IAEA General Conference highlighted the need for strengthened partnerships to achieve cancer-related SDG targets. Attending Member States stressed the importance of scaling-up investments in comprehensive cancer control in low- and middle-income countries.

Resource mobilization

The Agency continued to seek support from Member States, intergovernmental and non-governmental organizations, as well as the private sector for the Agency's cancer control activities.

A total of €1 591 281 was received in extrabudgetary contributions from Australia, the Republic of Korea, the Russian Federation, Switzerland, the United States of America; OFID, Pfizer, Austria, Pink Ribbon Red Ribbon, UNFCU and the UNWG.

Donor	Amount (EUR)
Australia	30 243
Korea, Republic of	63 940
Russian Federation	185 739
Switzerland	200 000
United States of America	788 993
OFID	278 416
Pfizer Corporation Austria GmbH	6 000
Pink Ribbon Red Ribbon	8 109
United Nations Federal Credit Union (UNFCU)	4 475
UN Women's Guild	25 266
Others	100
Total amount received	1 591 281

Support to resource mobilization to scale-up cancer services in IAEA Member States was provided, including through the review of bankable documents for Fiji, Lesotho and Papua New Guinea, and the development of dedicated funding proposals for several Member States.

Coordination with technical cooperation activities on cancer³²

The cancer-related parts of the CPFs of Botswana, Burundi, Central African Republic, Ghana, Iraq, Kenya and Zimbabwe were reviewed to ensure alignment with imPACT review recommendations, to identify opportunities for partnerships, and to facilitate the integration of radiation medicine into comprehensive cancer control strategies.

Cancer-related project proposals for the 2018–2019 TC cycle were assessed from a comprehensive cancer control perspective to ensure that imPACT recommendations were taken into account where appropriate.

³² This section responds to section B, operative paragraph 6 of resolution GC(59)/RES/11 on planning and implementing PACTS activities and projects in MSs; and to operative paragraph 11 on follow-up activities that build on the findings of imPACT missions and translate the recommendations into actions with sustainable impacts for Member States.

List of frequently used abbreviations

AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
Agency	International Atomic Energy Agency
APCs	assessed programme costs
ARASIA	Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology
ARCAL	Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean
CPF	Country Programme Framework
FAO	Food and Agriculture Organization of the United Nations
IAEA	International Atomic Energy Agency
LDC	least developed country
NNI	national nuclear institution
NPCs	National Participation Costs
NPP	nuclear power plant
PACT	Programme of Action for Cancer Therapy
PUI	Peaceful Uses Initiative
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
SIDS	small island developing States
SDG	sustainable development goal
TC	technical cooperation
TCF	Technical Cooperation Fund
UNDAF	United Nations Development Assistance Framework
WHO	World Health Organization



Annex 1. Achievements in 2016: Project Examples by Thematic Sector

Annex 1. Achievements in 2016: Project Examples by Thematic Sector

Health and Nutrition

REGIONAL HIGHLIGHTS

Human health is a priority area for Member States, and the Agency supports many projects that contribute to SDG 3, 'Ensure healthy lives and promote well-being for all at all ages'.

In Africa, the Agency is working to build human and technical capabilities in counterpart institutions to detect and treat cancer more efficiently and effectively, to apply nuclear techniques to strengthen national nutrition programmes, and to address the challenges posed by emerging diseases. By paying attention to maternal and infant health and nutrition, the TC programme has also supported national and international efforts to achieve international development goals.

A number of countries in the region are collaborating with the Agency in the development of radiotherapy facilities. Here, ensuring national capabilities to provide safe, high quality radiotherapy services is a prime focus of Agency assistance, including the development of national capacity to conduct training in various fields. Africa has also been severely affected by the emergence of zoonotic diseases, such as the recent outbreak of EVD. Shortages of human resources and technical capabilities have hampered national and regional efforts to fight such diseases.

The TC programme continues to support Member States in the Asia and the Pacific region in improving human health and addressing challenges in nutrition. In 2016, the programme focused on enhancing regional capacity to apply emerging multimodality molecular diagnostic imaging and therapeutic nuclear medicine techniques for the management and treatment of NCDs, including cancer and cardiovascular diseases. Regional capacity building fostered the safe and secure application of nuclear medicine techniques, as did the dissemination and the application of quality assurance systems. A renewed emphasis on human resource development for nuclear medicine professionals was made concrete through Practical Arrangements on Cooperation for the IAEA Curricula for Nuclear Medicine Professionals, signed with the Dubai Health Authority and Osaka University, Japan.

In the Europe region, human health also remains a priority area for technical cooperation. In this region, nuclear technology plays an important role in the diagnosis and treatment of cardiovascular diseases and cancer. Regardless of differences in the availability of facilities and the quality of services, all Member States recognize the need for training in the safe and effective use of relevant medical nuclear technologies. There is a strong commitment in the region to enhancing national capabilities, and several regional and many national projects are addressing those gaps. The increased use of digital images in cancer diagnosis has created additional needs for capacity-building to fully utilize the benefits of new equipment and technology, including hybrid modality machines.

Throughout 2016, the Agency continued its successful collaboration with EANM, supporting the participation of total 55 nuclear medicine practitioners in six specialized EANM training courses. A total of 233 radiotherapy practitioners were trained on advanced radiation treatment modalities in 2016 in partnership with ESTRO and InHolland University.

Human health is a priority area for development and cooperation with the Agency for all Member States in the Latin American and the Caribbean region. In 2016, 17 new national projects and two new regional projects started implementation and, jointly with others from



“Throughout 2016, the Agency continued its successful collaboration with EANM, supporting the participation of total 55 nuclear medicine practitioners in six specialized EANM training courses.”

the previous cycle, will contribute to enhancing capabilities in radiation oncology, medical physics, and nuclear medicine to diagnose and effectively treat cancer. Other national and regional initiatives to use nuclear techniques to address nutritional problems were also supported in 2016. New technical and human capacities established through these projects will support medical applications and the delivery of quality services in the region.

CONTROL OF CANCER

Building capacity in support of the implementation of imPACT recommendations³³

The Agency undertook several human resource capacity building measures to strengthen cancer control for a large number of IAEA Member States to support the implementation of imPACT recommendations.

Health professionals from 35 African Member States strengthened their understanding of the importance of high quality cancer data in support of informed decision-making for cancer control planning. They also enhanced their abilities to establish and operate population-based cancer registries in two topical regional workshops, organized in cooperation with WHO's Regional Office for Africa, International Agency for Research on Cancer (IARC) and the African Cancer Registry Network (AFCRN). Three medical professionals from the Central African Republic received four weeks of training on the establishment and operation of a population-based cancer registry at the national cancer registry of Côte d'Ivoire. This fellowship arrangement was organized in cooperation with IARC and APCRN.

Health professionals from nine Member States in the Asia and the Pacific region attended a regional workshop on palliative care as an integral part of comprehensive cancer control to broaden their understanding of the role of radiation medicine for palliative care. The workshop was conducted in collaboration with WHO, the Union for International Cancer Control, the United Nations Office on Drugs and Crime, International Narcotics Control Board and the International Association for Hospice & Palliative Care.

Six radiation medicine professionals from Mongolia, Sri Lanka and Viet Nam were trained in radiation oncology, medical physics and radiation therapy technology at KIRAMS.

The Health Ministries of Namibia and Rwanda and related authorities received dedicated in-country assistance in developing and strengthening their national cancer control plans (NCCPs) through expert advisory support at national planning workshops and specialist reviews of their respective draft NCCPs. In addition, the NCCPs of Chad, Ethiopia and Senegal were appraised with a view to ensure alignment with relevant imPACT recommendations, and to identify partnership and resource mobilization opportunities.

RADIATION ONCOLOGY IN CANCER MANAGEMENT

Following the breakdown of the only Cobalt-60 machine in Uganda in March 2016, the Government of Uganda requested Agency assistance in re-establishing radiotherapy services in the country. The Agency assessed the feasibility of using the existing bunker at Mulago Hospital to house a new teletherapy machine. IAEA experts confirmed that the bunker could be used for a new machine, pending decommissioning of the old source and refurbishment. In November 2016, the Agency successfully decommissioned the old Cobalt-60 source, which was stored safely on-site, and the Government of Uganda initiated the refurbishment of the bunker at Mulago Hospital.

³³ This section responds to section B, operative paragraph 4 of resolution GC(59)/RES/11 on the integrated and actionable framework for collaboration with the WHO and the IARC; and to operative paragraph 13 on the participation of health professionals working in cancer control in LMICs in training courses on cancer prevention and control.

“Health professionals from 35 African Member States strengthened their understanding of the importance of high quality cancer data in support of informed decision-making for cancer control planning.”



Decommissioning the old Cobalt-60 source at Mulago Hospital, November 2016.

The Agency initiated the procurement of a new Cobalt-60 machine in December under UGA6018, 'Establishing Radiotherapy Services at the Cancer Institute'. In addition, expert support was provided regarding the construction of six new bunkers at the Uganda Cancer Institute. The Agency is also providing support to Uganda to develop its human resources in the area of radiation medicine through fellowship placements.

A comprehensive training event on Selection, Acceptance, Commissioning and Maintenance of Equipment in Radiotherapy was carried out at MD Anderson, USA, in May, within the framework of regional project RAS0073, 'Supporting Human Resource Development and Nuclear Technology', for Member States in the Asia and the Pacific region. The training provided participants with an in depth understanding of the process for selection, acceptance, commissioning and maintenance of radiotherapy dosimetry equipment and radiotherapy treatment units, which are key elements in ensuring the quality and sustainability of radiotherapy services in Member States.



Construction of six new bunkers at Uganda Cancer Institute started in June 2016.

In Fiji, the national project FIJ6001, 'Establishing a Radiotherapy Centre', has successfully paved the way for the establishment of the first cancer centre in Fiji.

TC project ISR6023, 'Strengthening Capacity Building and Improving Quality Assurance in Radiotherapy,' which is a continuation of ISR6018, 'Supporting a National Programme for Radiotherapy Quality Control', continues to focus on the implementation of quality assurance principles in Israel. All the radiotherapy centres have undergone QUATRO audits. Human capacity was enhanced through the establishment of a radiotherapy training centre. The Agency also supported the commissioning of a Cobalt-60 unit for radiotherapy level calibration at the Secondary Standards Dosimetry Laboratories (SSDLs) of the Ministry of Health.

In Myanmar, demand for radiotherapy has increased significantly over the last ten years, and the trend is expected to continue, with new patients increasingly requiring radiotherapy. TC project MYA6032, 'Strengthening Human Resource Capacity in Nuclear Medicine and Radiotherapy Services for Improving the Diagnosis and Treatment of Cancer Patients', was initiated to strengthen human resource capacity in PET-CT, cyclotron, and linear accelerator and high dose rate (HDR) brachytherapy services in Myanmar. In 2016, support was provided for brachytherapy practice at Yangon General Hospital and Mandalay General Hospital, X-ray therapy at Nay Pyi Taw General Hospital, and external beam dosimetry at the radiotherapy department of Taunggyi Hospital. The project succeeded in introducing and enhancing a broad range of radiotherapy-related capacities.

In Romania, a dosimetry audit system to verify the accuracy and safety of patient treatments with radiation is not in place at the national level. Project ROM6018 'Enhancing Radiotherapy Services by Establishing a National Dosimetry Audit Facility' is expected to improve the quality and safety of radiotherapy services by supporting the establishment of a National Dosimetry Audit Facility/System, and to improve staff competencies in treatment planning system and QA/QC procedures. During 2016, a national training course on acceptance and commissioning of radiotherapy equipment – a practical approach for LINAC based equipment – was held. Three international experts provided the theory, which was complemented by practical exercises in performing measurements that are used in commissioning and for acquiring data for the beam modelling in treatment planning systems. In addition, a scientific visit built capacities in dosimetry auditing programmes for radiotherapy, from simple audits of basic beam parameters to advanced end-to-end audits using anthropomorphic phantoms. A follow-up expert mission was held to advise the Romanian Government on specifications for the radiotherapy equipment.



Mya Mya Kyi (far right), Chief Medical Physicist at the Yangon General Hospital, is working with radiotherapy operators treating a patient. Photo: M. Gaspar/IAEA

In the Latin American and the Caribbean region, efforts continued throughout 2016 to improve the quality of radiation therapy through the ARCAL project RLA6072, 'Supporting Capacity Building of Human Resources for a Comprehensive Approach to Radiation Therapy (ARCAL CXXXIV)'. Radiation oncologists, medical physicists and radiation therapy technologists were trained in the basic principles of clinical treatment using linear accelerators for 3D conformal radiotherapy. Intensity modulated radiation therapy and image guided radiation therapy (IGRT) techniques were also covered in the trainings, together with the imaging systems most commonly used in IGRT. In addition, training on the quality control of the equipment or systems and procedures that need to be applied was included. Specific training in radiobiology for radiation oncologists was also provided.

The Agency is supporting Guatemala in the establishment of a HDR brachytherapy programme for gynaecological tumours in the National Cancer Institute and Hospital Dr. Bernardo del Valle S under GUA6020, 'Establishing a High Dose Rate Brachytherapy Programme for Gynaecological Tumours'. Training for this health facility was organized in the form of fellowships with other institutions in the region, and relevant equipment was provided. These activities will increase access to, and quality of, brachytherapy services for patients with gynaecological tumours in Guatemala and neighbouring countries.

In Nicaragua, significant effort in 2016 went into building capacities in cancer radiation treatment. Advice on the introduction and installation of new technologies was provided to the country through TC project NIC6019, 'Building Capacity in Cancer Radiation Treatment'. Support focused on providing training for the safe, effective use of the technology within a quality assurance framework.

In order to deal with the current worldwide shortage in the production of radioisotope alpha emitters for targeted therapy, Argentina is working to develop local bismuth-213 and actinium-225 production. The goal is to supply these types of radioisotopes for targeted cancer therapy and treatment to the country and region. Argentina is supported by TC project ARG6017, 'Expanding Knowledge and Facilities for the Production of Alpha Radioisotopes for Therapy (Ac-225 and Bi 213)', which aims to assist the country in expanding knowledge and training personnel – both critical needs. With a significant national investment in this area, Argentina has already started the construction of new facilities in order to carry out the local project within 36 months. In 2016, with support from the Agency, the National Atomic Energy Commission (CNEA) team in Argentina received first class training in partnership with centres in Europe and the European Commission Joint Research Centre, working on the production of radioisotope alpha emitters.

NUCLEAR MEDICINE AND DIAGNOSTIC IMAGING

In a continuous effort to improve the quality of the clinical practice in nuclear medicine, four Quality Management Audits in Nuclear Medicine Practices (QUANUM) were implemented in 2016 through the interregional project INT6056, 'Supporting Quality Management Audits in Nuclear Medicine Practices (QUANUM)'. In addition, a regional training course on radionuclide therapies was conducted in cooperation with Argonne National Laboratory and the MD Anderson Cancer Centre. Twenty-five participants from the same number of Member States benefited from the training.

In Sri Lanka, patient management capabilities have been improved for patients with cancer or arthritis associated with active joint disease who benefit from radioisotope based therapies, with the support of SRL6034, 'Strengthening Nuclear Medicine Procedures for Radionuclide Therapy to Improve Clinical Outcome of Patients with Cancer and Chronic Joint Diseases'. The Agency, working with the University of Peradeniya and the Sri Lanka Atomic Energy Board, has implemented the use of new radionuclide based therapeutic procedures for bone pain palliation, lymphoma and radiosynovectomy. Support was provided through workshops on nuclear medicine techniques in lymphoma therapy, pain palliation and related conditions, and on nuclear medicine techniques in neurological



Undergraduates at the Peradeniya Nuclear Medicine Unit in the Central Province of Sri Lanka. Photo: L. Potterton/IAEA.

diseases with an emphasis on oncology and neurology. Additionally, expert advice to enhance the clinical practice of nuclear medicine for nuclear medicine technologists was arranged and training was provided to experts for the conduct of nuclear medicine auditing under QUANUM guiding principles. The Agency also sponsored fellowships and scientific visits to train professionals involved in the delivery of nuclear medicine and radioisotope therapy services in Sri Lanka.

In addition, the projects ISR6024, 'Improving Quality Management and Clinical Practice in Nuclear Medicine, Radiopharmacy and Diagnostic Imaging', and ISR6026, 'Improving the Quality Management and Clinical Practice of Diagnostic Imaging, Invasive Radiology and Computed Tomography', supported the conduct of three QUANUM audits in Israel.

TC project OMA6006, 'Using Radionuclide-Based Molecular Methods for the Detection of Imported Drug Resistant Malaria', has focused on strengthening Oman's national technical capabilities for the eradication of malaria and the control of any recurrence due to the spread of drug resistant genotypes via asymptomatic carriers. Following constructive discussions with the Agency, the application of diagnostic technology such as loop-mediated isothermal amplification will be considered by the Ministry of Health. As a result, the Ministry is making efforts to further advance its current national surveillance methodology.

In Malaysia, project MAL6021, 'Improving Human Resource Skills in Hybrid Imaging', is focusing on improving knowledge and skills in hybrid imaging for human resource development, contributing to national training programme development. In 2016, the Agency conducted two expert missions: one on improving skills via a PET-CT course for radiologists, and another on improving utilization of single photon emission computed tomography-computed tomography (SPECT-CT) and PET-CT in NCDs. Scientific visits organized by the Agency provided training to initiate a new diagnosis and treatment option for prostate cancer patients, and to help establish hybrid imaging capability in the future to benefit the patients. The project has built capacity in the counterpart institution, ensuring that personnel are trained in hybrid imaging.

The States Parties to ARASIA have embarked on the introduction of hybrid nuclear modalities (SPECT-CT and PET-CT). However, most ARASIA States Parties have inadequate nuclear medicine capabilities, as the number of practitioners with solid training is limited. The regional project RAS6078, 'Strengthening Nuclear Medicine Application through Education and Training to Help Fight Non-Communicable Diseases', has aimed to improve the management of NCDs by enhancing the quality of practice and application

of nuclear medicine techniques in ARASIA States Parties. A regional training course on radioimmuno imaging and emerging nuclear medicine therapy approaches was held in Dubai, United Arab Emirates, in March 2016. It covered the management of lymphoma, and other immune related malignancies in collaboration with haematologists, oncologist, radiopharmacists and nuclear medicine physicist. A further training course was held in May 2016, also in Dubai, to provide training on the use of integrated PET-CT reading and tumour, node, metastasis (TNM) classification in CT-based cancer staging in the abdomen and urogenital system.

