

Technical Cooperation Report for 2018

Report by the Director General



IAEA

International Atomic Energy Agency

Atoms for Peace and Development

Technical Cooperation Report for 2018

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Preface

The Board of Governors has requested the transmission to the General Conference of the attached Technical Cooperation Report for 2018, the draft of which was considered by the Board at its June 2019 session.

The Director General is also hereby reporting in fulfilment of the request contained in resolution GC(62)/RES/8 on "Strengthening of the Agency's technical cooperation activities".

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Summary

The Technical Cooperation Report for 2018 provides an overview of the Agency's Technical Cooperation (TC) activities during the year and 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 2018. Annex 1 gives examples of project activities and achievements in specific thematic areas. Annex 2 lists the TC programme Fields of Activity, grouped for reporting purposes. The report also responds to General Conference resolution GC(62)/RES/8.

Part A.1 provides an overview of the Agency's TC activities in 2018, beginning with the global development context for the TC programme. It describes how the Agency has participated in global development dialogue, for example by attending the 2018 meeting of the United Nations High-Level Political Forum on Sustainable Development to raise awareness of how the Agency, through its technical cooperation programme, can contribute to Member States efforts to achieve the Sustainable Development Goals (SDGs). Given the intensified global dialogue around climate change, Part A.1 includes an overview of how the Agency is supporting Member States efforts to mitigate and adapt to climate change.

The TC programme is tailored to respond to the specific needs and priorities of each country and region, and activities in this area are covered in the next section of the report, which describes how the programme supports South-South and triangular cooperation, as well as how it helps least developed countries and small island developing States (SIDS) address the challenges that confront them. A section on how the programme contributes to the attainment of the SDGs provides specific project examples, followed by an extensive section on targeted approaches to develop human resources and build capacities. Part A.1 closes with a review of efforts to build awareness of the TC programme.

Part A.2 focuses on the continuing efforts to enhance the efficiency and effectiveness of the TC programme, and describes activities to strengthen the role of the technical cooperation programme within the larger development context by ensuring that projects are linked, where applicable, with Member States' national development plans and other relevant development policies and goals, including United Nations Development Assistance Frameworks (UNDAFs) and the nationally relevant SDGs. In order to maximize the contribution of nuclear science and technology to the achievement of development priorities, the Agency works in close partnership with Member States, United Nations agencies, national institutes and civil society. Practical Arrangements signed in 2018 to support such partnerships are also described in Part A.2, which also provides an overview of the Agency's activities to improve programme quality in 2018 through workshops, training events and quality reviews and assessments. Part A.2 also presents figures on the participation of women in 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 2018 totalled €78.3 million (not including National Participation Costs, assessed programme costs and miscellaneous income), or 91.4% of the TCF target set for the year¹. New extrabudgetary resources for 2018 came to €17.2 million and in-kind contributions were €0.3 million. Overall, implementation for the TCF reached 85.7% in 2018, and health and nutrition, safety and security, and food and agriculture were the top areas of disbursement for the programme.

¹ Total payments received in 2018 include €0.4 million either of deferred or of additional payments by ten Member States. Excluding these payments, the 2018 rate of attainment on payments would have been lower, at 91%.

Part C highlights programme activities and achievements, and covers assistance to Member States in the peaceful, safe, and secure application of nuclear science and technology. It highlights regional and interregional activities and achievements in technical cooperation in 2018, and presents an overview of the activities of the Programme of Action for Cancer Therapy (PACT).

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 lists the technical cooperation programme Fields of Activity.

The Agency's Technical Cooperation Programme in Figures

(as at 31 December 2018)



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.