The first accredited TC workshop on the applications of nuclear medicine was conducted at Osaka University Graduate School of Medicine, Osaka, Japan, in May, under regional project RAS6078, 'Strengthening Nuclear Medicine Application through Education and Training to Help Fight Non-Communicable Diseases'. The course focused on the application of nuclear medicine techniques in the imaging of cerebrovascular and neurological diseases, including brain tumours, dementia and epilepsy. Fifteen ARASIA participants were joined by an additional 65 local and international participants who, motivated by the course's high standard of educational quality, financed their own participation in the workshop independently. Participants who successfully completed the workshop were awarded with 26 European continuing medical education (CME) credits (ECMEC) by the European Union of Medical Specialists (UEMS) European Accreditation Council for Continuing Medical Education (EACCME). This is the first time that a TC workshop has been given external accreditation by UEMS-EACCME.

The Agency provides training opportunities to Member States on hybrid nuclear medicine technologies to improve the management of patients affected by chronic diseases under the regional project RER6035, 'Strengthening Single Photon Emission Computed Tomography/Computed Tomography and Positron Emission Tomography Hybrid Imaging Applications for Diagnosis of Chronic Diseases, including Cancer'. In 2016, three regional training



RAS6078: Participants at the accredited TC workshop on the application of nuclear medicine. Photo: IAEA.

courses were held in Italy, Latvia and Slovenia, training a total of 76 nuclear medicine practitioners. The training course in Slovenia provided nuclear medicine physicians and neurologists with the most recent updates on the use of PET-CT (fluorodeoxyglucose (FDG) and non-FDG) and SPECT-CT in neurological diseases. The course in Latvia was organized in conjunction with the 2016 Baltic Congress of Radiology and the participants deepened their knowledge on state-of-the-art hybrid imaging using PET-CT technology for the management of cancer patients. Furthermore, a training course on hybrid imaging including the use of SPECT-CT and PET-CT technology for the modern management of infection and inflammatory conditions was organized in Italy. The participants had an opportunity to attend a hands-on observation course at the Sapienza University, as well as the 2nd Advanced European Congress on Imaging Infection and Inflammation in Rome.

In Latin America and the Caribbean, efforts continued throughout 2016 to strengthen the clinical applications of diagnostic imaging modalities and radionuclide therapies for their appropriate use in paediatric and adolescent cancer patients. With the support of regional project RLA6075, 'Supporting Diagnosis and Treatment of Tumours in Paediatric Patients (ARCAL CXXXIII)', training targeting professionals working with paediatric patients were organized, and relevant guidelines elaborated. Under this project, a Regional Training Course on Internal Dosimetry, Clinical Protocols and Radiation Safety Applied to Radionuclide Therapies in Paediatric Patients was organized in Cuba. The training course introduced participants to dosimetric models for internal dose calculation with a focus on paediatric patients, and was attended by 33 participants (mainly medical physicists) from 12 Member States. The training course demonstrated methods for the quantification of administered activity and techniques to estimate patient dose for the effective and safe use of radiopharmaceuticals in nuclear medicine therapy.

A four year project aiming to improve the care of patients with coronary artery disease (CAD) through nuclear cardiology in Latin America and the Caribbean, TC project RLA6078, 'Improving Coronary Artery Disease Patient Care with Nuclear Cardiology', was initiated in 2016. It provides training opportunities to strengthen the role of nuclear techniques in the appropriate evaluation of patients with CAD, particularly in diagnosis, risk stratification and the selection of therapeutic modalities. In 2016, a baseline survey on the epidemiologic situation of cardiovascular diseases and utilization of nuclear cardiology techniques was performed, resulting in the publication of an article, *Current Status of Nuclear Cardiology Practice in Latin America and the Caribbean*, in the Journal of Nuclear Cardiology.

In Jamaica, the re-establishment of nuclear medical services at the University Hospital of the West Indies remains one of the country's top national health priorities. The Agency made significant efforts to support the country within the framework of JAM6012, 'Re-Establishing Nuclear Medicine Capacity', and JAM6013, 'Promoting Healthy Growth in Children'. Several fellows were trained in nuclear medicine radiography, nuclear pharmacy and paediatric radiography.

In Argentina, project ARG6016, 'Improving Cancer Management by Applying Positron Emission Tomography Radiotracers for Staging, Treatment, Response Assessment and Radiotherapy Planning', aims to strengthen the capacities of the Nuclear Medicine School Foundation (FUESMEN) in the Province of Mendoza to improve cancer management by applying PET radiotracers for staging, treatment, response assessment and radiotherapy. Patients will benefit from more accurate diagnosis and treatment of several oncological diseases. In 2016, staff were trained through fellowships on topics, such as PET physics, radiopharmaceutical production and quality control. Expert advice provided through the project was instrumental in providing guidance on the most appropriate radiolabelled compounds to produce and the associated equipment required for that purpose.

In Uruguay, the Agency helped the country to establish a new centre for diagnostic and therapeutic nuclear medicine, located in the middle of the country. With the support of project URU6035, 'Developing the First Regional Nuclear Medicine Centre to Provide Diagnostic and Therapeutic Procedures to the Northern and Central Regions', capacities



FUESMEN laboratory. Photo: FUESMEN, Argentina.

were established to increase the access of patients from less central areas of the country to more efficient, effective and faster treatment.

Also in Uruguay, radiopharmaceutical production capacities have been improved and procedures harmonized in line with international standards through URU6037, 'Harmonizing In-Hospital Radiopharmacy to International Standards'. As a result, University of the Republic of Uruguay is working towards the establishment of a diploma programme in radiopharmacy. The capacities established through the project and training will be of interest to many countries in the region.

National projects in Brazil have focused on improving the delivery of nuclear medicine to patients in 2016: BRA6025, 'Supporting Technological Improvement and Human Resource Qualification in Molecular Imaging'; and BRA6028, 'Developing Human Resources for High Technology Radiotherapy and Related Safety and Quality Assurance'. As a result, capacity has been built regarding understanding the appropriate use of FDG PET-CT imaging and the applications of other tracers such as Gallium 68 PSMA in certain malignant conditions in which FDG PET-CT has limited applications such as prostate cancer; participants have learned about the indications, advantages, limitations, patient preparation, necessary complementary clinical and radiological information, imaging protocols and interpretation of 68-Ga DOTA peptide PET-CT imaging of neuroendocrine tumours; and about imaging with other non-FDG PET tracers, among others. National experts have been trained in the application of QUANUM, and additional practical training has been completed on the implementation of volumetric modulated arc therapy in radiotherapy and in 4D breathing management and treatment protocols.

The TC programme provided important support to the International Conference on Integrated Medical Imaging in Cardiovascular Diseases (IMIC 2016), enabling 94 participants from 59 Member States to attend this educational event.

RADIOISOTOPES, RADIOPHARMACEUTICALS AND RADIATION TECHNOLOGY

National capacity for the production of radio diagnostic and radio therapeutic agents for nuclear medicine and brachytherapy has been enhanced in the Islamic Republic of Iran with the support of IRA6009, 'Developing Therapeutic Radiopharmaceuticals and Brachytherapy Products for Cancer Treatment and Radioimmunoassay Diagnostic Kits'. The project has helped meet national needs for therapeutic radiopharmaceuticals, brachytherapy sources and cold kits by developing and enhancing the range, amount and quality of such products for cancer treatment. Specifically, the project has ensured the production of (i) antibody-based therapeutic radiopharmaceuticals; (ii) Y-90 solutions with high radionuclides and chemical purity for medical use; and (iii) radioimmunoassay diagnostic kits on a laboratory scale. Quality assurance and dosimetry protocols for laboratory production of brachytherapy sources were also implemented under the project. The beneficiaries include the collaborating hospitals and medical centres (21 radiotherapy and 71 nuclear medicine facilities) in general, and the cancer patients of the Islamic Republic of Iran in particular.

An on-going project in the Philippines, PHI6024, 'Enhancing Capacity for Synthesis and Characterization of Medical Diagnostic Kits for Nuclear Pharmacy Applications', has focused on developing and preparing the most commonly used technetium-99-based radiopharmaceuticals (^{99m}Tc) for cardiovascular diseases and heart imaging. Through the upgrading and completion of a production facility for radiopharmacy kits for cardiovascular and thyroid applications, and with the training and qualification of personnel to produce cold kits, the project will enable in-country production of diagnostic kits for nuclear pharmacy applications. The Agency is providing support in the form of fellowships, scientific visits, expert missions and equipment.

In Uzbekistan, project UZB6011, 'Introducing Production of Radiopharmaceuticals for Cancer Therapy' was completed in 2016. The project supported the state-owned enterprise 'Radiopreparat' in producing radiopharmaceuticals following good manufacturing practices (GMPs). The Agency provided expert recommendations to the counterpart on applying GMPs in the production of radiopharmaceuticals, and also trained facility managers on the implementation of GMP and quality standards through scientific visits and fellowships. The project supported the acquisition of equipment needed for the installation of a 'clean room' for the production of Samarium-based radiopharmaceuticals.



CUB6023: New hot cells procured under the project. Photo: Center of Isotopes (CENTIS).

Cuba has been able to license a national facility for the production of pharmaceutical-grade Mo 99/99mTc generators with the support of TC project CUB6023, 'Enhancing the Production and Use of 99Mo/99mTc Generators through Compliance with Good Manufacturing Practice and Quality Management Requirements', which was finalized in 2016. The project aimed to improve the availability of locally produced radiopharmaceuticals for diagnostic imaging. The new production facility will soon become operational in 2017. The Site Acceptance Test for the new equipment was finalized with the support of the Agency. In addition, technicians were trained in good manufacturing practices and generator production technology. Cuba can now produce its own technetium-99m generator for nuclear medicine diagnostic imaging.

Peru, with Agency support, established a tissue bank at the Child's Health Institute in 1996, and has continued to benefit from training courses, expert missions, scientific visits and equipment. Tissue engineering skills using radiation technology, developed under PER6017, 'Improving National Capabilities to Treat Patients with Burns, Lesions and Polytraumatized Conditions Through the Application of Radiation-Processed Cells, Scaffolds and Tissues', have been used to treat severe burns. Last year, radiation specialists were able to grow enough new skin to treat a severely burned child. The Peruvian Institute of Nuclear Energy and the Child's Health Institute of San Borja are planning to collaborate with universities to teach these new techniques.

DOSIMETRY AND MEDICAL PHYSICS

The regional project RAS6084, 'Harmonising Radiation Dosimetry Practices through the Enhancement of Metrology and Quality Management for Secondary Standards Dosimetry Laboratories', aims to achieve a high level of accuracy in the field of metrology in ionizing radiation by enhancing calibration capabilities and implementing relevant quality systems. The project is supporting the first ever intercomparison exercise on calibration coefficients for ionization chambers for radiation protection among all operational SSDLs in the region, namely in Jordan, Lebanon, Saudi Arabia, Syria and the United Arab Emirates. The goal is to assess existing competence, and to help the laboratories prepare a functional QMS.

Under RER6032, 'Strengthening Quality Assurance and Quality Control in Diagnostic X rays', participating Member States are receiving support in the development of guidance relevant to quality assurance and training of medical physicists in the establishment and



RAS6084: Learning about radiation protection measurements at the Dosimetry Laboratory in Seibersdorf. Photo: IAEA.

application of quality practices. In 2016, more than 40 professionals have participated in regional training activities, and two workshops have been organized to draft a Comprehensive Quality Control Handbook, as well as Guidelines for the Development of Quality Systems in Diagnostic and Interventional Radiology.

In Serbia, project SRB6012, 'Upgrading of Calibration Service for Medical Applications of Ionizing Radiation' aims to improve national calibration services and introduce new services. A scientific visit in October has increased knowledge of QMSs, written protocols for calibration services, maintenance of secondary standards, diagnostic radiation and uncertainty estimations. Two members of staff from the Vinca Institute of Nuclear Sciences have received training in the calibration of dosimeters used in diagnostic radiology, including mammography. With a new X-ray unit for calibration purposes and the newly trained personnel, Serbia is better equipped to improve the accuracy of radiation measurements in medical applications.

Two training courses designed to build capacity in medical physics were carried out in 2016 under RLA6072, 'Supporting Capacity Building of Human Resources for a Comprehensive Approach to Radiation Therapy (ARCAL CXXXIV)'. Twenty-three medical physicists from 14 different countries in the Latin America and Caribbean region were trained in Argentina on Quality Assurance in Image Guided Radiotherapy, receiving theoretical knowledge and hands-on training with a focus on the effective application of radiotherapy and enhanced treatment precision and quality assurance procedures. Thirty-three radiotherapy professionals participated in a regional training course on Modern Radiotherapy using Linear Accelerators, held in Argonne (USA). The course provided participants with a comprehensive overview of the current practice of radiotherapy using different imaging techniques, energies and treatment planning techniques. Both courses support the implementation of safe and effective radiotherapy, and contribute to the improvement of patient healthcare.

The RCA regional project RAS6077, 'Strengthening the Effectiveness and Extent of Medical Physics Education and Training', offers opportunities for medical physics trainees to become clinically qualified. In that context, the project has supported the creation of the Advanced Medical Physics Learning Environment (AMPLE) hosted by the IAEA's CLP4NET. AMPLE provides a structured clinical training guide, based on IAEA publications, in the areas of radiotherapy, radiology and nuclear medicine. AMPLE also provides links to electronic resources for trainees, opportunities for communication between trainees and supervisors, and a grading system that allows the progress of the trainees in their clinical training programme to be recorded and tracked. More than 100 medical physics trainees have been enrolled in AMPLE from countries including Bangladesh, Indonesia, Myanmar, Nepal, Philippines, Thailand, and Viet Nam. Each trainee is assigned a local or remote supervisor who also benefits from the access to e-learning training material. With AMPLE, RAS6077 provides a resource for sustainable medical physics training programmes in RCA countries, aiming to increase the number of much-needed clinically qualified medical physicists.

Students from Latin America and the Caribbean and Africa have been provided with support through the TC programme to enable their attendance at the Joint ICTP-IAEA Workshop on Internal Dosimetry for Medical Physicists Specializing in Nuclear Medicine. The workshop, held in November 2016 in Trieste, was organized with the support of the American Association of Physicists in Medicine (AAPM) and the European Federation of Organisations for Medical Physics (EFOMP). The workshop provided participants with a comprehensive review of nuclear medicine image quantification and internal dosimetry and was attended by 38 participants from 24 countries, together with students from the ICTP Masters in Medical Physics.

NUTRITION

A regional consortium, Reducing Obesity Using Nuclear Techniques to Design Interventions in Africa (ROUND-IT) has been created in order to compile individual Member State data in a pooled database for further analysis under the project RAF6042, 'Applying Nuclear Techniques to Design and Evaluate Interventions to Reduce Obesity and Related Health Risks'. ROUND-IT will continue to work on obesity and physical activity in the context of NCDs beyond the completion of the project. The project findings are particularly important as they are the first situation assessment carried out on overweight, obesity and physical activity levels in African school children in urban areas, where the problem is most prevalent. The data collected through the project will be shared with policy makers and other stakeholders in order to support evidence-based intervention planning and the development of action plans. RAF6042 has been implemented with the participation of the WHO regional office for Africa.



RAF6042: Group photo, Final Coordination Meeting, Quatre Bornes, Mauritius, 10-14 October 2016.

Undernutrition, overweight and obesity affects people of all ages in Thailand. Project THA6041, 'Establishing Human Energy Requirements in the Population Using the Doubly Labelled Water Technique' aims to acquire new knowledge on the energy requirements of young and middle aged Thai people. It also aims to support understanding of the relationship between body-composition phenotypes and energy expenditure in a representative population. Data obtained through the project will be used to establish the energy requirements of this population group. Once collection of data on total energy expenditure and physical activity of young and middle aged adults is completed and data analysis conducted the project will disseminate the results in order to establish optimum energy recommendations for the general population of Thailand.

Breastfeeding is an important public health strategy for improving infant and child morbidity and mortality, improving maternal morbidity, and helping to control health care costs. The project RAS6073, 'Using Stable Isotope Techniques to Monitor Situations and Interventions for Promoting Infant and Young Child Nutrition', continued successfully in 2016. The project, also funded by the US through PUI, focused on enhancing awareness of the importance of breastfeeding up to six months of age in the Asia and Pacific region. The deuterium oxide dose-to-mother technique is being used to measure breast milk intake of infants and the body composition of lactating mothers. Project RAS6073 is building capacity in the use of the deuterium oxide dose-to-mother technique to validate reported breastfeeding practices in the first six months of life in participating countries.



Expert presentation on the crisis of obesity. Photo: Valentina Varbanova/IAEA.

Overweight and obesity represent a great public health problem in Europe. The Agency has fostered the widespread use of stable isotope techniques in Member States to support their efforts to develop effective, evidence-based nutrition interventions. The unique characteristics of stable isotope techniques make these methods highly suitable for development and evaluation of interventions to improve nutrition throughout the life course. The project RER6034, 'Applying Nuclear Techniques to Design and Evaluate Interventions to Prevent and Control Obesity in Adolescents in South – Eastern Europe', uses stable isotope techniques to measure the percentage of body fat. The accurate assessment of nutritional status (body fat and lean body tissue) in school children provides much needed evidence to design interventions to prevent and control obesity and NCDs in participating Member States. The project is directly linked to regional WHO strategies on childhood obesity and on prevention of NCDs and aligns well with SDG 3 regarding the reduction of mortality related to NCDs. In 2016, a Regional Workshop on Assessment of Body Composition using Nuclear Techniques was held in November in Sarajevo, Bosnia and Herzegovina. Provision of equipment necessary to measure body composition and physical activity was initiated.