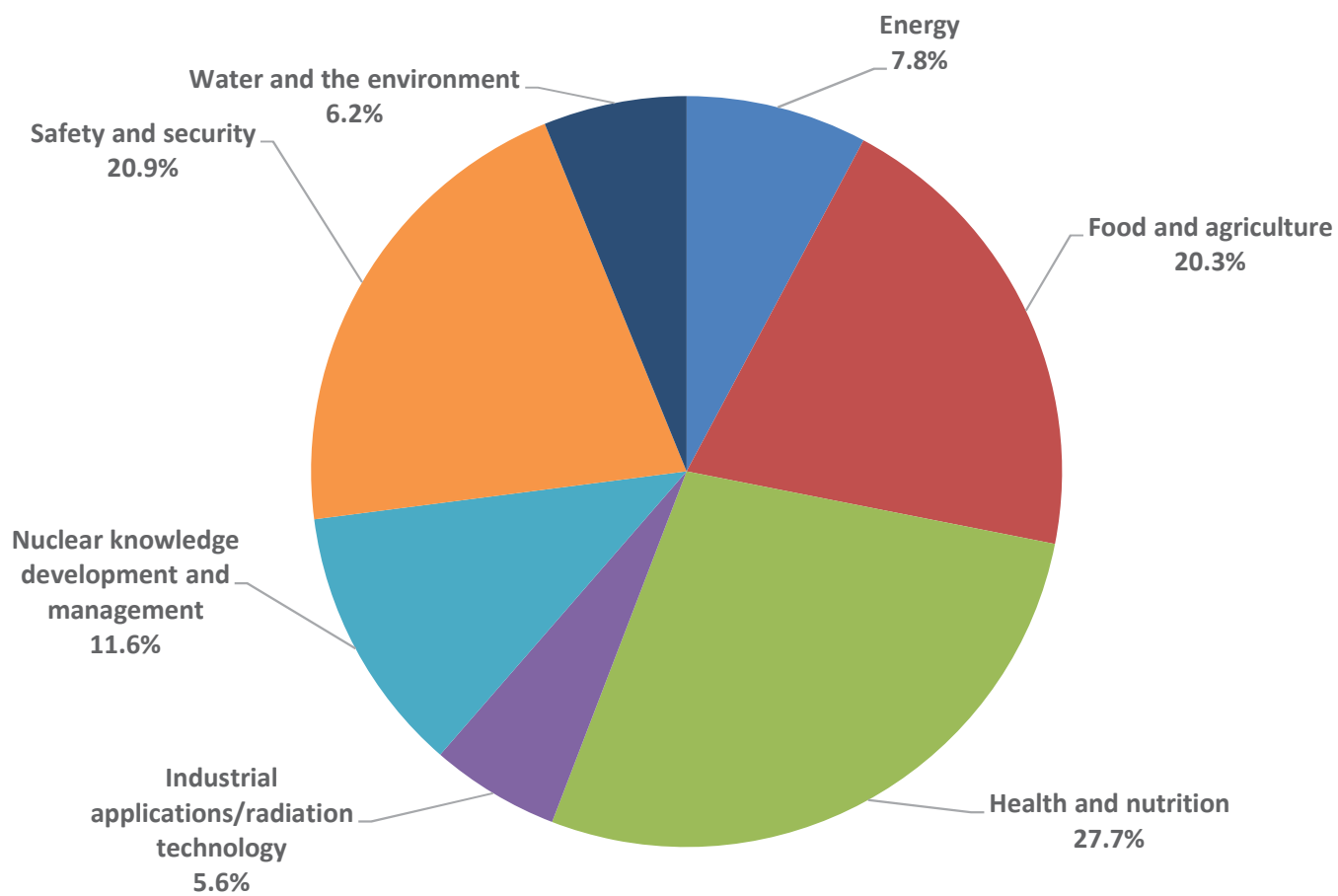


Figure 1: Actuals by technical field for 2018⁵

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

Technical Cooperation Report for 2018

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(62)/RES/8

Part A of the report provides an overview of the progress achieved in delivering the technical cooperation programme in 2018.

Part B reports on the management of financial resources and programme delivery at an aggregate level in the calendar year 2018.

Part C reports on regional activities and programme achievements during 2018.

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

Annex 2 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 2018: AN OVERVIEW⁷

Global developments in 2018: The context for the TC programme⁸

Global development dialogue

2018 marked the third year of the implementation of Agenda 2030 and its associated Sustainable Development Goals. The Agency's motto – Atoms for Peace and Development – reflects the importance the IAEA accords to assisting its Member States in achieving their development priorities through the peaceful use of nuclear science and technology. The main platform for follow-up and review of Agenda 2030 and the Sustainable Development Goals (SDGs) is the United Nations High-level Political Forum on Sustainable Development (HLPF) which meets annually under the auspices of the Economic and Social Council for eight days, and includes a three-day ministerial segment. The theme of 2018's forum was 'Transformation towards sustainable and resilient societies'. The Agency attended the 2018 HLPF in New York to take stock of progress towards the global goals and highlighted the Agency's role in supporting its Member States in using nuclear science and technology to achieve the SDGs.

The Agency also attended the 2018 Multi-Stakeholder Forum on Science, Technology and Innovation for the SDGs in New York, which is a part of the Technology Facilitation Mechanism mandated by the 2030 Agenda and the Addis Ababa Action Agenda. At the forum, a poster was presented on the TC programme's support to the use of nuclear techniques to improve air quality in the Asia and the Pacific region. During the plenary session the Agency highlighted the importance of the IAEA's technical cooperation (TC) programme as a major vehicle through which the IAEA supports its Member States, including for the achievement of their identified SDGs.

Throughout the year, and in support of the implementation of Goal 17 – strengthen the means of implementation and revitalize the global partnership for sustainable development – the Agency took part in the United Nations Inter-Agency Task Team on Science, Technology and Innovation, one of the pillars of the Technology Facilitation Mechanism. The Agency was also a partner in the dialogue on the implementation of the Addis Ababa Action Agenda through the UN Inter-Agency Task Force on Financing for Development. As a result, for the first time, language was introduced into the 2018 Financing for Development report

“The Agency's motto – Atoms for Peace and Development – reflects the importance the IAEA accords to assisting its Member States in achieving their development priorities through the peaceful use of nuclear science and technology.”

⁶ Section A responds to section 2, operative paragraph 2 of resolution GC(62)/RES/8 on strengthening TC activities through the development of effective programmes and well defined outcomes; section 2, operative paragraph 4 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; section 4, operative paragraph 6 on supporting Member States' development efforts, including the attainment of the SDGs; 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 7 of resolution GC(62)/RES/8 on examining characteristics and problems of LDCs and addressing this matter.

⁸ This section responds to section 5, operative paragraph 1 of resolution GC(62)/RES/8 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 participating in the HLPF.

(in the chapter ‘Science, Technology, Innovation and Capacity Building’) that highlights the role nuclear and isotopic techniques play in increasing agricultural productivity and resilience.

Ministerial Conference on Nuclear Science and Technology⁹

In 2018, the Agency organized the first Ministerial Conference on Nuclear Science and Technology: Addressing Current and Emerging Development Challenges. The Declaration of the Ministerial Conference recognized the important role of nuclear science and technology in meeting the common goals of achieving sustainable development and protecting the environment in the context of the 2030 Agenda for Sustainable Development. It highlighted the contribution of the IAEA in the delivery and promotion of nuclear science and technology, and recognized the role of the IAEA’s technical cooperation programme as “a major mechanism to support Member States in building, strengthening and maintaining their capacity to use nuclear technology in a safe, secure and sustainable manner”, underscoring the importance of programme alignment with Member State needs, and of maximizing synergies across the IAEA.

The conference also provided an opportunity for additional outreach: a side event on ‘Sustainable radiotherapy services: Current and future challenges for low and middle-income countries in Africa’ was arranged. Panellists drawn from the field of radiotherapy and cancer control planning led the discussion, providing guidance and lesson learned on topics that ranged from establishing a radiotherapy centre to the steps needed to expand radiotherapy in a sustainable manner. The event benefitted from the participation of four ministers from Djibouti, Lesotho, Nigeria and Zambia, and was opened by the Nigerian Ambassador and the Deputy Director General and Head of the Department of Technical Cooperation.

“It highlighted the contribution of the IAEA in the delivery and promotion of nuclear science and technology, and recognized the role of the IAEA’s technical cooperation programme as “a major mechanism to support Member States in building, strengthening and maintaining their capacity to use nuclear technology in a safe, secure and sustainable manner””



The Vice President of Costa Rica, HE Ms Epsy Campbell Barr, attended the Ministerial Conference in November. Photo: IAEA

Climate change

Dialogue around climate change intensified in 2018, with the United Nations Intergovernmental Panel on Climate Change releasing a report on the impacts of global warming of 1.5°C above pre-industrial levels. In December, negotiators gathered in

⁹ This section responds to section 2, operative paragraph 10 of resolution GC(62)/RES/8 on the 2018 Ministerial Conference on Nuclear Science and Technology.