RER6034: Participants at the regional workshop in Sarajevo (left), portable Fourier transform infrared spectrometer (FTIR) (right). Photo: Victor Owino/IAEA

Food and Agriculture

REGIONAL HIGHLIGHTS

Concern about food safety is increasing among African Member States as they strive to ensure food security, and access lucrative sub-regional, regional and international markets. The inevitable use of agrochemicals and veterinary drugs, coupled with natural hazards and poor hygienic conditions during production, handling and marketing of agricultural products, all contribute to health risks of different degrees. Agency support is also being provided to improve livestock productivity through strengthened diagnosis and control of transboundary animal diseases (TADs) and Emerging Zoonotic Diseases, and by optimisation of livestock breeding and nutrition using indigenous animals and locally available feed resources. In addition, the Agency continues to support African Member States in exploring the use of SIT as a technique for controlling vectors such as mosquitoes and tsetse flies, which are responsible for transmission of diseases to livestock and humans.

Food security is a priority in Member States in the Asia and the Pacific region. Extensive support was given to several countries to improve the early and rapid diagnosis of animal diseases through the application of nuclear-related techniques. Regional and national projects have enhanced human capacity in using nuclear and related techniques to achieve improved crop yield. Support was also provided in areas related to climate proofing staple production systems, and to the management of water and soil using nuclear and other analytical techniques.

Food security and agricultural production are also high priority areas for a sub-group of countries in the Europe region. The region also faces some challenges related to the quality and quantity of agricultural products, and to pests and plant or animal diseases. Most food and agriculture projects in the Europe region are implemented on the national level due to differences in priorities among Member States in the region, and also due to the need for long term activities with significant contributions from the beneficiary countries. Throughout 2016, as in past years, technical cooperation efforts focused on improving crop yield and quality by enhancing diversification and adaptability through mutation breeding programmes. Mutation breeding programmes were implemented in several Member States, helping to develop new varieties of crops such as pepper, tomato, potato, bean, pea, onion and watermelon. Projects resulted in higher yields, benefitting mostly small and medium scale producers. Staff from several agriculture institutes were trained in various techniques and topics related to mutation induction and the use of molecular techniques for mutant characterization. The infrastructure of some laboratories was upgraded to allow the use of modern nuclear and molecular techniques.

In Latin America and the Caribbean, pest control for regional food security played an important role in the eradication of the Mediterranean fruit fly and the progressive control of the new world screwworm. Ensuring food safety through capacity building in chemical risk analysis and detection and control of chemical contaminants and residue increased the competitiveness of animal food products on national and regional levels. Capacities in the selection and breeding of animals are being enhanced under RLA5071, 'Decreasing the Parasite Infestation Rate of Sheep (ARCAL CXLIV)'. The project aims not only to reduce farmers' expenses regarding animal production but also to address the challenge of parasite resistance to drugs. In the area of soil and water management, water use efficiency and productivity was improved on national levels through the application of stable isotopic techniques for soil fertility assessment and nitrogen isotopes to determine sources of pollution.



“Agency support is also being provided to improve livestock productivity through strengthened diagnosis and control of transboundary animal diseases (TADs) and Emerging Zoonotic Diseases, and by optimisation of livestock breeding and nutrition using indigenous animals and locally available feed resources.”

CROP PRODUCTION

The capacity of the Kenya Agricultural and Livestock Research Organization (KALRO) to improve two important forage crops, Brachiaria grass and Dolichos Lablab, using mutation breeding and related molecular techniques has been strengthened under project KEN5034, 'Using Irradiated Improved Brachiaria Grass and Dolichos Lablab Species for Increasing Quantity and Quality of Milk Production and Reproduction for Smallholder Dairy Farms in Drought Prone Areas'. Technology and knowledge of mutation induction and the handling of mutant populations has been transferred to KALRO and the knowledge has been applied to generate the first mutant populations in Brachiaria and Dolichos Lablab. This will be further advanced in the subsequent project, KEN5037, 'Using Climate Smart Bracharia Mutants to Develop Integrated Farm Model Technologies for Improved Livelihood Among Smallholder Farmers'. Both forage species are used as livestock feed and the improved mutants can have a direct impact on the improved quantity and quality of milk production and reproduction in smallholder farms in Kenya. Furthermore, essential knowledge on breeding Brachiaria grass and design for a Brachiaria mutation breeding programme has been transferred, and contacts with world leaders in Brachiaria breeding and research have been established which will facilitate the implementation of sustainable improvement programmes in Kenya based on mutation breeding.

Decreasing annual precipitation rates pose an important challenge to the production of durum wheat, which is an important crop in the territories under the jurisdiction of the Palestinian Authority. The project PAL5006, 'Enhancing the Performance of Durum Wheat Landraces by Induced Mutation', aimed to enhance the performance of durum wheat through mutagenesis application. The Agency has provided support in inducing mutation for desired traits which have led to the production, evaluation and selection of the required traits. Human capacity building, both theoretical and practical, on wheat breeding methodologies, particularly in relation to wheat abiotic stress and drought tolerance, was delivered through fellowships and scientific visits.



KALRO Lanet's site for Brachiaria cultivation.

National training course on Mutation Breeding of Brachiaria Grass and Dolichos Lablab Species at Beef Research Institute; Photo: KALRO Lanet.



RAF5071: After learning about the drip irrigation system, the farmers work to maintain their fields as the crops grow. Photo: Dr. Imad-eldin A Ali Babiker/ARC.

AGRICULTURAL WATER AND SOIL MANAGEMENT

Under the regional project RAF5071, 'Enhancing Crop Nutrition and Soil and Water Management and Technology Transfer in Irrigated Systems for Increased Food Production and Income Generation (AFRA)', the Agency has helped Sudanese farmers to improve crop productivity using isotopic techniques. Monitoring how atoms behave in soil, water and fertilizer is helping small-scale farmers in the arid Kassala region of Sudan to cope more efficiently with a changing climate. After a successful pilot project supported by the Agency, in partnership with the FAO, thousands of farmers in the region are now benefiting from a combination of drip irrigation and isotopic techniques to more effectively grow vegetables. The project initially began around with 100 farmers in villages north of Kassala city. It was expanded to three more villages and the system was adopted by 75 more families. After it was proven successful for small-scale farms, the technology began spreading from village to village. The SRC and the UNHCR took an interest and began scaling up the technology in efforts to help more farmers adapt to climate change and ultimately improve livelihoods and relieve poverty in the country. It is now used by more than 2000 farmers in the region, half of whom are women.

The Agency is working with African nuclear institutions and other partners to increase understanding of the causes of soil degradation, and is providing tools for controlling erosion in twelve African countries (Algeria, Benin, Côte d'Ivoire, Egypt, Madagascar, Mali, Morocco, Senegal, Sudan, Tunisia, Uganda and Zimbabwe) under RAF5075, 'Enhancing Regional Capacities for Assessing Soil Erosion and the Efficiency of Agricultural Soil Conservation Strategies through Fallout Radionuclides'. In Morocco, for example, initial pilot studies indicate that steps taken as part of the project have reduced soil loss in the El Hachef watershed of the Tangier Tetouan region and in the Oued Mellah watershed of the Casablanca-Setta region by around 40% and 60% respectively. This has in turn greatly reduced the sedimentation of local reservoirs. Another example is Madagascar, where a study using isotopic techniques on the mountainous island found that traditional terrace farming can reduce soil erosion and run-off in the country by up to 40% when compared to unprotected agricultural fields. The results of this study should encourage farmers in Madagascar to revert to using traditional terracing systems to better conserve their soil.



The 'Lavaka', a typical erosional feature in Madagascar's highlands. Photo: Naivo Rabesiranana/INSTN-Madagascar.

In Afghanistan, the Agency is providing support to increase crop production in irrigated and rain-fed agricultural systems using nuclear techniques under national project AFG5006, 'Developing and Implementing Soil and Water National Management System Using Nuclear Techniques'. Training has been provided on the use of neutron probes and other related equipment for soil and water management. Training has also covered water balance and modelling, the use of nitrogen-15, as well as calculation of nitrogen use efficiency.

“The Agency has helped sustain the growth of Jamaica’s agricultural sector by increasing water irrigation quality and crop productivity at farms for selected crops.”

The Agency has helped sustain the growth of Jamaica’s agricultural sector by increasing water irrigation quality and crop productivity at farms for selected crops, under project JAM5012, 'Optimizing Irrigation Water Management to Improve Crop Output and Water Quality Control'. This is particularly important as Jamaica has insufficient water, and climate change is having a negative impact on the growth of crops. In 2016, a training workshop was conducted in St. Elizabeth to train members of the Jamaican National Irrigation Commission in the application of nitrogen-15 urea for crop fertilizer management, as well as in the use of real-time, continuous soil, water and salinity profiling technology.



JAM5012: Preparing a hole for the soil probe during a training activity at the Hounslow Demonstration Plot in St. Elizabeth. Photo: Ministry of Commerce, Industry, Agriculture and Fisheries, Jamaica.

LIVESTOCK PRODUCTION

Stockbreeding accounts for 17% of Mauritania's gross domestic product (GDP). The sector employs many people, and ensures a safe and reliable source of food for the Mauritanian population. However, the climate conditions in the country and the threat of climate change call for improvements in food production. The Agency, through TC project MAU5004, 'Supporting Genetic Improvement of Local Cattle Breeds and Strengthening the Control of Cross-Border Diseases', is helping the National Centre for Stockbreeding and Veterinary Research (CNERV) to increase livestock productivity. Under the ongoing national genetic improvement programme (cross-breeding of local and foreign cattle), to which CNERV contributes through quality control and experimentation in local semen production, several artificial insemination farms have been established throughout the country. The Agency has provided CNERV with expert advice, training and state-of-the-art equipment. Several national training courses have taken place to transfer the latest knowledge on artificial insemination techniques.

Under project BEN5010, 'Using Nuclear Techniques for Better Utilization of Local Feed Resources and Improved Reproduction Practices to Enhance Productivity and Conserve Nature', the Agency is supporting the Faculty of Agronomic Sciences (University of Abomey-Calavi), the Kpinnou Breeding Farm (Livestock Department, Ministry of Agriculture, Livestock and Fisheries) and local farmers to increase the productivity of local livestock breeds using artificial insemination. Through a hands-on training programme, local professionals and breeders in Benin have acquired technical knowledge which will help them enhance animal productivity, thus contributing to increased national food security.

The Central Veterinary Laboratory in Huambo (CVLH) operates as a designated laboratory for specific regions of Angola. It is also a coordinating laboratory for the other six regional veterinary laboratories of Angola. The duties of the laboratory are linked to the strategic national control programmes for priority diseases (African swine fever, foot-and-mouth disease, lumpy skin disease, peste de petits ruminants, contagious bovine pleuropneumonia, contagious caprine pleuropneumonia, Newcastle disease and rabies). In most of the cases, laboratory work is performed upon demand, and is oriented mainly to emergency response for disease outbreaks.



BEN5010: Practical training session on artificial insemination in Benin. Photo: Dr. Naceur Slimane, École Nationale de Médecine Vétérinaire, Tunisia.

“The Agency has supported the initiative by the Government of Cambodia to boost beef production.”

The Agency has supported the initiative by the Government of Cambodia to boost beef production. The initiative, which began some years ago as a national programme, has included the establishment of the Animal Production Research Institute (APRI) under the Ministry of Agriculture, Forestry and Fisheries. The Agency has been working with APRI since 2012, with the aim of establishing an artificial insemination centre and improving capacities for animal disease diagnosis. Under TC project KAM5002, ‘Using Nuclear and Molecular Techniques to Improve Animal Productivity and Control Transboundary Animal Diseases’, an important milestone has been achieved: a semen laboratory started producing good quality semen in mid-2016. The centre is fully equipped and local staff have been trained in semen collection, evaluation and processing through expert missions and fellowship training. Frozen semen is now being used at the government farm and in private small holdings around Phnom Penh. A national training course was held to build the capacity of field inseminators, and six professionals were trained in Sri Lanka. Capacity building on the determination of reproductive hormones using radioimmunoassay has been initiated to facilitate the understanding of estrous detection and fertility problems, and to provide services for non-pregnancy status. The artificial insemination service will be expanded to various regions of the country in the coming months within a follow-up TC project, started in 2016, to improve animal production through the applications of modern breeding technologies and improved feeding.

In Mongolia, the Agency, in cooperation with the FAO, has lent its support to veterinarians and scientists through the project MON5020, ‘Improving the Health Status of Livestock by Developing a Technology to Produce the Vaccine and Diagnostic Kit for Transboundary Animal Diseases’. The support has contributed to the establishment of Mongolia’s comprehensive animal disease control system. Having established zones free of foot-and-mouth disease in the country, the animal disease control system is now working to build confidence in the country’s animal products, thereby opening up export opportunities. As a result of the Agency’s training efforts, a recent outbreak of a new small ruminant disease, *peste des petit ruminants*, was rapidly diagnosed. Veterinarians were able to take samples correctly and to manage potentially infected livestock properly to contain the disease.



MON5020: Conducting laboratory work.



VIE5019: Staff at NCVD, Viet Nam.

Viet Nam is also facing animal disease problems. Many diseases, including TADs, are emerging or re-emerging, with a significant economic impact on livestock production, food supply and trade. The TC project VIE5019, 'Applying Nuclear Related Techniques for Transboundary Animal Diseases (TADs) Diagnosis' has addresses weaknesses in TAD diagnosis in Viet Nam. The current project offers a unique opportunity for the National Center for Veterinary Diagnosis (NCVD) to strengthen national research and diagnostic capacities for Goat pox, *Clostridium* sp., Leptospirosis and Parasitaemia diseases. IAEA technical experts have carried out visits to the NCVD to advise on improved nuclear-related techniques, such as serology and molecular techniques, to determine TADs. The Agency also provides the necessary equipment to detect the species, antigen and antibodies of some TADs. In addition, six fellowships are being implemented in international laboratories.

In El Salvador, the Agency has supported a holistic intervention involving a cooling system, feeding with leguminous forages and farm data recording, which has improved cattle productivity and benefited farmers. The national projects ELS5011, 'Enhancing Livestock Productivity and Decreasing Environmental Pollution through Balanced Feeding and Proper Manure Management', and ELS5012, 'Optimizing Livestock Production Systems through Cultivation and Efficient Use of Local Feed Resources, Monitoring of Performance and Reduction of Environmental Pollution through Solid Waste and Biogas Utilization' have provided important support that has helped farmers reduce the cost of milk production by 7 to 12 percent.

The regional ARCAL project RLA5071, 'Decreasing the Parasite Infestation Rate of Sheep (ARCAL CXLIV)', aims for sustainable control of gastrointestinal parasite (GIP) infections in sheep and goats though genetic selection. At an expert meeting in Paraguay, a 'road map' was developed to guide project counterparts on the implementation of genetic improvement programmes in sheep and goats to enhance their resistance to GIP. A regional training course in Uruguay brought together 29 participants from eleven countries (Argentina, Bolivia, Brazil, Costa Rica, Cuba, Dominican Republic, Mexico, Paraguay, Peru, Uruguay and Bolivarian Republic of Venezuela) to strengthen capacity in animal identification, collection of performance records and DNA samples, and the establishment of a database for storage, retrieval and analysis of genetic data in sheep and goat breeding programmes.



RER5022: Regional workshop to share technical knowledge on invasive mosquitoes, and synergize future project activities.

INSECT PEST CONTROL

The regional project RER5022 'Establishing Genetic Control Programmes for *Aedes* Invasive Mosquitoes' was designed to deal with the substantial increase in the spread of invasive mosquitos observed in Europe. Genetic control programmes of *Aedes* mosquitos are supported by selected mosquito suppression programmes in which the use of the SIT and SIT/incompatible insect technique (IIT) has already proven to be technically feasible. To facilitate the exchange of technical knowledge and synergize future activities in Member States, a regional workshop was conducted in Vienna in August, attended by 17 experts and 17 participants from Member States in the Europe region. SIT-capacity packages for each country are being developed to increase competence and capacity in relation to their differing levels of advancement. The procurement of equipment for each Member State has started, with the goal of providing basic technologies and devices for effective mosquito surveillance, and to establish an entomology laboratory.

FOOD SAFETY

Weak technical and analytical laboratory capabilities have hampered the development of Benin's agricultural sector, hindering the implementation of an efficient control and surveillance plan to reduce the rejection of many food exports. In 2011 the Government set up the Central Laboratory for the Control of Food Safety (LCSSA) with the main goal of obtaining international recognition through official accreditation to certify all imported and exported agricultural products. Extensive support has been provided to Benin under the TC project BEN5009, 'Monitoring Safe Food Supply through Total Diet Studies and the Application of Nuclear and Complementary Analytical Techniques'. This includes the development of institutional capacity (both human and technical), the modernization of laboratory instrumentation, and the set up of validation tools. As a result, the annual number



BEN5009: Sample preparation at LCSSA. Photo: Miguel Roncero/IAEA.

of tests conducted by the laboratory increased from 300 to 5000, and parameters analysed increased from 30 to 300. As a result of these efforts, LCSSA obtained the accreditation ISO/ IEC 17025 in March 2016. The institution is now recognized as competent to apply five different methods in microbiology. LCSSA has also built a national, regional and international network to improve and expand the services it delivers. LCSSA is the first and only laboratory in Benin to implement and gain accreditation for a QMS according to ISO/IEC 17025.

The capacities of Morocco's national veterinary laboratories to detect veterinary drug residues and animal diseases have been greatly enhanced through the project MOR5034, 'Improving Veterinary Drug Residue Detection and Animal Disease Diagnosis with Nuclear and Molecular Techniques'. The project, initiated in January 2014, was designed to support the work of Morocco's ONSSA. Today, the Moroccan government is able to better implement its national drug residue monitoring plan using high level analytical standards that meet international guidelines and those of major trade partners. This has enhanced food safety levels in the Moroccan market and will support plans to export poultry products. In the field of animal health, the awareness of laboratory analysts regarding quality assurance and quality control in molecular biology analysis has been greatly improved. The analysts participated in the diagnosis of the first outbreak of H9N2 (a variety of the virus commonly known as 'bird flu') in Morocco, which happened in early 2016.