Katowice, Poland, at the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change, to finalize the goals set out in the 2015 Paris agreement, chief of which is the aim of keeping the global average temperature rise to below 2 degrees Celsius above pre-industrial levels. One of the central mechanisms of the Paris agreement are national climate action plans. Climate change poses a threat to sustainable global development and the Agency is committed to promote and support the contribution of nuclear technologies to help Member States mitigate and adapt to it.

Three hundred and fifty technical cooperation projects are supporting Member States efforts around climate change. In Asia and the Pacific, a regional project, RAS5079, 'Improving Crop Resilience to Climate Change through Mutation Breeding in Pacific Islands' is focusing on developing crop mutation breeding capacities in Pacific small island developing States (SIDS) that will lead to the development of local crop varieties that are more resilient in the face of climate change, while in Latin America and the Caribbean, a regional TC project, RLA5068, 'Improving Yield and Commercial Potential of Crops of Economic Importance (ARCAL CL)', has produced plants with greater tolerance for drought, extreme temperatures and salinity, resistance to diseases and herbicides, and greater potential to face the effects of climate change. In Zimbabwe, the same technique is being used to develop a cowpea strain with increased drought tolerance and insect resistance.

Other technical cooperation activities strengthen Member State analytical capacities – a national TC project in Djibouti, DJI7001, 'Enhancing and Strengthening the Analytical Capacities of the National Laboratory of Chemistry', has expanded analytical capacities and expertise to survey pollution in the marine environment, leading to a national initiative to set up a regional Observatory for Climate Change. An interregional project, INT5153, 'Assessing the Impact of Climate Change and its Effects on Soil and Water Resources in Polar and Mountainous Regions', on assessing the impacts of climate change on land-water-ecosystem interactions, carried out in close cooperation with the Food and Agriculture Organization of the United Nations (FAO), has built Member State capacities to establish long term monitoring of climate change impact, and to analyse the data collected in a way that is meaningful for policy makers.

Recognizing the importance of raising awareness of the role that nuclear science and technology can play in climate change monitoring and adaptation, the Agency participated in the Global Environment Facility (GEF) Biennial International Waters Conference in November. The event brought together over 300 participants from other UN agencies, country representatives, non-governmental organizations, transboundary and regional management institutions and the private sector. The Agency participation has enhanced partnerships with other relevant stakeholders and water projects in the Europe region, in particular regarding the evaluation of groundwater resources and groundwater-surface-water interactions in the context of adapting to climate change.

Several partnership agreements signed by the Agency in 2018 refer explicitly to cooperation in the field of climate change, including a Cooperation Framework Agreement with the Asian Development Bank, and Practical Arrangements with the Caribbean Community Climate Change Centre (CCCCC) which focuses specifically on building climate resilience in the Caribbean region.

Tokyo International Conference on African Development (TICAD)

In 2018, the Agency participated in the TICAD Ministerial Meeting and side event in Tokyo, Japan, in preparation for the TICAD 7 in 2019. During the meeting, the IAEA representative held several bilateral meetings with African delegations including Ethiopia, Eritrea, Guinea Bissau, Kenya, Liberia, Malawi, and other organizations, such as the African Union Commission and the African Development Bank, to highlight the role of the Agency in supporting the development of African countries through the peaceful application of nuclear technology.

Tailoring the TC programme to Member State needs¹⁰

The TC programme promotes the safe, secure and sustainable use of nuclear science and technology for peaceful purposes in areas that address national and regional development priorities. It provides important assistance in the nuclear field to Member States in a range of diverse areas: health and nutrition; food and agriculture; environmental protection (including climate change mitigation, adaptation and monitoring); water resource management; energy planning and nuclear power particularly for newcomer States; and safety and security, as well as radiation technology for industrial applications. The programme also supports nuclear knowledge development and management.

The programme supports South-South and triangular cooperation, or technical cooperation among developing countries (TCDC), and contributes to the implementation of the principles expressed in the Istanbul Declaration, the Programme of Action for the Least Developed Countries for the Decade 2011–2020 and to the attainment of internationally agreed development goals, including the SDGs. The IAEA's technical cooperation programme also supports the implementation of the New Partnership for Africa's Development.