Successive TC projects in Botswana, such as BOT5010, 'Enhancing Veterinary Drug Residue Monitoring Capabilities', have focused on building local capacity in analytical laboratories, covering an increasingly wide scope of contaminants in food, such as veterinary drug residues, and animal diseases. By the end of 2016, the Botswana National Veterinary Laboratory was able to perform tests for 13 different substances, and sending samples abroad for analysis is no longer necessary. This will reduce costs by over half and lower test turnaround time from around nine months to less than a month, thus helping the country to control animal diseases, ensure food safety and maintain its beef exporting capacity.

Project SYR5024, 'Enhancing Capabilities to Monitor Naturally-Occurring and Synthetic Anabolic Hormones and other Veterinary Drug Residues in Foods', aims to expand Syria's

national capacity to carry out assessments to ensure that animal products used for human consumption are free of hormones and veterinary drug residues. Through the project, hands on training, lectures and discussions on screening and confirmatory techniques such as radio immunoassay and use of gamma counters for food safety, as well as complementary tools e.g. enzyme-linked immunosorbent assay (ELISA) for testing residues of commonly used drugs in animal products for human consumption, have been delivered. The counterpart is now capable to apply such techniques to foods safety and related testing.

The national project OMA5003, 'Strengthening National Capabilities in Food Safety and Food Traceability', aimed to enable the export of Omani agricultural products and to monitor the quality of imported and local food commodities. National capacities have been enhanced through expert missions, a national training workshop on method development and validation of the analysis of veterinary drugs residue, and a national training course on mycotoxin analysis of food products.

The capability to certify food origin or authenticity is of significant economic importance to many stakeholders in developing countries. Nuclear and related techniques can provide an independent means of verifying 'paper' traceability systems, and also help to prove authenticity, to combat fraudulent practices and to control adulteration. A regional project RAS5062, 'Building Technological Capacity for Food Traceability and Food Safety Control Systems through the Use of Nuclear Analytical Techniques', has strengthened capabilities in the Asia and the Pacific region in utilizing nuclear techniques to verify the origin of food products. Sixteen countries in the region participated in the project, using rice as the key commodity for research on food authenticity. Thirty eight young scientists from the participating countries attended three training courses on sampling techniques, application of stable isotope and trace element analysis, and statistical tools and data analysis. Key project accomplishments include: the establishment of a self-sustaining network of laboratories utilising nuclear and related techniques for food traceability; increased awareness of the role of nuclear and isotopic techniques within Member State stakeholder groups, such as analytical labs, regulators, producers, policy-makers, decision-makers; increased analytical capability following the training of staff in stable isotope, trace elements and other complementary techniques; increased success in attracting external and matching funding for research on food safety and authenticity; technology transfer through the extension of applications in rice to other commodities; and a significant amount of publications in international peer-reviewed literature, reports and presentations.

The Agency provided two gas chromatography systems, training, expert advice and reference materials to Paraguay under PAR5010, 'Strengthening the National Network of Laboratories Involved in Chemical Risk Analysis to Ensure Food Safety Through the Use of Nuclear and Complementary Non-Nuclear Techniques'. The procurement of these systems, supported by a total of €50 000 in government cost sharing, will enable interlaboratory method validation within Paraguay, an important requirement for ISO17025 certification, rather than using laboratories abroad, which is more expensive. The project facilitated the establishment of a local network of ten food safety testing laboratories where resources and technical knowledge are shared. The project also provided technical advice on the legislation for the creation of a National Food Safety Monitoring programme. The project has greatly strengthened Paraguay's food safety monitoring programme, protecting its citizens' health and safety, and ensuring that food products meet international food safety standards, thereby increasing global marketability.

In Panama, the TC programme supported the project PAN5024, 'Developing Analytical Capabilities for the Detection of Chemical Contaminants in Food and the Quality of Agrochemicals'. The counterpart laboratory from the Ministry of Agricultural development validated a method for glyphosate in water and applied it to verify the contamination of a river in Panama. Glyphosate is the most largely imported herbicide in Panama, but its effects on the food chain and the environment have not been fully studied, so further work is required to understand its effects and fate in Panama. With expert advice from the Agency, the counterpart laboratory reviewed and adapted a calculation sheet for the estimation

of the uncertainty of an analytical method for the determination of pesticides that was validated in the first phase of this project and is included in the scope of accreditation of the laboratory. The pesticides were present in different crops such as strawberries, celery, peppers and others. This project is of great importance to Panama as it will contribute to pesticide surveillance programmes being implemented in the country for food safety and improved trade.

Costa Rica has been able to improve delivery of public health services and increase the competitiveness of Costa Rican animal food products through the effective and timely detection and control of chemical contaminants and residues, with the support of COS5032, 'Enhancing the Capacity to Control Contaminants and Residues of Veterinary Medicines and Pesticides in Foodstuffs of Animal Origin Using Nuclear and Conventional Analytical Techniques'. The National Veterinary Services Laboratory is now equipped and able to effectively apply both conventional and nuclear analytical technologies to detect contaminants in animal products, thus increasing food safety. Moreover, laboratory personnel have become more competent in monitoring and controlling contaminants and residues in foodstuffs of animal origin in accordance with international standards.



PAN5024: Technical staff perform an analysis of glyphosate in water, Laboratory of Analysis of Pesticide Residues, National Directorate of Plant Protection - Ministry of Agricultural Development. Photo: Ministry of Agricultural Development, Panama.

Water and the Environment

REGIONAL HIGHLIGHTS



The Sahel region faces major challenges that include rapid population growth, poverty, food insecurity, environmental problems and adverse climate change effects. These challenges not only affect local populations but intensify the vulnerability of the region as a whole. Under the TC programme, isotopic investigations are contributing to the efficient management of water resources, thereby ensuring sustainable livelihoods and complementing efforts to enhance human health, food security and agriculture. The TC programme also continues to provide support to African Member States in developing and implementing climate change mitigation and adaptation strategies, through controlling soil erosion and land degradation, improving soil fertility and water resource management and exploitation.

In the Asia and the Pacific region, the TC programme focused on building capacities in the management of marine and air pollution, establishing environmental monitoring laboratories, and assessing the impact of off-shore oil and gas operations on the marine environment. In 2016, the programme also focused on the evaluation and management of groundwater resources, on improving drinking water quality using hydrochemical and isotope techniques, and on building capacity in radioactivity monitoring.

Member States in the Europe region recognize air and water pollution control as an important priority. Regional projects enhance capabilities for developing pollutant models and for monitoring different pollutants using nuclear and complementary analytical methods. Other national projects help to upgrade technology and equipment for environmental monitoring. The Agency has provided equipment, expert services and on-the-job training to strengthen national capacities in geochemistry and isotope hydrology.

In the Latin American and Caribbean region, the TC programme focused on capacity building in sustainable water resource management as well as improving the management and evaluation of water quality and security. Water pollutants were evaluated, for example, to improve the management of major basins and safety of agricultural products. Mining and industrial activities and their effects on water resources were also assessed using nuclear and isotopic techniques, as were marine, terrestrial and coastal environments. This has led to the establishment of a robust science-based network in the Greater Caribbean, to support Member States in the region to adopt and implement programmes on climate change mitigation and adaptation.

WATER RESOURCE MANAGEMENT

The project PAL7004, 'Evaluating Groundwater Resources Using Environmental Isotopes', aimed to improve water resource management with respect to quantity and quality is being implemented in the territories under the jurisdiction of the Palestinian Authority. Intensive field sampling campaigns were implemented which included the collection and analysis of rain- and groundwater samples. Unlike previous analyses, the study utilized the environmental isotopes oxygen 18 and deuterium to identify the recharge zones of the deep aquifers. The use of environmental isotope techniques, in combination with the interpretation of hydro-geochemical data, provided national experts and scientists with a detailed understanding of recharge/discharge mechanisms, replenishment rate, and groundwater flow pathways, offers a way to understand the hydrogeological setting of the NE-Basin, information which in future can be disseminated to various stakeholders working within the water sector. The results of the studies carried out were showcased at a national workshop held at the Palestinian Water Authority in Ramallah in January 2017, and will be further discussed at the Palestine Technical University in February 2017.

The regional ARASIA project RAS7027, 'Using Environmental Isotopes and Natural Radioactivity in the Assessment of Ground Water Quality', aims to assess water resources using environmental isotope techniques, focusing on groundwater dynamics, seawater intrusion and quality. Human capacities were enhanced through training in the analysis of stable isotopes in water samples using laser-based stable isotope analysers. Also under this project, the International Center for Biosaline Agriculture, Dubai, United Arab Emirates, carried out isotope hydrological studies for the first time in February 2016. The field and isotope results of groundwater samples collected during the 2016 campaign were interpreted.

In Kuwait, project KUW7004, 'Managing Groundwater Resources Using Stable and Radioactive isotopes', supported the evaluation of potential sources of nitrate and sulphate contamination in the northern groundwater field in Kuwait through the isotopic characterization of groundwater, and the measurement of naturally occurring radionuclides. The Agency provided isotope analytical laboratory services for 40 groundwater samples. The results of these measurements enabled the identification of pollution sources, assessment of their relative contribution to the pollution, and the quantification of pollutant transport and removal processes. Assistance in preparing sampling protocols and interpreting the isotopic data was provided through expert missions. Geochemical modelling software provided by the Agency was used to help identify the geochemical processes which lead to high nitrate and sulphate concentrations in groundwater.



In Chile, efforts are underway to improve water resource monitoring programmes by using isotopic techniques to complement conventional methodologies. Water monitoring programmes for mining and/or industrial activities are thus strengthened and improved, especially in instances where tailings dams are used. Under CHI7013, 'Strengthening the Monitoring of Mining or Industrial Activities and Their Effects on Water Resources Using Isotopic Techniques', the Agency is building the capacity of the General Directorate for Water (DGA) in collaboration with CCHEN to better monitor water resources near mining and industrial sites. DGA is responsible for water resource testing, monitoring and licencing, and for levying fines in the event of releases that violate national regulations and standards.

"In Chile, efforts are underway to improve water resource monitoring programmes by using isotopic techniques to complement conventional methodologies."

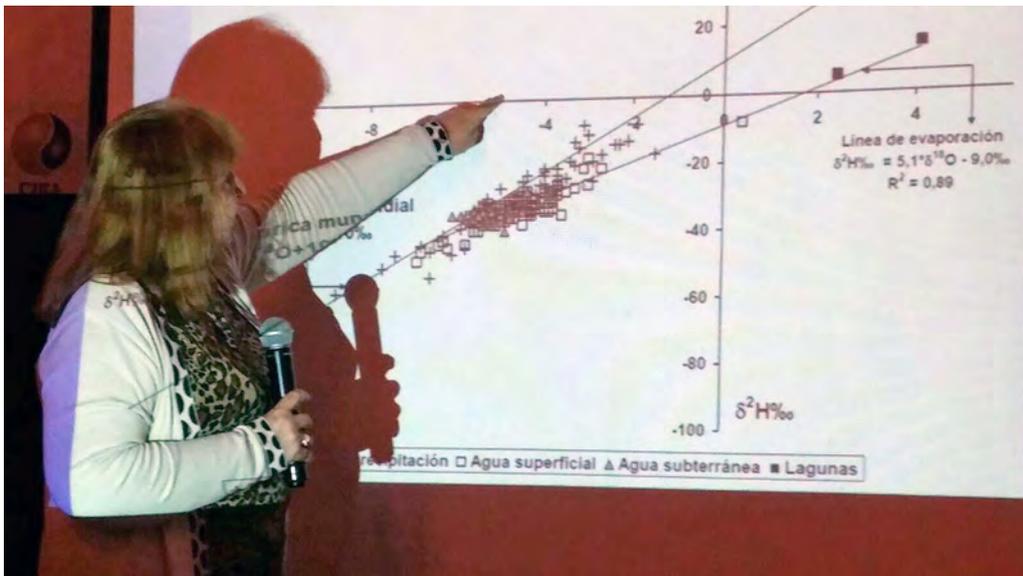
Costa Rica has experienced a decrease in rainfall in the last three decades, and in 2013 and 2014, surface water discharge within the Barva-Colima groundwater springs decreased by up to 65%, resulting in severe water shortages for roughly 65 000 inhabitants. Project COS7005, 'Ensuring Sustainability and Water Security in the Central Valley', aims to contribute to national water sustainability and security by supporting better water resource planning in the face of current climate variability. The project builds capacities in an analytical technique known as cavity ring-down spectroscopy to achieve analysis of water samples. With Agency assistance, several professionals were trained in hydro-meteorological modelling in 2016. Laboratory capabilities were improved, and by the end of the project in 2017, more precise water balances will be determined in the four main watersheds in the Central Valley of Costa Rica and a long term hydrological and meteorological monitoring network will be in place.

Cuba also suffers from lack of water availability. This issue is aggravated by climate change, as extreme meteorological events are occurring. Water scarcity generates negative socioeconomic impacts on areas such as public health, fishing, industry, agriculture, cattle husbandry and food safety. The project CUB7009, 'Strengthening Isotope Hydrology Capabilities for Sustainable Management of Water Resources', aims to increase knowledge on the origin and sources of groundwater, its occurrence, time of recharge, presence of pollutants and the magnitude of saline intrusion, and to contribute to the sustainable management of water resources in Cuba. In 2016, the project provided considerable support for the installation of an isotope monitoring network for precipitation. In addition, local staff were trained in the design and installation of a network for groundwater sampling. By the end of 2017, groundwater maps will be finalized and interpreted, and the laboratory will be fully operational.

In Bolivia, the Agency is supporting the hydrogeological characterization of the Viacha aquifer, which supplies water to the cities of El Alto and Viacha near the capital La Paz, through BOL7004, 'Characterizing and Setting Up a Management Plan for the Viacha Aquifer Through Application of Traditional Techniques Complemented by Hydrochemical and Isotopic Techniques'. More than one million people depend on these aquifer water resources, so the development of a sustainable management plan is very important. In 2016, two national training courses were carried out on the use of hydrochemical tools in hydrology and on isotope hydrology, and over 50 local scientists were trained. Expert missions were conducted to evaluate and confirm on-site the proper installation and operation of a spectroscope laser provided at the beginning of the project, ensuring that it can obtain reliable results.



BOL7004: Taking samples in the Andean Plateau. Photo: Louise Potterton/IAEA.



RLA7018: Training in Mexico, August 2016. Photo: Emilia Bocanegra/Argentina

The IAEA Water Availability Enhancement (IWAVE) methodology has been implemented through the regional project RLA7018, 'Improving Knowledge of Groundwater Resources to Contribute to their Protection, Integrated Management and Governance (ARCAL CXXXV)', leading to the identification of national or provincial gaps in hydrological understanding, data and information. The results were presented at the latest Latin American Association of Groundwater Hydrology for Development (ALHSUD) congress in Mexico. The implementation of IWAVE methodology has helped strengthen national capacities to conduct comprehensive assessments of water resources in Latin America. In four pilot areas, action plans that include the identification and filling of gaps in hydrological knowledge and institutional capacity have been developed. The availability of hydrological information, legislation, public policies and social and technical aspects in eleven participating countries has been assessed, and capacity building is being provided through both national and regional courses. Implementation of IWAVE will help countries to address water resource management problems more efficiently and effectively.

In Ecuador, TC project ECU7006, 'Determining Recharge Areas and Groundwater Dynamics for a Sustainable Exploitation in the Eastern Valleys of the Metropolitan District of Quito Using Nuclear Techniques,' aimed to establish the hydrogeological characterization of the eastern aquifers of the city of Quito, and to determine recharge sites, preferential flows and the storage time of aquifers, using isotopic techniques to validate preliminary assumptions of water dynamics. The project, carried out in 2014 and 2015, enabled fellowships and scientific visits for Ecuadorian experts to build capacities in groundwater hydrology and sampling, and in the interpretation of isotopes in hydrology. Expert advice and training was provided throughout the project lifespan, as was advice on the final interpretation of the hydrochemical and isotopic information obtained from field sampling campaigns. As a result, Ecuador's authorities have better hydrogeological knowledge of the Pita River basin highlands, which are considered a strategic reserve for potable water for the population of Quito. These valuable project results are being used to prepare a strategic and sustainable exploitation plan to facilitate the development of eastern populations within Quito, and will later be used in nationwide studies of the Andean valley.

Under project GUA7004, 'Developing Capabilities to Evaluate the Transfer and Fate of Water Pollutants to Improve the Management of Major Basins and the Safety of Agricultural Products', Guatemala has been able to enhance its capabilities to evaluate radioactivity levels in export agricultural products (such as cardamom) to improve radioactivity control

in the country. Training and expert advice have been given on sampling techniques and strategies. The data collected on water quality management and the safety of agricultural products in the basins will benefit decision makers, and will support improvements to environmental regulations for wastewater treatment, wastewater discharge intervention levels and the protection of aquatic ecosystems.

In Jamaica, national TC project JAM7003, 'Assessing the Kingston Hydrological Basin', has produced a summary of existing hydrogeological information on the study site. Basic field equipment, stable isotope laser equipment and consumables, as well as an ion chromatograph have been procured, and the first sampling campaign for water stable isotopes and hydrochemistry has been carried out.

Project ARG7008, 'Improving Management and Evaluation of Quality and Availability of Water Resources in Certain Regions through the Use of Isotopic Techniques', is crucial for Argentina, as its results will contribute to better management of water resources in Valle de Uspallata, Mendoza, for different ongoing productive initiatives in the region. The project will also provide concrete scientific data to feed into the design of the engineering project for the remediation of the former uranium mine in Los Gigantes, Córdoba. In 2016, field teams conducted four field monitoring campaigns, and a series of workshops and trainings were held to contribute to the analysis and consolidation of data. As a result, the teams were able to characterize the isotopic and chemical composition of different water bodies, the dynamics and age of groundwater, and the interconnection of surface and subsurface water, thus improving the hydrogeological conceptual model of two study sites.