The Agency's TC programme is delivered in four regions (Africa, Asia and the Pacific, Europe, and Latin America and the Caribbean), and is developed to address the specific needs of Member States, particularly developing countries and least developed countries (LDCs). These needs are identified from national development plans, sectoral strategies, regional profiles and other relevant programming strategies, such as the 2030 Agenda, including the SDGs, and UNDAFs, through the Country Programme Framework (CPF).

Regional cooperative agreements are in place in Africa, Asia and the Pacific, and Latin America and the Caribbean which support the identification of common challenges and the optimal use of skills, facilities and services in a region. A Quadripartite Forum, held on the margins of the annual IAEA General Conference, provides an opportunity to share experience and support collaboration between the regional cooperative agreements.

The interregional technical cooperation project INT0093, 'Applying Nuclear Science and Technology in Small Island Developing States in Support of the Sustainable Development Goals and the SAMOA Pathway', approved in 2017, is supporting SIDS that are also IAEA Member States in their efforts to achieve the SDGs and the SIDS Accelerated Modalities of Action (SAMOA) Pathway in areas including the marine environment, cancer, nutrition and food security. This is the first IAEA project that brings together countries in Africa, the Caribbean and the Pacific that face similar and unique challenges as SIDS. In 2018, SIDS representatives attended workshops and meetings organized to present commonalities in the fields of soil nutrient and water management, safety and security of radioactive sources, marine environment, crop productivity and nutrition, and human nutrition.

In Africa, the management of the TC programme focused on the six major priority areas highlighted in the 2014–2018 AFRA Regional Strategic Cooperative Framework (RCF) and the draft 2018–2023 Regional Programme Framework (RPF) for Africa. These are food and agriculture, human health, environment protection and water resource management, industrial applications, sustainable energy development, and radiation and nuclear safety. The development of human resources through education and training formed a major component of the assistance provided in 2018, supporting Member States' efforts to build capacities and ensure the availability of skilled staff in African Member States.

In Asia and the Pacific region, in recognition of the impediments and vulnerabilities shared by SIDS, the IAEA addresses the SIDS Accelerated Modalities of Action (SAMOA) Pathway and their attainment of the SDGs through interregional, regional and national technical cooperation projects. Within the framework of RAS5079, 'Improving Crop

¹⁰ This section responds to section 3, operative paragraph 1 of resolution GC(62)/RES/8 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.

“The programme supports South-South and triangular cooperation, or technical cooperation among developing countries (TCDC), and contributes to the implementation of the principles expressed in the Istanbul Declaration, the Programme of Action for the Least Developed Countries for the Decade 2011–2020 and to the attainment of internationally agreed development goals, including the SDGs.”

Resilience to Climate Change through Mutation Breeding in Pacific Islands', a workshop on Mutation Breeding and Supportive Biotechnologies was held in May in Seibersdorf. This provided participants from small island developing States in the Pacific with theoretical and practical knowledge about crop mutation breeding, with a special focus on vegetatively propagated crops. Project activities continued with a regional training course on Application of In-Vitro Mutagenesis to Pacific Crops, which took place in the Centre for Pacific Crops and Trees in Fiji from 26 November to 7 December. The course offered theoretical and practical training on the application of mutation induction to Pacific crops, with the goal of achieving better resilience to climate change, specifically biotic and abiotic stress. Lectures and practical sessions were held on mutation induction and its application to Pacific crops, including taro, sweet potato, banana, yam and bread fruit. Other topics covered included in vitro mutagenesis techniques application to Pacific crops, the handling of mutant plant populations/lines in laboratory and field conditions, in vitro screening methods, and the application of advanced tissue culture techniques to improve crops.

In Europe, the application of nuclear technologies is widespread and at different stages of development. Some Member States have advanced capacities in both production and use of the technology, others are at the initial stage of applying nuclear technology and establishing an independent regulatory authority for its safe use. The Agency helps Member States to develop tailored programmes to address these different needs.