Los Gigantes, Córdoba, Argentina. Photo: CNEA, Argentina.

Los Gigantes, Córdoba, Argentina. Measurement of hydrochemical parameters with a multiparametric sonde. Photo: CNEA, Argentina.

Each year, the availability of drinking water in Honduras needs to increase to meet the needs of the growing population. In the dry season, levels in the two main reservoirs that provide drinking water to the capital Tegucigalpa fall to the minimum allowable for safe drinking water treatment. There are around 1600 drilled water wells in the Central District alone, and for most of these wells, the rates of water extraction and quality are unknown. The project HON7001, 'Using Isotopic Techniques to Improve the Management of Groundwater Resources in the Central District', aims to identify the most important groundwater recharge areas, using stable environmental isotopes (oxygen-18 and deuterium) to generate the isotope baseline for the Central District, establish a groundwater monitoring network and develop the maps needed to describe groundwater dynamics. With Agency assistance, personnel from different public institutions involved in the project

have been trained in isotopic hydrological techniques, the laboratory infrastructure of the National Autonomous Service for Aqueducts and Drains has been strengthened, and the counterpart institution has been able to carry out its first water sampling campaign. More samples will be collected and analysed in 2017, and the isotope results will be used to better map water resources in the Central District.

MARINE, TERRESTRIAL AND COASTAL ENVIRONMENTS

Two national projects, TUN7002, 'Using Isotopic and Hydrochemical Tools for Management and Development of Water Resources in Coastal Aquifers and Identifying the Origin of Groundwater Degradation', and TUN7003, 'Using Isotope Tracers Techniques for Integrated Sustainable Groundwater Management', have improved understanding of the recharge process of Tunisia's Menzel Bouguiba and Ghar el Melah aquifer systems. A better insight into the consequences of overexploitation of groundwater resources caused by urbanization and other human factors has been achieved. In addition, a thorough assessment of the consequences of climate change and related human activities on the degradation of groundwater quality, the interplay between marine intrusion and over-utilization of groundwater resources, the vulnerability of groundwater to pollution and the extent to which such factors affect the sustainable use of available resources has been made, and useful data that can inform strategic and operational decisions have been derived. The various assessment exercises have been carried out in tandem with various human and institutional capacity building measures, contributing to the overall improvement of water resources management in the country.

The Agency has provided the Marshall Islands with support to measure chemical pollutants in fish and seafood. Project MHL7001, 'Developing a National Radioactivity Monitoring Capacity', aimed to establish national capacity to measure artificial radionuclides in the marine, terrestrial and coastal environment of the Marshall Islands. Through national training workshops and group fellowships, as well as through the provision of equipment, the project supports informed government decision-making on issues pertaining to radioactive contamination and the management of natural resources, and ultimately helps to ensure national food safety.

Kuwait has established a facility to conduct ocean acidification experiments on various organisms using nuclear techniques. This capability includes wet laboratories with flow through systems, and advanced instrumentation to regulate pH, temperature and salinity in the experimental facility. Kuwait has also developed a water quality monitoring programme for in-situ monitoring of key water quality parameters. The national project



KUW7003: Staff at the laboratory.

KUW7003, 'Addressing Ocean Acidification and Carbon Export in Marine Waters', complements national capacities, and aims to build understanding of the effects of ocean acidification on the Gulf across the food chain and to understand the carbon fluxes. The project has produced some remarkable datasets. A national seminar on the application of nuclear technologies in various sectors for stakeholders and decision makers was held 29 May to 2 June 2016. Participants were trained on the interpretation of recent water analyses results, and a laser water isotope analyser was demonstrated.

The regional project RAS7026, 'Supporting the Use of Receptor Binding Assay (RBA) to Reduce the Adverse Impacts of Harmful Algal Toxins on Seafood Safety' aimed to strengthen HAB monitoring capabilities in the Asia and the Pacific region through the use of the radioligand RBA techniques to identify ciguatera and puffer fish poisoning. Participants from 11 Member States attended a training course on Benthic Dinoflagellate Sampling, Identification and Culturing in the Marshall Islands in September. Project achievements were presented at the 17th International Conference on Harmful Algae, held in October in Brazil.

“Oman’s marine ecosystem and rich fishing grounds suffer periodic massive fish kills, caused by depleted oxygen triggered by HABs. With Agency support, Oman has established a red tide reference laboratory.”

Oman’s marine ecosystem and rich fishing grounds suffer periodic massive fish kills, caused by depleted oxygen triggered by HABs. With Agency support, Oman has established a red tide reference laboratory under OMA7001, 'Establishing a Reference Laboratory for Harmful Algal Blooms'. RBA, a key technique to detect marine toxins, can detect low levels of paralytic, amnesic and other types of shellfish and fish toxins, providing early warning information to decision makers and stakeholders. A new national project, OMA7003, 'Building Capacity for Effective Management of Harmful Algae Blooms (Red Tide)' was initiated in 2016, to build on previous efforts to achieve effective management of HABs. Under this project, a national workshop on the identification and classification of HABs species took place in Muscat in September. Hands-on training on toxic phytoplankton identification and phytoplankton cell counting was provided. A sampling strategy for HAB monitoring was established. A second national workshop focused in more detail on methods and protocols for toxins analysis and RBA data analysis and interpretation.

In Europe, the regional project RER7008, 'Strengthening Capabilities for Radionuclide Measurement in the Environment and Enhancing QA/QC System for Environmental Radioactivity Monitoring' supports the development of Member State capacities in monitoring radionuclides in the terrestrial and aquatic environments. During 2016, in an effort to start harmonizing procedures, 22 professionals from 16 countries met in Vilnius, Lithuania, to exchange the experiences of monitoring laboratories in environmental radioactivity control, including the implementation of national regulations, and QA/QC. Participants discussed potential sources of radioactive pollution, related legislation (Euratom Treaty, EU regulation, national regulation), monitoring principles, typical environmental samples, applied radioanalytical methods and data evaluation. The project has also supported the harmonization of sampling procedures for soil and vegetation. Twenty-four experienced radioanalytical professionals from 20 countries met in Karlsruhe, Germany, at a workshop that provided guidelines for upgrading methods and for extending the scope of accreditation, including sampling techniques. As a result, Member States are now able to introduce up-to-date techniques for sampling, sample preparation and rapid measurement for soil and vegetation monitoring. The project supported two proficiency tests: one on surface contamination monitoring and the other one on analysis of environmental river water for low level radio-caesium. Both exercises have enhanced the exchange of knowledge regarding routine laboratory procedures, the evaluation of measurement uncertainties, and the reporting of results.

Also in Europe, 20 Member States have participated in RER1015, 'Apportioning Air Pollution Sources on a Regional Scale'. A training course and a workshop were organized in 2016. The participants developed a communication network and are exchanging advice and information regularly in the framework of the project.

The overall objective of regional project RLA7020, 'Establishing the Caribbean Observing Network for Ocean Acidification and its Impact on Harmful Algal Blooms, using Nuclear

and Isotopic Techniques,' is to establish a robust science-based monitoring network in the Greater Caribbean to support Member States in the region in the adoption and implementation of programmes on climate change mitigation and adaptation. A network of regional operational laboratories conducting toxicity analysis of marine products using receptor binding assay (RBA) is now operating in El Salvador and Costa Rica. Regional capacities to quantify the acidification of the oceans and to assess their historical trends in the Caribbean Sea by applying nuclear and isotopic techniques have been established, and historical trends in the Caribbean have been evaluated. Synergies and joint activities have been established with the Caribbean regional network of the IOC Harmful Algal Bloom (HAB) Programme and the Harmful Algal Information System (HAIS); furthermore, activities have been established with the Latin American Ocean Acidification Network. Results achieved through the project were presented at the 17th International Conference on HABs in Brazil.



RER7008: Proficiency test under RER7008: Shipment of novel reference materials with radionuclides imprinted homogeneously by ink printers on paper sheets (each color denoting a different radionuclide). Photo: S. Tarjan/IAEA.

Industrial Applications

REGIONAL HIGHLIGHTS

In Africa, the TC programme focuses on providing support to African Member States' efforts to improve the maintenance of medical and scientific instrumentation, in particular the development of capacity for repair services, preventive maintenance, provision of instrumentation infrastructure and cost recovery through income generated from the provision of services. The Agency is also providing support to several Member States who have expressed an interest in establishing multipurpose irradiators for commercial operations, including the preservation of fruit for export.

In the Asia and the Pacific region, the TC programme continues to enhance national capabilities in the region in radioisotope and radiation technology for industrial applications. This includes helping Member States to build capacities in advanced NDT techniques, and supporting the establishment of gamma and electron beam facilities. In particular, research reactors are being commissioned and operated through national and interregional projects implemented by the Agency.

Radiation processing technologies are used in a number of production processes and for preservation purposes in the Europe region. The majority of applications are well established and are implemented on a commercial basis. Most TC programme efforts are therefore devoted to enhancing of safety, promoting best technologies and harmonizing management approaches. The TC programme also supports some Member States under national projects to build human and technical capacities to meet local needs sustainably and effectively. Knowledge and awareness of cultural heritage sites and their contribution to tourism development in the Europe region has been enhanced with the support of several projects.

The TC programme in the Latin America and the Caribbean region is supporting Member States in developing capacities in the use of radiation technology with the aim of improving industrial performance and reducing environmental impact. The programme supports the industrial application of nuclear science and technology through a mix of regional projects and multiple national projects. For example, national projects under implementation in Argentina, Brazil, Mexico, Panama and Peru include: use of alpha emitting particles radioisotopes as a complementary alternative for targeted therapy of some cancer types; treatment of industrial effluents using electron beam accelerators; production of iridium-192 for use in cancer treatment in accordance with high quality standards; introduction of electron beam/X-ray irradiation technology; investigation of sediment transport in the Panama Canal Basin using tracers; and the application of radiation-processed cells, scaffolds and tissues.



“The TC programme in the Latin America and the Caribbean region is supporting Member States in developing capacities in the use of radiation technology with the aim of improving industrial performance and reducing environmental impact.”

RADIOISOTOPES AND RADIATION TECHNOLOGY FOR INDUSTRIAL APPLICATIONS

The Agency has supported the upgrading of the national system for qualification and certification of NDT personnel in Syria in 2016 under project SYR1011, ‘Building National Capacity in Advanced Non-Destructive Testing (NDT) Techniques’. Recently, computed radiography using imaging plates and the ultrasonic phased array technique have replaced conventional radiography and ultrasonic techniques, respectively, in many areas of industrial application. Training in 2016 focused particularly on these two techniques.

In Nepal, the four year project NEP1001, ‘Introducing Non-Destructive Testing (NDT)’, aims to enhance the safety of public places prone to structural damage due to natural disasters. The Agency has provided assistance in introducing NDT techniques, and in

selecting a core team to carry out this work. An expert mission has supported an evaluation of the situation and the selection of buildings and civil structures for NDT testing.

Project RER1017 'Using Advanced Radiation Technologies for Materials Processing' is enhancing the application of advanced radiation technologies for radiation processing of human health care products, environmental remediation and production of advanced materials in the Europe region. In 2016, 16 professionals from 10 countries received theoretical and practical training at a training course in Bucharest, Romania, on the implementation and maintenance of a QMS in radiation processing facilities in line with ISO 9001:2015, ISO 13485:2003 and other related standards. In addition, participants from 12 Member States were trained in Budapest, Hungary, in dosimetry for applications of gamma and electron beam facilities. The participants gained knowledge of validation and control for radiation processing, focusing on dosimetric aspects in installation, operational and process qualification as well as in process control. In 2016, experts gathered in Vienna to discuss the safe and reliable operation of irradiation facilities and to report on their experiences with irradiation facilities, radiation technologies and applied QA/QC procedures in the region.

The project KAZ1003, 'Supporting Preparation of Reference Materials', supports the certification and manufacture of radioactive reference materials which are needed when performing activities such as acceptance and calibration of measuring instruments. The Institute of Radiation Safety and Ecology created a research team and planned to produce soil and plant reference materials for the major radionuclides ^{137}Cs , ^{90}Sr , $^{239+240}\text{Pu}$, ^{238}Pu , ^{241}Pu , ^{241}Am , and material of micro-and macro-elemental composition. It is planned that the basic material for the production of the materials will be taken from the environment of the former Semipalatinsk Nuclear Test Site, which is contaminated with various radioactive isotopes. Several activities were carried out in 2016 to support the development of infrastructure for the production of radioactive reference materials in the country. The staff of the Institute were trained in quality control standards in the production and attestation of reference materials, and equipment was provided to upgrade the laboratory to allow the preparation of reference materials.



KAZ1003: Museum of the Semipalatinsk Test Site (left), New laboratory at the Institute of Radiation Safety and Ecology dedicated to production of reference materials (right).

In the Latin American and Caribbean region, the TC regional project RLA0058, 'Using Nuclear Techniques to Support Conservation and Preservation of Cultural Heritage Objects', aims to promote and harmonize the uses of nuclear science in the field of cultural heritage. Countries in the region are consolidating the capabilities and techniques already established with Agency support through previous research and TC projects, including hands-on training using nuclear techniques to characterize and preserve historical objects. A national and regional collaborative network of conservation scientists and conservators has been established, enhancing regional cooperation in terms of knowledge exchange and the sharing of specialized facilities among Member States. Furthermore, a regional statistical database has been created.

RESEARCH REACTORS

A regional project on research reactors RER1016, 'Enhancing Utilization and Safety of Research Reactors', is focusing on enhancing their research base, quality of products and sustainable and safe operation, as well as on networking and international cooperation. Eight meetings have been held, some of which had participation from countries of other regions that added to a broader perspective of the issues and strategies. Meetings brought together more than 100 participants, and focused on (i) specific applications of research reactors (RRs), (ii) e-learning tools for neutron activation analysis, (iii) safety reassessments of RRs following feedback from the Fukushima accident, and (iv) the graded approach in the application of safety requirements of RRs. The project also supported participation in the annual meetings of the Regional Advisory Safety Committee for Research Reactors, in Norway, and the Annual Commonwealth of Independent States Research Reactor Coalition meeting, in Almaty.³⁴

Project AZB1002 'Conducting Preparatory Work for Establishing a New Research Reactor' has supported four scientific visits and three fellowships, two national workshops and one technical meeting. The project has helped Azerbaijan to develop a sound strategic plan for the building of their planned research reactor that will now be transformed into an action plan.

The Agency has provided support to the only research reactor in the Caribbean, which is located at the University of the West Indies in Jamaica, under the national project JAM1001, 'Upgrading the Research Reactor Infrastructure at the University of West Indies, Slowpoke, Facility JM-1'. Following Agency advice, the research reactor console will be converted from analogue to digital in 2017, ensuring the continued safe and secure utilization of the reactor.

The regional TC project RLA1012, 'Developing a Capacity Building Programme to Ensure Sustainable Operation of Nuclear Research Reactors through Personnel Training (ARCAL CLI)', is supporting seven countries in Latin America and the Caribbean that have operating research reactors. The project aims to overcome the existing gap in human capacity preservation and knowledge management, and provides support to increase the number and quality of professionals trained in the operation, maintenance, safety and utilization of research reactors. Support has been provided through theoretical, practical and on-the-job training. During the project, a train-the-trainers workshop was organized in Prague, Czech Republic, enabling participating Member States to learn how to operate research reactors. The hands-on-workshop was implemented by the Eastern European Research Reactors Initiative. Fifteen participants from six countries learned about the education and training methodologies and approach needed to successfully stimulate the professional development of human resources in the operation of nuclear research reactors in the Latin American and Caribbean region.

³⁴ This paragraph responds to section 2, operative paragraph 6 of resolution GC(60)/RES/11 to provide assistance and support to MSs to identify and implement lessons learned from the Fukushima Daiichi accident.



RLA1012: Lecture room above the control room at VR-1 of the Czech Technical University research reactor. Workshop participants are acting as regular students as the hosts demonstrate how to teach nuclear and reactor physics to others, and how operating a research reactor is integrated into an academic curriculum. Photo: Czech Technical University, Prague.

Energy Planning and Nuclear Power

REGIONAL HIGHLIGHTS

Sustainable, reliable and clean energy remains a priority for African Member States. One of the main obstacles to better analysis of alternative energy paths in Africa is the lack of appropriate background social, economic and energy service information. The Agency is strengthening regional capacity to conduct energy planning on a sub-regional basis. Following COP21 and the entry into force of the Paris Agreement, the Agency is responding by building capacity for efficient Nationally Determined Contributions (NDCs) including nuclear power, covering the domains of energy data collection, energy statistics, energy balances and energy demand analysis. Several countries are receiving individual support to address specific national issues and fill in gaps in knowledge and skills related to energy policy analysis and design.

In the Asia and Pacific region, the Agency is supporting the development of national infrastructure for several Member States embarking on building their first NPP. In addition, capacity building for uranium extraction has been enhanced through the projects.

In Europe, nuclear power is contributing to assure sustainable, reliable and clean energy, and provides for sustainable social and economic development. Member States in the region are continuing to show interest in nuclear power, and a number have taken steps towards constructing their first NPPs, while others are extending NPP operations beyond their original designed lifetimes, or expanding existing facilities. A number of regional projects are therefore not only focusing on strengthening national safety infrastructures and the operational safety of existing NPPs, but are also providing guidance to Member States that are considering expanding their nuclear power programmes or introducing nuclear power. Several coordination meetings on integrated work plans (IWP) for Nuclear Power Programmes were held in 2016 to ensure coordination of national efforts and support was provided under relevant regular programmes and TC projects to carry out Integrated Regulatory Review Service (IRRS), Emergency Preparedness Review (EPREV) and Integrated Nuclear Infrastructure Review (INIR) missions. The Agency is also supporting some countries with energy planning and on the evaluation of the potential role of nuclear power in the energy mix.

Reducing dependency on imported energy and increasing energy security is a priority in the Latin American and Caribbean region. The population of the region was slightly more than 632 million in 2015, and is growing at a rate of about 1% per year. Electricity demand in the region is estimated to grow on average by 2.7% per year, and the Agency is helping Member States to develop the reliable and clean energy necessary for sustainable social and economic development in the future. Although some countries in the Latin American region have over 25 years of experience in nuclear electricity generation, nuclear power reactors in the region are coming to the end of their planned lifetime, and an analysis and evaluation of lifetime extensions will therefore be undertaken with the support of the Agency.