In the Caribbean, the Agency is facilitating the preparation of the Regional Strategic Profile for IAEA Technical Cooperation in the Caribbean 2020–2026. This overarching framework document will outline regional priorities that can be addressed through the application of nuclear science and technology. Experts from the Caribbean, together with IAEA staff, met in November to advance the preparation process and ensure alignment of the document with regional priorities and the strategic advantages of the IAEA. The document will guide IAEA activities in the region and will provide a framework for collaboration among Member States and regional organizations. It focuses on six thematic areas: food safety and security, and nutrition; human health; environment; energy; radiation safety; and radiation technologies.

Many Member States face significant challenges in the area of cancer, and here the Agency also offers targeted support, assisting low and middle income Member States to strengthen the role and improve the effectiveness of radiation medicine as an integrated part of a comprehensive cancer control approach. In 2018, seven Member States received integrated missions of PACT (imPACT) reviews (Afghanistan, Guyana, Indonesia, Mauritius, Mexico, North Macedonia¹¹ and Ukraine), which examined national cancer control capacities and needs, and provided governments with recommendations to assist their efforts to address their cancer burden. Lesotho, Malawi, Mozambique, Namibia, Nicaragua and Viet Nam received expert advisory support in the development of their national cancer control plans from the Agency, in close cooperation with the World Health Organization (WHO).

Contributing to the Sustainable Development Goals

Nuclear science and technology can make a significant contribution to the achievement of several of the SDGs, and can also help Member States to enhance their capacities for evidence-based decision-making. The TC programme has built capacity in the application of nuclear science and technology in the areas of food and agriculture, energy, knowledge management, industry, health and environment. Projects in these areas contribute to the achievement of SDGs such as Goal 2, End hunger, achieve food security and improved nutrition and promote sustainable agriculture; Goal 3, Ensure healthy lives and promote well-being for all at all ages; Goal 7, Ensure access to affordable, reliable, sustainable and modern energy for all; Goal 9, Build resilient infrastructure, promote inclusive and

¹¹ The name 'North Macedonia' replaces the former name 'the former Yugoslav Republic of Macedonia' as of 15 February 2019.

sustainable industrialization and foster innovation; Goal 13, Take urgent action to combat climate change and its impacts; Goal 15, Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; and Goal 17, Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development. In 2018, National Liaison Officers (NLOs), new counterparts and Designated Team Members were presented with an enhanced methodology to link new TC projects to the SDGs.

In Namibia, seven new varieties of cowpea and four new varieties of sorghum have been developed, selected by farmers and officially released by the Ministry of Agriculture, Water and Forestry under TC project NAM5014, 'Evaluating Efficient Water and Nutrient Use, Molecular Characterization and Nutritional Composition of Mutant Germplasm Populations'. Seed multiplication was carried out during the 2017–2018 cropping season to produce foundation seeds during the off-season period. These newly certified seeds will be available to farmers for planting in the 2018–2019 season, contributing to the achievement of SDG2, Zero Hunger.

In Botswana, TC project BOT5015, 'Establishing District Laboratories that use Nuclear and Molecular Techniques for Early and Rapid Diagnosis of Endemic and Transboundary Animal Diseases', is leading to an improved turnaround time for analysis, which will contribute to early disease diagnosis and reaction. The Botswana National Veterinary Laboratory continues to act as a central laboratory providing specialized services and research, and is expanding its training role and its support to other laboratories, both in-country and regionally, to enhance their expertise and services to farmers, thus also contributing to SDG2, Zero Hunger.

A number of projects are helping Member States to address the targets under SDG6, Clean Water and Sanitation. In Morocco, for example, the national TC project MOR7006, 'Using Environmental Isotopes to Investigate the Interaction between Surface Water and Groundwater', obtained data on the degree of interaction between surface and groundwaters and its impact on water availability and quality in the Gharb plain of the Sebou Basin. The results are being shared with the State Secretariat in Charge of Water to improve the management and sustainable exploitation of groundwater to contribute to the socioeconomic development of this region.