ENERGY PLANNING

The regional project RAF2010, 'Developing, Expanding and Reinforcing Energy Planning Capabilities including Nuclear Power (AFRA)', has succeeded in bringing together countries on a sub regional basis. Regional energy plans, currently being finalised, will enable countries to consider energy mix options at the sub-regional level. A training course was organized to enhance the knowledge of grid connection issues in eight African countries considering nuclear power. The course focused on the development of transmission system networks and the potential integration of NPPs, and covered topics such as the connection



“In the Asia and Pacific region, the Agency is supporting the development of national infrastructure for several Member States embarking on building their first NPP.”

between energy planning and transmission system development, the reliability of transmission networks, power flow, transmission system stability, grid connection studies and grid code development. This course was timely as many of these countries' grids will need to be enhanced to incorporate commercially available NPPs safely, and grid issues should be considered in the national and regional contexts.

The Agency has provided assistance to the Nuclear Power Plants Authority (NPPA) to further develop Egypt's nuclear power infrastructure through EGY2014, 'Building Capacity for the Nuclear Power Plant Project Construction Stage'. A national workshop provided NPPA staff with training on the practical aspects of conducting construction and vendor inspections for a new NPP, as well as on the inspection areas for construction and the role of residence inspector, a plan for comprehensive inspection, and on inspection procedures. Advisory services were also provided to NPPA on the site development plan for El-Dabaa.

Energy planning in Member States in Latin America and the Caribbean is supported under RLA2015, 'Supporting the Development of National Energy Plans with the Purpose of Satisfying the Energy Needs of the Countries of the Region with an Efficient Use of Resources in the Medium and Long Term (ARCAL CXLIII)'. The project develops and updates national energy strategies to meet future energy needs in the context of sustainable development. Local capabilities in the use of energy planning tools are strengthened, for a better elaboration of national strategic studies. The viability of the nuclear option in the medium and long term is assessed, and local expertise in sustainable energy planning is enhanced so that national institutions are capable of designing strategies, policies and action plans for the sustainable development of the national energy sector. The project has identified the energy potential of countries within the region, as well as their ability to sustainably meet future energy needs. At present, countries fulfil the minimal requirements for the computational and communication infrastructure necessary to use IAEA planning models. National experts have been trained in the use of the IAEA tools Model for Analysis of Energy Demand (MAED) and Model on Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE) for analysis of energy demand and supply. These tools are now in regular use. National analytical competencies to ensure access to suitable, affordable and secure energy services have increased.



RLA2015: Itaipu, Paraguay. Photo: Ilse Berdellans/Cuba

INTRODUCTION OF NUCLEAR POWER

In April 2010, the Government of Saudi Arabia established the King Abdullah City for Atomic and Renewable Energy, and tasked this new entity to plan and execute the introduction of a nuclear power programme in Saudi Arabia in accordance with the highest international safety standards. Under the national project SAU2006, 'Developing Infrastructure for the Introduction of a Nuclear Power Programme (Phase 1)', the Agency has provided Saudi Arabia with advice, guidance and training on the related work plan. Phase 2 of the project was initiated in 2016. The Agency assisted in studies on cost evaluation of desalination systems and Desalination Economic Evaluation Program (DEEP) for the preparation of bankable feasibility.

In the Philippines, PHI2011, 'Assessing the Development of a Nuclear Power Programme', is providing assistance to the Philippine Government as it decides whether or not to include nuclear power in the country's energy mix. The project has, so far, supported a workshop on the potential role of nuclear power in energy strategies for the SDGs and climate change mitigation. Public understanding, stakeholder involvement and pre-feasibility studies have been addressed through expert missions; improving abilities to make the public and other stakeholders familiar with nuclear technology, power plants, and the associate benefits and risks.

In Bangladesh, competencies for the construction, preparatory and erection stage of the Rooppur nuclear power plant are being enhanced under BGD2014, 'Developing Infrastructure for the First Nuclear Power Plant (NPP): Preparatory Stage Construction and Erection Phase'. Support has been provided for project management and review, and a meeting has also been held on Bangladesh's Country Nuclear Infrastructure Profile and IWP. A follow-up INIR mission and a Simulator Training Programme meeting have also been facilitated through the project. In May, a technical meeting was held to share lessons learned from recent human performance related events at NPPs. The project has contributed to developing an appropriate national infrastructure to support the successful introduction of nuclear power and to facilitate the training of competent personnel who will be able to actively participate, along with personnel of the vendor country, in the construction activities of the Rooppur NPP, which – in the long run – will help address Bangladesh's growing energy demands.

Four scientific visitors from Poland have received training at CEA France International Nuclear Agency in planning and supporting human resource development for a nuclear power programme under POL2017, 'Supporting Nuclear Energy Infrastructure Development'. In addition, the Agency has supported the participation of Polish representatives in relevant meetings, including a meeting of Polish industry stakeholders and UK nuclear industry representatives in Sheffield, UK, a meeting with Finnish nuclear industry representatives in Helsinki, Finland, and a bilateral meeting on Belgian's nuclear waste management system in Dessel, Belgium. The knowledge gained regarding radioactive waste management has improved national competence, which is being utilized in the development and implementation of a national radioactive waste management strategy. This has led to visible progress in attaining national infrastructure readiness for the introduction of nuclear power.

Three regional meetings were held in Europe under RER2013, 'Enhancing Energy Planning, Nuclear Power Infrastructure Development and Nuclear Safety Regulatory Oversight' during 2016: on building a national position for a new nuclear power programme, and on assessment of regulatory competence need for regulating nuclear safety (Guidelines for Systematic Assessment of Regulatory Competence Needs (SARCON) seminar) in Warsaw, Poland, and a regional training course on assessing the potential role of nuclear power in the future energy mix using Multi-Criteria Decision Analysis methodology in Budapest, Hungary. In addition, representatives from interested Member States took part in a workshop on design and safety assessment principles of nuclear power plants in Trieste in November, which focused on methods and tools based on the IAEA Safety Standards.



RER2013: Participants at the Warsaw workshop.

NUCLEAR POWER REACTORS

Agency assistance under IRA2011, ‘Strengthening and Upgrading Capabilities for Safety and Reliable Operation and Maintenance of a Pressurized Light Water Reactor’, has contributed to the successful construction, start-up, commissioning and initial operation of Bushehr NPP unit 1 (BNPP-1), which continues the efforts of earlier TC projects IRA4029, ‘Strengthening Owner’s Functions for Bushehr NPP Project’, and IRA4035, ‘Strengthening Owner’s Capabilities for Commissioning and Start-up of Bushehr Nuclear Power Plant’. Support is being provided to the owner of the plant, Nuclear Power Production and Development Company, the Iran Nuclear Regulatory Authority and to the Waste Management Department. In addition, with the support of several TC projects, the Talmesi Radioactive Waste Disposal Facility managed by the Iran Radioactive Waste Management Co. (IRWA) is now established, and able to safely operate a waste repository for low and intermediate level radioactive waste. IRWA has received low level waste packages from the Bushehr NPP, which are currently stored at Talmesi Radioactive Waste Disposal Facility. IRWA operational activities are currently being supported through IRA9023 ‘Strengthening Owner’s Capabilities in the Safe Operation of Talmesi Radioactive Waste Disposal Facility’.

Improved NPP operational safety is not only a major concern but also an essential goal of Latin American countries that operate NPPs for commercial purposes (Argentina, Brazil and Mexico). The project RLA9080, ‘Enhancing Nuclear Power Plant Life Management and Safety Culture Practices’ aims to improve the operational safety of NPPs. In 2016, significant progress was achieved: important workshops were organized for participants from regulatory bodies, operating companies and technical support organizations from Argentina, Brazil and Mexico. The workshops dealt with procurement and supply chain management for nuclear facilities, operational safety with a focus on nuclear oversight, and maintaining environmental qualification during plant operation and safety culture. Preparatory and follow-up missions on Safety Aspects of Long Term Operation (SALTO) of Water Moderated Reactors as well as Operational Safety Review Team (OSART) missions also took place, yielding important recommendations.

NUCLEAR FUEL CYCLE

Capacities in Africa in the concept of comprehensive extraction of minerals and the implementation of environmentally sound management of uranium mining to minimize its adverse impacts on human health and the environment have been built through two training courses organized under RAF2011, 'Supporting Sustainable Development of Uranium Resources'. Member States have also received training on the fundamentals of uranium geology, uranium metallogeny in time and space, deposit typology and its economics for the deployment of innovative uranium extraction techniques, with the application of global good practices configured for specific local requirements.

The Asia and the Pacific region is a major consumer of mineral raw materials. The regional project RAS2019, 'Conducting the Comprehensive Management and Recovery of Radioactive and Associated Mineral Resources', tackles the issue of scarcity of high-grade deposits of mineral commodities such as uranium, thorium, rare earth elements, niobium-tantalum and phosphates. This scarcity, along with an increased difficulty in mining high-grade deposits, has made low-grade, unconventional and technologically more difficult to process resources into new targets. This has adverse implications with respect to waste management. In addition, lack of exposure to, and familiarity with, internationally accepted project management practices has led to serious problems in successful commercialization, inhibiting progress. A regional training course on processing unconventional radioactive mineral resources was held in Colombo, Sri Lanka. The beneficiaries of this regional project include Bangladesh, Indonesia, Islamic Republic of Iran, Jordan, Malaysia, Mongolia, Philippines, Sri Lanka, Thailand and Viet Nam. All these countries have active national programmes in the development of mineral sectors, focusing on integrated mineral extraction techniques to treat difficult and unconventional ores.

Radiation Protection and Nuclear Safety

REGIONAL HIGHLIGHTS



Nuclear and radiation safety remains a priority area for TC in Africa. In order for Africa to fully benefit from the application of nuclear science and technology, African Member States have to aim to satisfy all the requirements of the International Basic Safety Standards for radiation protection, along with other Safety Standards as appropriate. In 2016, regional projects addressing the key elements under the seven Thematic Safety Areas were implemented, with a strong focus on capacity building, self-assessment and on reviewing the regulatory infrastructure of some African Member States in order to help them address gaps to enhance their radiation safety infrastructure.

In the Asia and Pacific region, radiation and nuclear safety also continues to be a priority area. Regional projects in the thematic area of radiation safety applied focused support to assist the efforts of Member States in the region to establish and sustain robust national infrastructure for radiation safety, via review missions, the development of national plans, and capacity building events for regulatory bodies, including potential regulatory bodies and users of radiation technology.

Nuclear and radiation safety remains a top priority area for TC for the Europe region. Through many regional and national TC projects, Member States have experienced an overall improvement in their regulatory infrastructure. Notable results include an increase in the knowledge of regulators to carry out their regulatory functions in an efficient manner at various levels. One key success is related to the promotion of sharing experiences and lessons learned, not only among Member States participating in TC activities but also among developed and developing Member States in the Europe region at large. Substantial assistance has been provided to strengthen safety, not only for regulatory authorities but also to all key stakeholders such as nuclear power operators, radioactive waste management operators and technical support organizations. Many group activities were conducted to provide training and to share good practices in the preparation and implementation of national regulations.

In 2016, several regional projects in Latin American and the Caribbean provided education and training in radiation protection and safety. Major initiatives included strengthening the radiation protection of patients and medical professionals, and improving control of radioactive sources and waste management. Another priority for the region was strengthening the regulatory framework and infrastructure for radiation safety in Member States.

GOVERNMENTAL REGULATORY INFRASTRUCTURE FOR RADIATION SAFETY

Under RAF9049, 'Enhancing and Sustaining the National Regulatory Bodies for Safety (AFRA)', participating Member States used the SARIS methodology for the development and implementation of national action plans to improve their national regulatory bodies. The project enhanced capacities to conduct regular national self-assessment for continuous improvement of regulatory performance, and action plans for the improvement and further development of regulatory infrastructure and processes were prepared and implemented. This means that all participating African Member States have not only conducted a self-

assessment of the core functions and responsibilities of their regulatory body using SARIS, but now also have an action plan to address identified gaps. The recommendations will prove useful for African Member States as they set out to improve their regulatory infrastructure in line with the IAEA Basic Safety Standards.

The regional project RAS9074, 'Enhancing and Strengthening National Regulatory Infrastructure for Safety through Self-Assessment,' supports the Asia and Pacific region. With the active involvement of government representatives, senior professionals, and representatives and staff of national regulatory bodies, the project helped raise awareness concerning the need to develop comprehensive national infrastructure for radiation safety. To enhance understanding of the need for improvements, to build a feeling of ownership in achieving them and to support safety culture as a whole, a high level seminar on building national radiation safety infrastructure in line with IAEA Safety Standards was held in June. Participants from Cambodia, Lao People's Democratic Republic, Marshall Islands, Myanmar, Nepal, Vanuatu, Oman, Papua New Guinea, Palau and the territories under the jurisdiction of the Palestinian Authority were involved. In addition, a regional training course and several advisory as well as assessment missions were held under the project to address shortcomings within the participating Member States and respective regulatory bodies. With the strong engagement of national experts, strong improvements were observed in the appropriate uses of radiation sources as well as occupational and patient radiation protection, particularly in medical and industrial facilities field with high radiation risks.

Israel operates two nuclear research centres and employs nuclear technology in the fields of health, agriculture, industry and more. The widespread use of nuclear application technology in Israel makes maintaining a focus on radiation protection essential. Through the national project ISR9008, 'Improving and Strengthening Radiation Protection Education and Training', the education and training of radiation protection practitioners in Israel was improved, as part of expanding the use of nuclear applications in various fields. In 2016, participants were trained in various topic areas, ranging from inspection of consignors and carriers to first response to nuclear and radiological emergencies.





RAS9062 and RAS9085: Regional training course on orphan source search.

In Indonesia, activities under national project INS9026, 'Strengthening Regulatory Capacity for Nuclear and Radiation Safety', worked to further strengthen the regulatory capacity of the Nuclear Energy Regulatory Agency (BAPETEN) in accomplishing its regulatory objectives and meeting regulatory challenges, by focusing on the improvement of its regulatory effectiveness and capability. The Agency also helped the country to enhance its national capabilities in the management and regulatory control of naturally occurring radioactive material (NORM). National workshops and expert missions built competencies in safety review and assessment of the construction and operation of irradiators, and on the safety and development of regulatory control of radiopharmaceutical production.

Although many Member States in the Asia and the Pacific region have established a regulatory body and started implementing a regulatory programme, some are not yet fully consistent with the relevant IAEA Safety Standards. Under RAS9062, 'Promoting and Maintaining Regulatory Infrastructures for the Control of Radiation Sources,' the Agency supported the upgrade of regulatory infrastructure for the safe control of radioactive sources in the region. A regional training course on orphan source searches was held in October in Quezon City, Philippines, which brought together 25 participants from Member States in the region. Topics covered in the course included the discussion of orphan source searches, radiation protection for search teams, and post-discovery actions. Lectures covered topics such as the categorization and field identification of radioactive sources, administrative searches for orphan sources, physical searches for orphan sources, and basic radiation protection for search teams. The lectures also highlighted the appropriate actions after finding an orphan radioactive source: recovery, transport and conditioning. Participating countries and territories included Cambodia, Fiji, Lao People's Democratic Republic, Nepal, Palau, Papua New Guinea, Philippines, Vanuatu and the territories under the jurisdiction of the Palestinian Authority.

In Belarus, several national workshops were carried out in 2016 under BYE9022, 'Strengthening the Professional Capacity of the Nuclear Safety Regulator and its Technical Support System'. Topics included the transportation of nuclear materials, elaboration of nuclear safety regulations, and inspection of NPP commissioning activities. Another important achievement in 2016 was the conduct of an IRRS full scope mission in October. Twenty-one international experts and five IAEA staff members reviewed the status



BYE9022: IRRS mission in Belarus.

of national regulatory infrastructure in all areas of its activity against the IAEA Safety Standards.

The regional project RER9134, 'Enhancing Safety in Accordance with the IAEA Action Plan on Nuclear Safety', focuses on improving safety of NPPs within the 12 main areas identified in the IAEA Action Plan. During 2016, the project delivered three regional workshops on (i) Safety Standards in ageing management and SALTO and International Generic Ageing Lessons Learned (IGALL) programmes); (ii) Periodic Safety Review Programmes for NPPs; and (iii) Sharing Best Practices in Development and Implementation of Severe Accident Management Guidelines. These workshops were attended by over 50 experts from ten countries in the region. A training course in OSART methodology for first-time reviewers was also organized under the project in Slovakia, attended by 17 participants.

The project POL9022, 'Strengthening the Nuclear Regulatory Authority for Nuclear Power Introduction (Phase II)', is focused mostly on the development of well-trained staff in the regulatory authority. In 2016 an expert mission provided assistance to the National Atomic Energy Agency in developing guidelines and procedures for regulatory activities during the site licensing process. Other activities included on-the-job-training in the field of regulatory inspections at the US Nuclear Regulatory Commission for future resident inspectors at the NPP construction site. The activities will ensure the readiness of the regulatory authority to perform its duties related to the nuclear power programme, focusing on safe and secure introduction of nuclear power in Poland.

The Agency provided assistance to the regulatory body of Latvia, the Radiation Safety Centre (RDC), emphasizing knowledge management, efficiency and effectiveness under LAT9012 'Strengthening of the Regulatory Infrastructure'. The RDC is facing a continuous growth in the number of operators to be regulated while functioning with limited human resources. Five fellows attended a two week long radiation safety supervision training course in Belarus, and five RDC staff took part in workshops on preparedness and response for nuclear and radiological emergencies, held at the Belgian Nuclear Research Centre (SCK•CEN), which addressed state-of-the-art nuclear and radiological emergency management. Supplementary IT equipment, portable mobile contamination monitors and integral passive radon detectors were also delivered to Latvia under the project.

TC project GEO9014, 'Developing Regulatory Infrastructure for Nuclear and Radiation Safety', is helping to strengthen the regulatory infrastructure of Georgia, in line with IAEA Safety Standards. In 2016, Georgia's Agency of Nuclear and Radiation Safety made a strong effort to strengthen its regulatory authority in terms of enhanced independence, adequate

budget and staffing, and implementation of regulations. The Agency supported these efforts through the revision of national regulations for radiation safety, and analysed possible gaps and duplications in radiation safety provisions using the IAEA Safety Standards as a benchmark. Two specialists visited the Radiation Protection Centre of Lithuania to learn about systems of radiation safety and protection, QA/QC procedures, and regulatory body supervision and enforcement. Georgia also benefited from an informative IRRS preparatory meeting and a self-assessment national seminar in 2016, and the country hosted an Education and Training Appraisal mission, which provided a detailed appraisal of the status of provisions for education and training in radiation protection and the safety of radiation sources at the national level.

The project RER9139, 'Strengthening Inspection Capabilities of Regulatory Authorities (Phase II)', has helped strengthen the capacity of regulatory bodies of participating Member States by defining and implementing effective inspection programmes for nuclear facilities. Two regional workshops were organized in 2016 on: (i) Inspection methods, techniques and types used by Member States to oversee management for safety; and (ii) use of the graded approach when establishing and implementing an inspection programme. The project also supported the organization of a Regional Training Course on Regulatory Oversight of Human and Organizational Factors in Lithuania, attended by 19 trainees from 11 Member States.

Although Lithuania's regulatory framework were being improved regularly, Lithuania requested a full scope review of its regulatory infrastructure to ensure full compliance with international safety standards. An IRRS mission was conducted in 2016 under LIT9014, 'Enhancing the Regulatory Infrastructure in Line with International Safety Standards'. The IRRS team consisted of 17 senior regulatory experts from 16 IAEA Member States and 3 IAEA staff members. To update their knowledge in the field, a number of officials from the State Nuclear Power Safety Inspectorate (VATESI) participated in different conferences, including the Nuclear Regulatory Commission 28th Annual Regulatory Information Conference 2016 in USA, and the annual meeting for nuclear industry communicators: Public Information Materials Exchange (PIME) 2016, in Romania. Six VATESI specialists were attended two training courses in USA and in Latvia. Finally, an expert mission was conducted to provide recommendations for the effective design and operation of Lithuania's upgraded early warning system.

In Latin America and the Caribbean, the regional TC project RLA9079, 'Enhancing Governmental and Regulatory Safety Infrastructure to Meet the Requirements of the New IAEA Basic Safety Standards', has been key in helping Honduras and Paraguay to follow the steps necessary to establish and improve their regulatory infrastructures in accordance with relevant IAEA Safety Standards. Paraguay has established a new independent regulatory authority and a specific road map for the institution was elaborated under the project, to ensure that all necessary capacity building support is being provided to its newly recruited personnel. Additionally, four different expert missions to Paraguay have supported the update of its regulatory infrastructure and the establishment of a new management system for the regulatory authority. Honduras has also taken important steps to strengthen its national radiation safety infrastructure. In 2016, the country created the General Directorate of Radiation Safety, named its Director General and increased the number of staff. The National Dosimetry Laboratory has also begun operations, providing proper monitoring for occupationally exposed workers. This has led to an improvement of Honduras' radiation safety.

In Colombia, project COL9008, 'Supporting the Regulatory System for the Control of Medical and Industrial Applications using X ray and Linear Accelerators', has strengthened capacities in the Ministry of Health through technical assistance, fellowships and training courses. With guidance from a long term technical expert fielded by the TC programme, the Ministry established a working group dealing with radiation protection. This group reviewed and harmonized current national regulations dealing with the use of radiation sources, provision of radiation protection services and quality control. The country issued a

manual for inspection, monitoring and control of installations using equipment with ionizing radiation. Technical advice was provided to establish an information system for the proper inventory of equipment with radiation sources. Equipment kits for radiation monitoring were also provided through the project.

SUPPORTING SAFETY IN NUCLEAR POWER PLANTS AND RESEARCH REACTORS

In Singapore, SIN9023, 'Strengthening the Nuclear Regulatory Regime' has focused on providing Singapore with knowledge of the regulatory framework required for a country in transition from regulating radiation sources to regulating nuclear facilities. The Agency has provided guidance and information to key staff from relevant national agencies on the safety implications of embarking on a nuclear power programme, focusing on the regulatory framework required for the safety of nuclear reactors. It has also worked to enhance the knowledge and experience of local personnel on reactor design principles and safety related aspects. These achievements were made possible through national workshops on Governmental, Legal and Regulatory Framework for Safety of Nuclear Reactors, and on self-assessment of the regulatory infrastructure for safety using IAEA self assessment tools. The country has also built expertise and capabilities in regulatory control regimes, required to support and advance a high standard of nuclear safety.

In 2016, three regional training courses were conducted through project RER9144, 'Building Capacity for Infrastructure Development and Safety Assessment of Water Cooled Water Moderated Power Reactor Technology with Advanced Safety Features: the Case of WWER/PWR'. The training events aimed to enhance Member State understanding of severe accident prevention and mitigation by sharing knowledge and best practices for advanced water cooled, water moderated power reactor/pressurized water reactor (WWER/PWR), including improvements for the application of Severe Accident Management Guidelines after the Fukushima Daiichi accident. The participants received advanced information on the design and related advanced safety features of the WWER/PWR reactor design currently available on the marketplace.³⁵



RER9144: Students participating in control panel training.

³⁵ This paragraph responds to section 2, operative paragraph 6 of resolution GC(60)/RES/11 to provide assistance and support to MSs to identify and implement lessons learned from the Fukushima Daiichi accident.



UZH9005: Instrumentation and control devices from the 1960s that were replaced with modern technologies.

UZH9005: Modern instrumentation and control systems supported by the project.

The project UZH9005 ‘Improving Operational Safety of the Research Reactor at the Institute of Nuclear Physics (Phase II)’, was completed in 2016. It was complemented by UZH1001 ‘Strengthening Nuclear Safety and Improving Use of the Research Reactor at the Institute of Nuclear Physics’. Both projects supported the rehabilitation and refurbishment of the research reactor, including modernization of the radiation monitoring system, modernization of the protection, operation, and instrumentation and control systems of the reactor, rehabilitation of the ion exchange filtration system, and upgrade of the exhaust system and emergency ventilation system, which were completed in December 2016. In addition, important capacity building and human resources development activities were implemented to fortify the technical capacity of the staff, including several expert missions, scientific visits, fellowships, workshops, and technical meetings.

RADIATION PROTECTION OF WORKERS, PATIENTS AND THE PUBLIC

An intercomparison exercise was held at the regional level in Africa under RAF9057, ‘Strengthening National Capabilities on Occupational Radiation Protection in Compliance With Requirements of the New International Basic Safety Standards’. With the cooperation of the Algerian Atomic Energy Commission and the SSDL of the Algiers Nuclear Research Centre, 22 Member States in Africa assessed the capabilities of their dosimetry services to measure the quantity of the radiation dose in a person’s body. The exercise also provided countries with guidelines to improve the performance of existing dosimetry services, with the overall objective of achieving more accurate dosimetry services and strengthening occupational radiation protection in Africa. The exercise unfolded throughout 2016, ending with a regional meeting which took place in Ghana from 31 October to 4 November, organized in cooperation with the Ghana Atomic Energy Commission.

The Final Coordination Meeting of the Asia and the Pacific regional projects RAS9074, ‘Enhancing and Strengthening National Regulatory Infrastructure for Safety through Self Assessment’, and RAS9073, ‘Strengthening the Regulatory Infrastructure for Radiation, Transport and Waste Safety’, was held in November in Putrajaya, Malaysia. During this meeting the work plan for a new proposed regional project for the next TC cycle was finalized, and activities for the year 2017 were identified. Each participating country presented the status of their regulatory infrastructure, progress made and challenges, and the required input for a follow up project was identified based on the needs and priority areas of Member States.

The Joint South Africa-IAEA Nuclear Energy Management (NEM) School, the first of its kind in the African region, took place from 17 to 28 October 2016 in Cape Town,



The final coordination meeting of the regional projects on safety, Malaysia, 2016.

South Africa in cooperation with the North-West University, supported by RAF9056, 'Strengthening Education and Training in Radiation Safety and Sustaining Human Resources Development and Nuclear Knowledge Management (AFRA)'. The NEM School contributed to promote and foster knowledge on a wide range of issues related to the peaceful use of nuclear technology. The two week course covered important issues and challenges facing the nuclear energy sector. The participants from 28 Member States were trained on management issues, such as the economics of nuclear power, energy policy and planning, legal aspects, knowledge management, human resource management, and stakeholder involvement. Similarly, an AFRA Network for Education in Science and Technology Workshop on Establishing National Networks for Nuclear Education, Science and Technology took place in September in Arusha, United Republic of Tanzania, to address the effectiveness and sustainability of nuclear education in Member States, and to assist them to implement the AFRA Strategy in nuclear knowledge management and human resource development.

Member States in the Asia and the Pacific region have enhanced their national human resources in the area of occupational radiation protection under the regional project RAS9080, 'Enhancing National Capabilities on Occupational Radiation Protection in Compliance with Requirements of the New International Basic Safety Standards'. An advanced training course on 'Assessment of Occupational Exposure due to Intakes of Radionuclides, Method for Direct and Indirect Measurement' was organized in May in collaboration with the Government of the Republic of Korea through KIRAMS. Before taking part in the practical training course, the candidates were required to carry out the revision on this topic and perform an on-line evaluation to ensure they had adequate theoretical and technical knowledge for the course. Finally, the participants applied the methodologies and techniques in their own laboratories, and reviewed and updated their respective protocols. A further workshop was held in Manila, Philippines, in August, on optimization of as low as reasonably achievable principles in compliance with requirements of the international basic safety standards (GSR Part 3). The first draft of an occupational radiation protection programme was prepared for the respective medical facilities of the workshop participants.

Through project RER9136, 'Reducing Public Exposure to Radon by Supporting the Implementation and Further Development of National Strategies', Member States of the Europe region are being helped develop capabilities to control public exposure to radon in accordance with international standards. In 2016, 21 professionals met in Tallinn, Estonia,

"An AFRA Network for Education in Science and Technology Workshop on Establishing National Networks for Nuclear Education, Science and Technology took place in September in Arusha, United Republic of Tanzania."

to exchange experience and information on the control of radon in workplaces with high occupancy by members of the public, such as schools and hospitals, as an element of a national radon action plan. Thirty professionals increased their awareness of quality assurance for laboratories measuring radon in dwellings and workplaces, as well as of the development of radon risk communication strategies for a target audience such as doctors. In 2016, the project facilitated an advisory mission to support Georgian authorities in designing a national radon survey, and a follow-up mission to assist Serbia on measures to reduce radon levels in buildings.

The TC project RER9135, 'Strengthening Radiation Protection of Patients and Medical Exposure Control', assists Member States in improving the radiation protection of patients in compliance with the requirements of the International Basic Safety Standards (GSR Part 3). The ultimate aim of the project is the justified and optimised use of medical procedures using radiation and the prevention of unintended or accidental medical exposure. During 2016, standardized data collection tools and guidelines were developed and disseminated. A number of participating countries have already carried out patient dose surveys, and further surveys are ongoing. The results of the surveys are being used to initiate optimization actions in several countries. A large number of medical staff have received training and new training materials have been developed and disseminated. Several countries have taken the first steps in addressing justification of medical procedures, despite the widely recognized complexity of this topic.

The Agency provides substantial assistance to Member States in the Europe region in strengthening regulatory infrastructure for safety. Under RER9142, 'Establishing Sustainable Education and Training Infrastructures for Building Competence in Radiation Safety', a train-the-trainers course for radiation protection officers, delivered in Russian, was organized from 27 June to 1 July 2016 in Bishkek, Kyrgyzstan. The event was attended by 23 participants from 12 Member States, who gained competencies to act as trainers of radiation protection officers for medical and industrial facilities in their countries. Under the same project, a workshop on National Strategies for Education and Training (E&T) in Radiation, Transport and Waste Safety: Policy Framework and Analysis of E&T Needs, took place in October in Nicosia, Cyprus, to assist Member States in developing the policy for the establishment of national strategies, and to collect the preliminary data necessary to implement such strategies.



RLA9075: Radiation Protection Officers at the regional 'train the trainers' workshop, 23 -27 May, Honduras. Photo: Hospital San Felipe, Honduras.

In the Latin America and the Caribbean region, project RLA9075, 'Strengthening National Infrastructure for End-Users to Comply with Regulations and Radiological Protection Requirements', facilitated the participation of regional experts in the Ibero American Conference on Radiation Protection in Medicine (CIPRaM 2016). The Conference served to review advances in the implementation of actions proposed in the tenth Bonn Call for Action on radiation protection of patients, to identify problems and possible solutions, to promote good practices and to define progress indicators for those actions. The Conference also provided an opportunity for the exchange of information and experience gained in recent years on issues relevant to radiation protection in medicine, and to establish and strengthen relations between Ibero-American countries for cooperation in this field.

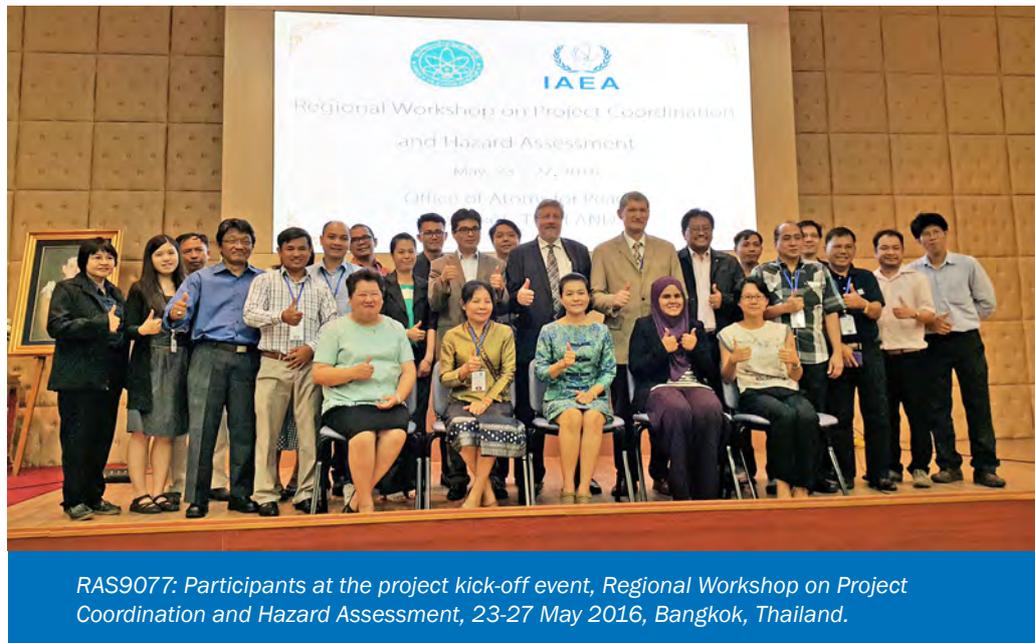
In addition, the project enabled the establishment of radiation protection and optimization programmes in several countries, as well as strengthened radiation protection in interventional procedures, resulting from expert missions and national courses focusing on the matter. The project has continued to invest significantly in the training of human resources in the field of radiation protection.

TRANSPORT SAFETY

Transport of radioactive material has well-established regulation in the Asia and the Pacific region. The regional project RAS9067, 'Strengthening an Effective Compliance Assurance Regime for the Transport of Radioactive Material', has led to the production, endorsement and implementation of a regional action plan for 12 areas of transport safety. Subsequently, changes and improvements by the participants were identified and the national profiles were updated by national counterparts. The project has contributed to aligning Member States' transport safety frameworks more closely with the IAEA Safety Guide for Compliance Assurance for the Safe Transport of Radioactive Material. The project also fostered improved coordination in the application of transport standards between participating countries. These contributions have been valuable in helping reduce weaknesses in transport safety, leading to smooth international shipments in the region.



RAS9067: Participants discussing transport safety regulations. Photo: M. Kurylchyk/IAEA.



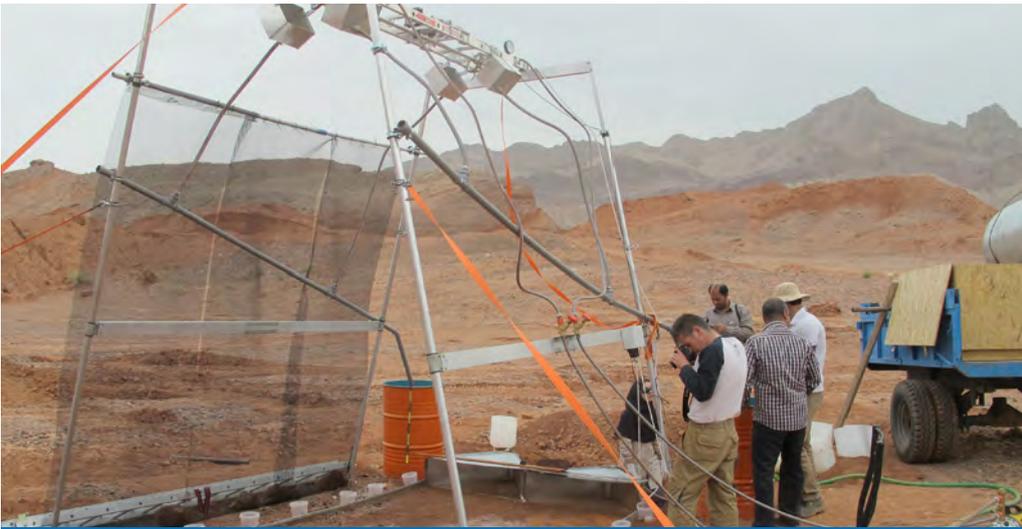
RAS9077: Participants at the project kick-off event, Regional Workshop on Project Coordination and Hazard Assessment, 23-27 May 2016, Bangkok, Thailand.