MOR7006: Water sampling for chemical and isotope analyses in Morocco – scientists from the National Centre for Nuclear Energy, Sciences and Technology (CNESTEN) sample a spring in the Gharb plain. Photo: Acil Ghassan/CNESTEN

At the regional level in Africa, all countries participating in RAF7015, 'Strengthening Regional Capacities for Marine Risk Assessment Using Nuclear and Related Techniques', are now actively performing marine pollution monitoring for radionuclides (including historical reconstruction of pollution through geochronological dating), trace metals and organics. The eight Member States participating in the project since its start now have marine pollution databases, of varying levels of comprehensiveness, and are regularly producing national reports in the field of marine pollution. The participating institutions have also published 88 peer-reviewed articles in international scientific journals, which contain national datasets on coastal pollution, and 30 additional scientific manuscripts are in preparation for publication. The regional project has contributed substantially to marine resources conservation and management, and has greatly enhanced capacities in the region to safeguard the environment and human health, contributing to SDG3, Good Health and Well-Being, and to SDG14, Life Below Water.

In Qatar, national staff have received theoretical and practical training on mutation induction, mutation breeding, mutation related biotechnologies, and on phenotyping mutants (screening mutant lines for desired traits) under TC project QAT5006, 'Enriching Genetic Diversity and Conserving Plant Genetic Resources Using Nuclear Techniques and Related Technologies'. Soil moisture probes have been successfully installed on site ready for experiments, and the knowledge and capacity gained have contributed significantly to national breeding programmes that will release improved varieties to farmers, addressing SDG2. Also in Qatar, efficient use of water and sustainable use of resources (SDG15, Life on Land) are being tackled under QAT5007, 'Improving Productivity of Ikhlas and Berhi Date Palm Varieties'. This is one of the most important challenges that Qatar expects to face over the next few decades – how best to manage its water resources in a way that supports the sustainable development of the nation. This year, a pilot project was initiated in the field to test and demonstrate best practice technologies and the use of advanced nuclear techniques, such as the cosmic-ray neutron sensor, for better water management and efficient water use.

Addressing the needs of Least Developed Countries

Activities under interregional project INT0097, 'Contributing to the Development of Least Developed Countries by Building Human and Institutional Capacities in Nuclear Sciences and Technology', have begun, with an interregional meeting on aligning the TC programme with the needs and priorities of LDCs. The participants discussed effective modalities for the formulation, implementation and monitoring of the TC programme so that the programme addresses the specific needs and priorities of LDCs including: (a) building human capacities by fostering the training and retention of staff; (b) strengthening radiation safety and regulatory infrastructure by building capacities that will further enhance an effective radiation safety and regulatory infrastructure; (c) enhancing awareness regarding the importance of adequate radiation safety infrastructure that is in compliance with the IAEA's Basic Safety Standards; (d) focused and tailored support to enhance national capacities in key thematic areas of the TC programme, including human health and nutrition, food and agriculture, energy, water and the environment; and (e) promoting and facilitating the transfer of knowledge generated through TCDC.

In the Asia and the Pacific region, the TC programme continued to focus on addressing the basic needs of LDCs throughout 2018. In the field of health, the programme supported a major effort in cooperation with the Royal Government of Cambodia to establish the first National Cancer Centre, which was set up with the support of the TC programme and inaugurated by Prime Minister Hun Sen in January 2018. The Centre is designed to cover up to 60% of the national demand for cancer diagnosis and treatment. Support was also provided for the National Animal Health Laboratory in Lao People's Democratic Republic, improving capacities for disease diagnosis and control, with the goal of helping the laboratory become a reference and confirmatory diagnostic and control laboratory. The

"In the field of health, the programme supported a major effort in cooperation with the Royal Government of Cambodia to establish the first National Cancer Centre, which was set up with the support of the TC programme and inaugurated by Prime Minister Hun Sen in January 2018."

TC programme also helped Afghanistan to enhance national capacity in effective water resource assessment and management.

The TC programme has also enabled Yemen to continue building capacity in the breeding of small ruminants in the central highlands region under a national project YEM5014, 'Improving Management of Small Ruminants', which contributes to national food security by increasing livestock productivity and farmer income. Yemen has also participated actively in various regional ARASIA projects, such as RAS5080, 'Developing Sustainable Agricultural Production and Upscaling of Salt-Degraded Lands through Integrated Soil, Water and Crop Management Approaches – Phase III,' and RAS9083, 'Establishing an Integrated Management System for Regulatory Bodies of ARASIA State Parties'.