EMERGENCY PREPAREDNESS AND RESPONSE

The Agency is supporting Member States within the Association of Southeast Asian Nations (ASEAN) in developing and implementing emergency preparedness and response (EPR) arrangements at both national and regional levels to protect the people and the environment in case of a severe nuclear and radiological incident, under regional TC project RAS9077, 'Supporting Regional Nuclear Emergency Preparedness and Response in the Member States of ASEAN Region'. The project aims to facilitate the sharing and exchange of information between Member States in the region in a timely manner, so as to prepare, plan and respond more effectively to potential nuclear and radiological emergencies. In 2016, an assessment of nuclear and radiological hazards in the region was completed and a concept for national and regional monitoring was drafted, paving the way for the future establishment of radiation monitoring capabilities in the region as part of the IAEA International Radiation Monitoring Information System (IRMIS). This will enable the routine and reliable exchange of radiation monitoring data, and will make it available to the Competent Authorities identified under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Coordination with the European Commission is taking place on related activities planned for ASEAN for complementarity and effectiveness.

A School of Radiation Emergency Management, held in Traiskirchen, Austria, aimed to create a cadre of managers capable of developing and managing sustainable EPR programmes, based on IAEA Safety Standards, technical guidelines, tools and training material. By the end of the school, participants had a comprehensive understanding of the nuclear and radiological EPR and were able to facilitate the effective implementation and coordination of sustainable EPR programmes in their own countries.

The Agency continued to provide significant support to improve national and regional emergency preparedness mechanisms under the regional Latin American and Caribbean project RLA9076, 'Strengthening of National Capabilities for Response to Radiation Emergencies'. Four scientific visits, three regional meetings with more than 50 regional participants and four national training courses were implemented, helping to develop relevant capacities and fostering collaboration for responding to radiation emergencies.



IRA9021: Rainfall simulation tests at the Talmesi disposal facility site.

RADIOACTIVE WASTE MANAGEMENT, DECOMMISSIONING AND ENVIRONMENTAL REMEDIATION

The safe and secure management of spent radioactive sources is a matter of concern in countries that do not have a specific repository for storage or immediate plans for disposal. In 2016, three disused sealed radioactive sources, which had been stored in Cameroon for several decades, were removed from the country to France under CMR9005, 'Upgrading Radiation Protection Infrastructures to Ensure the Implementation of Radiation Protection Milestones 1 and 2, Taking Into Account the Protection Against NORMs'. Two Co-60 sources were at hospitals in Yaounde and Douala, and one Cs-137 source was at the University of Yaounde.

Tasks necessary for the construction, commissioning, licensing and safe operation of Talmesi disposal facility for low and intermediate level waste have been safely completed under project IRA9021, 'Ensuring the Safe Construction of the Talmesi Radioactive Waste Disposal Facility'. Erosion at the Talmesi disposal site is considered to be one of the main issues, according to geological and site selection studies. An adequate erosion monitoring system has been designed, which makes the environmental issues controllable.

The Agency has supported Saudi Arabia in the establishment of a national radioactive waste management infrastructure, through the project SAU9007, 'Supporting the Establishment of a National Radioactive Waste Management Infrastructure'. This project aims to assist the development of radioactive waste policy and related strategies for management of radioactive waste and spent fuel that are consistent with Saudi Arabia's nuclear energy policy. The project supported the provision of advice to the counterpart on the classification of exempt waste, including clearance and exemption levels. The existing design for the Low Level Waste Radioactive Waste Management Facility was reviewed.

The project K UW9006, 'Establishing an Integrated Environmental Radioactivity Monitoring Network', supports efforts to establish a network of permanent monitoring stations throughout Kuwait to assess ambient radioactivity which will provide the first indication of abnormal levels of radioactivity in case of any nuclear emergency. Kuwait has successfully established an early warning system by building up analytical capability for studying concentrations of radioactivity in different environmental compartments, i.e. atmospheric, marine and terrestrial. This capability includes in situ monitoring systems and environmental analytical capabilities that are combined into a unified environmental data management system hosted at Kuwait Institute for Scientific Research.



RER9143; Workshop on Modular Design and Operation of Mobile Processing and Storage Facilities for Small Users participants in Serbia.

In 2016 the project RER9143, 'Enhancing Radioactive Waste Management Capabilities', started to provide support to Member States in the Europe region, promoting an integrated approach to ensure that interdependencies between the different disposal steps are taken into account from safety, technical and organizational standpoints. The project provides regulators, operators and support organizations with information about state-of-the-art technologies, and assists in the preparation of, or updates to, national waste management strategies. It has also shared examples of how to implement recommendations for safety and of the application of new technologies in countries with limited resources and small radioactive waste inventories. Seven meetings were held under the project in 2016, covering issues related to policy and strategy, obligations and benefits under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, and the implementation of safety standards in developing waste acceptance criteria. Participants received training in the selection of different waste management technological options that would fit national frameworks, be adequate for waste inventories, and take into account the resources available in their respective countries.

Many Member States in the Europe region have received assistance for decommissioning planning, especially with regard to financial assessments, through project RER9138, 'Enhancing Capacities in the Member States for Management of Decommissioning Projects'. In 2016 one training course was implemented on Decommissioning of Medical, Industrial and Research Facilities and many national experts received support to enable their participation in the International Conference on Advancing the Global Implementation of Decommissioning and Environmental Remediation Programmes, which took place in Madrid in May 2016.

National radioactive waste management capabilities in Latin America and the Caribbean are being strengthened through regional project RLA9078, 'Enhancing the National Regulatory Framework and Technological Capabilities for Radioactive Waste Management'. Three major regional events were organized in 2016. Over 90 professionals from 19 countries in the region enhanced their knowledge in topics such as licensing and inspection of radioactive waste management facilities, performance of safety assessments and the safe decommissioning of small facilities.



Participants at the regional training course on safe decommissioning of small facilities using radioactive material and safe radioactive waste management, 5-9 December in Montevideo, Uruguay. Photo: Alejandro Nader.

Argentina, according to the CNEA strategic plan for 2015–2025, must update technologies and methods for radioactive waste and spent nuclear fuel management, as well as for different streams of radioactive waste, specifically for the treatment of radioactive spent ion exchange resins and other existing organic wastes. There is a need to use simple, versatile, low-cost and robust processing methodologies that result in minimal waste volumes and waste form products, with high long term chemical and mechanical durability. The projects ARG9013, 'Treating Radioactive Waste by Thermal Processes', and ARG9014, 'Developing National Capacities in Vitrification of Nuclear Waste', are supporting the study of various options in support of this strategy.

Nuclear Knowledge Development and Management



Nuclear technology requires a high level of technical expertise and experience that must be developed and kept available for current and future generations. Assistance to African Member States in nuclear knowledge management aims to retain and transfer this knowledge through higher education, training and related research in nuclear science and technology. It also facilitates nuclear education, networking and experience exchange between nuclear institutions in Member States.

Capacity building, human resource development and knowledge management is key for a successful programme in the Asia and Pacific region. The Agency assists with the development and management of nuclear knowledge in fora, from secondary schools to synchrotron light centres. A regional project supports a network of NNIs, essential for managing knowledge.

The Agency provided assistance to enhance the sustainability of NNIs and other end users of nuclear techniques through several regional and many national TC projects in Europe. Such projects are also common for several developed countries in the region, which participate mainly in regional TC activities to allow them to provide training or re-training for the staff of their national institutions. In accordance with national development priorities, these countries take systematic care of the education and training of human resources and specialists, however, they still need to strengthen their regulatory bodies, relevant research institutions, universities, medical facilities etc. with the aim of enhancing competence and knowledge management.

Knowledge management in nuclear technology in and among Latin American and Caribbean countries is limited, due to the inadequate development of knowledge management. For many Member States, a lack of qualified personnel and an ageing workforce pose very concrete limitations. The Agency collaborates with Member States in the region to improve networking, develop IT tools, strengthen and foster cooperation and coordination among education and training institutions, and to preserve and disseminate knowledge. This collaboration is especially important as it takes a long time to develop qualified nuclear science and engineering professionals. Thus, skills in these areas need to be maintained, in order to meet the increasing demand from the energy, industrial and health sectors.

“Capacity building, human resource development and knowledge management is key for a successful programme in the Asia and Pacific region.”

CAPACITY BUILDING, HUMAN RESOURCE DEVELOPMENT AND KNOWLEDGE MANAGEMENT

Capacity building activities conducted under RAF0041, ‘Sharing of Best Practices in Preventive Maintenance of Nuclear Equipment’, have resulted in notable impact in terms of reduced down time of equipment due to improved maintenance skills and expertise, and the introduction of post graduate programmes in nuclear instrumentation and engineering. Some countries also reported increased income generation from equipment maintenance activities in their centres. The programme focused on providing support to Member States’ efforts to improve the maintenance of medical and scientific instrumentation. This has taken the form of capacity development for repair services, preventive maintenance, provision of instrumentation infrastructure, and cost recovery through incomes generated from the provision of services. Group fellowship training was provided at Seibersdorf and several regional training courses were also held. The equipment repaired with expertise and skills developed through the project includes high purity germanium detectors, gamma cameras, thermoluminescence dosimetry readers and radiotherapy machines. The support provided by the Agency has contributed to the improvement of quality management practices, and

thus to the sustainability of maintenance and repair activities. Support provided through the Agency's Seibersdorf Laboratory's calibration services has enabled the establishment of measurement traceability.

The Agency has supported the technological refurbishment of NNIs in the Asia and Pacific region under the regional project RAS0065, 'Supporting Sustainability and Networking of National Nuclear Institutions in Asia and the Pacific Region,' by promoting regional networking to exchange expertise in areas of relative excellence and comparative technological advantage. The Agency actively seeks to promote the study of nuclear science and technology in secondary schools, and to encourage the interest of high schools students in this area. As part of activities in this area, the Agency piloted a Compendium of Resources and Activities for Secondary School Teachers and Students on Nuclear Science and Technology in Indonesia, Malaysia, Philippines and the United Arab Emirates. A training course for teachers to introduce nuclear science in secondary schools using innovative approaches was held in Quezon City, Philippines, in August. Senior advisors, policy makers and stakeholders associated with school education in Member States also attended the course.

"The Agency actively seeks to promote the study of nuclear science and technology in secondary schools, and to encourage the interest of high schools students in this area."



RAS0065: Students in the Philippines measure natural radiation using the 'Hakaru-Kun' instrument, a handy type survey meter developed for education purposes. Photo: T. Iimoto/University of Tokyo.

The project UZB1003 'Enhancing Metrological Services for Nuclear and Radiation Safety' supported Uzstandard, the national regulatory body for standardization, metrology and certification, in developing a National Standard Base for metrological accuracy testing of radiation measurement devices. The project supported fellowships and scientific visits to build the capacities of Uzstandard staff in the verification and calibration of spectrometers and sources inspection. Gamma spectrometers, high precision dosimeters, large area calibration standards and reference sources were procured through the project. Uzstandard is now able to carry out its mandate of source inspection and certification of radiation measurement devices.

The project COL0014, 'Improving Existing Capabilities to Provide High Quality and Internationally Recognized Nuclear Analytical Services', aims to improve the existing capabilities of the Colombian Geological Service (SGC). This project is the flagship project of Colombian-IAEA cooperation in the current TC cycle. In 2016, the SGC team, with IAEA technical advice, conducted a series of assessment missions to various installations of the SGC, which served to make an analysis of needs in terms of infrastructure improvements and equipment acquisitions.



COL9008: Laboratory equipment. Photo: Ministry of Health and Social Protection, Colombia.

A regional training course on the development of e-learning courses for teachers was held in June, in Lima, Peru, under TC Project RLA0057, 'Enhancing Nuclear Education, Training, Outreach and Knowledge Management'. The course was developed under the 'blended-learning' modality, beginning with a pre-training conducted through the educational portal of LANENT and followed by an in-person training stage. The project also supported the participation of five professionals from Argentina, Bolivia, Brazil, Cuba and Mexico in the Joint ICTP-IAEA School of Nuclear Knowledge Management, held in Trieste, Italy, in September 2016.

In December 2016, taking into account high demand from the Latin American and Caribbean region, the Agency organized the First National School of Knowledge Management in Latin America and the Caribbean, organized at the country level. The curriculum and content of the Trieste School was adapted to the needs of the participating countries and organizations. The school itself took place in Rio de Janeiro, Brazil, in cooperation with Brazil's Institute of Radiation Protection and Dosimetry and LANENT. The objective of the event was to offer specialized training to professionals who have a role, or may have a role in the near future, in the development or implementation of nuclear knowledge management projects in their organizations. General knowledge on knowledge management tools and methodologies was provided, as well as case studies based on examples from organizations in the region. The School brought together 48 professionals, of which almost half were women, selected from 150 applicants, from various institutions in the Brazilian nuclear sector, such as universities, the National Nuclear Energy Commission, the Brazilian navy and the electronuclear industry.



RLA0057: Second regional introductory training course on the use of e-learning tools, Lima, Peru, 13-17 June 2016. Photo: Peruvian Institute of Nuclear Energy.

Annex 2. Summary of GOV/INF/2016/12³⁶

The Secretariat issued document GOV/INF/2016/12, 'Addressing the Challenges Facing Least Developed Countries in the Peaceful Application of Nuclear Energy through the Technical Cooperation Programme', in October 2016 in response to resolution GC(60)/RES/11, and previous resolutions, in which Member States requested the Director General to make every effort to ensure, where relevant, that the Agency's TC programme, taking into account the specific needs of each Member State, particularly developing countries and least developed countries (LDCs), as well as the Agency's adoption of the technical cooperation among developing countries (TCDC) modality in assisting LDCs, contributes to the implementation of the principles expressed in the Istanbul Declaration and the Programme of Action for the Least Developed Countries for the Decade 2011–2020, as well as to the attainment of the internationally agreed development goals, and further requested the Director General to keep Member States informed of the Agency's activities in this regard. The resolution also requested the Secretariat to examine in depth the specific characteristics and problems of LDCs with respect to the peaceful application of nuclear energy and requested the Secretariat to report its conclusions on this matter to the Member States during the next meeting of the Technical Assistance and Cooperation Committee.

The Secretariat accordingly reported its conclusions on this matter at the Technical Assistance and Cooperation Committee in November 2016. The Committee expressed its appreciation for the Secretariat's report.³⁷

In summary, GOV/INF/2016/12 noted that the Agency supports its Member States in building, strengthening and maintaining capacities in the safe, secure and peaceful use of nuclear technology in support of sustainable socioeconomic development. Through its TC programme, the Agency helps Member States to address specific development priorities such as food and agriculture, health and nutrition, water and the environment, sustainable energy development, and nuclear and radiation safety. The Guiding Principles governing the provision of technical assistance (INFCIRC/2671) note, *inter alia*, that the provision of technical assistance constitutes a major, high-priority function of the Agency, and requires that the Agency's resources for technical assistance are primarily allocated to meet the needs of developing countries.

The support offered through the TC programme to the Agency's Member States is tailored to their needs and priorities, and thus the programme contributes to addressing the sustainable development needs of LDCs. LDC priorities for support through the TC programme tend to focus on food and agriculture, and health and nutrition. As of 2016, 35³⁸ Member States of the Agency are LDCs³⁹.

LDCs share a number of characteristics and challenges with respect to the peaceful application of nuclear energy. These can be grouped and summarized as safety infrastructure, human and technical capacity, and financial limitations.

Delivery of the TC programme is tailored according to situation and context. Delivery of the programme in LDCs includes focusing TC support in the most relevant thematic areas; building human and institutional capacity; and facilitating partnerships, including TCDC and resource mobilization.

³⁶ This Annex responds to section 2, operative paragraph 8 of resolution GC(60)/RES/11 on specific characteristics and problems of the LDCs with respect to the peaceful applications of nuclear energy.

³⁷ GOV/2016/56, Annex 1.

³⁸ In addition, the membership of the Comoros and the Gambia has been approved by the Agency's General Conference and will take effect once these States have deposited the necessary legal instruments with the Agency.

³⁹ Compared to nine in 1981.

Annex 3. TC Programme Fields of Activity⁴⁰

Nuclear Knowledge Development and Management
Capacity building, human resource development and knowledge management (01)
Building national nuclear legal infrastructures (03)
Nuclear Instrumentation (33)
Industrial Applications/Radiation Technology
Reference products for science and trade (02)
Research reactors (08)
Radioisotopes and radiation technology for industrial, health-care and environmental applications (18)
Accelerator technology (32)
Energy Planning and Nuclear Power
Energy planning (04)
Introduction of nuclear power (05)
Nuclear power reactors (06)
Nuclear fuel cycle (07)
Food and Agriculture
Crop production (20)
Agricultural water and soil management (21)
Livestock production (22)
Insect pest control (23)
Food safety (24)
Health and Nutrition
Prevention and control of cancer (25)
Radiation oncology in cancer management (26)
Nuclear medicine and diagnostic imaging (27)
Radioisotopes and radiopharmaceuticals production for medical applications (28)
Dosimetry and medical physics (29)
Nutrition for improved health (30)
Water and the Environment
Water resources management (15)
Marine, terrestrial and coastal environments (17)
Safety
Governmental and regulatory infrastructure for radiation safety (09)
Safety of nuclear installations, including siting and hazard characterization (10)
Governmental and regulatory infrastructure for nuclear installations safety (11)
Radiation protection of workers and the public (12)
Transport safety (13)
Nuclear security (14)
Emergency preparedness and response (16)
Radioactive waste management, decommissioning and remediation of contaminated sites (19)
Radiation protection in medical uses of ionizing radiation (31)

⁴⁰ Updated in 2016 for the IAEA TC programme 2018–2019. The field of activity number is shown in parentheses.



60 Years

IAEA *Atoms for Peace and Development*

International Atomic Energy Agency
Vienna International Centre, PO Box 100
1400 Vienna, Austria
Tel.: (+43-1) 2600-0
Fax: (+43-1) 2600-7
Email: Official.Mail@iaea.org

www.iaea.org/technicalcooperation

GC(61)/INF/7