Haiti is the only LDC in the Latin America and the Caribbean region. An advisory mission took place in June 2018 to determine the status of the regulatory infrastructure for radiation safety, to review the contents of the radiation safety laws, regulations and regulatory processes in place, and to provide recommendations and propose an action plan to move forward. Furthermore, on the request of Haiti's Bureau of Mines and Energy, an advisory mission was organized in October 2018 to assess the current status of the energy system, energy policy priorities and related needs, and potential opportunities for collaboration. The two advisory missions resulted in a request from senior government officials of Haiti to support the setup of an inventory of radiation sources in 2019 and to strengthen national capacities to update the national energy plan and produce energy statistics. The Agency also continued to support Haiti in 2018 in its efforts to increase agricultural productivity and exportability through soil and water management and food safety monitoring, respectively. Equipment was also purchased for the Haitian Soil Laboratory.

Responding to emergencies

The TC programme is designed to be flexible and responsive to allow it to respond to the emerging needs of its Member States. Whether it be damaging flooding, earthquakes or disease outbreaks, nuclear techniques can be utilized quickly and effectively to aid efforts on the ground, accompanied by ample expertise. In recent years, the TC programme has provided important emergency support to Member States facing ebola, Zika virus disease and outbreaks of animal disease such as lumpy skin disease.

In 2018, TC supported preparation for natural disasters and recovery of civil structures in case of their occurrence in Asia and the Pacific under RAS0081, 'Supporting Human Resource Development and Nuclear Technology Including Emerging Needs', delivering a fellowship, eight scientific visits and two training events, one on non-destructive testing and radiation technologies for beginners, and the other a KOICA-IAEA-KAERI Joint Training Program on Fundamentals of Radioisotopes and Radiation Technology. The project establishes both pre- and post-disaster management capabilities, including preparing civil structures for natural disasters as well as helping in their recovery, studying coastal engineering, and designing protection solutions. Non-destructive testing methods and radiotracers are the main nuclear technologies being introduced for this purpose. The participating countries include Bangladesh, Brunei Darussalam, Cambodia, Fiji, Lao People's Democratic Republic, Marshall Islands, Myanmar and Nepal, Palau, Papua New Guinea and Vanuatu.

In response to the request for assistance made by the Government of Guatemala following the eruption of the Volcano of Fire (Volcan de Fuego), the IAEA, with support provided by the Government of Japan, sent three mobile medical diagnostic X-ray units to restore affected hospital services. The Agency also supported Ecuador and neighbouring countries in emergency response by providing equipment to strengthen non-destructive testing capacity in Ecuador, and in the region in general, and to strengthen Ecuador's capacities in diagnostic radiology and virus detection.

The Government of Mexico requested IAEA support following the earthquake of September 2017 which damaged over 3000 buildings in Mexico City. A national training

course in 2018, delivered under MEX0021, 'Developing Human Resources and Support for Applied Nuclear Technologies', trained local counterparts to apply non-destructive testing (NDT) to civil structures under normal conditions, and on NDT use in post-disaster management and the evaluation of damaged structures. This know-how is now being applied in the evaluation of civil structures in the country.

In Peru, the Agency delivered two sets of mobile X-ray systems and two reverse transcription–polymerase chain reaction (RT-PCR) kits in response to a request following floods in the Northern region of the country. The equipment was delivered under PER6018, 'Strengthening National Capacities for Diagnosis and Treatment of Cancer Patients'. The X-ray systems were installed in Hospital de la Amistad Peru-Corea, and Hospital de Apoyo II-2 de Sullana, located in Piura in the Northern region of the country.

Technical cooperation among developing countries and networking

The Agency's regional TC programmes are essential tools to promote South-South and triangular cooperation and TCDC to address common challenges efficiently and effectively, foster the exchange of best practices and encourage networking. In response to the strong interest from Member States with respect to South-South and triangular cooperation, the Agency took part in the Global South-South Development Expo in New York in November to showcase how nuclear science and technology can promote development by leveraging the knowledge and capacities of the Global South. The Agency also collaborated extensively with the United Nations Office for South South Cooperation (UNOSSC) in the preparation of a special IAEA-focused joint edition of the UNOSSC flagship document, South-South in Action.

In February 2018, the Agency signed Practical Arrangements with the Ministry of Research, Technology and Higher Education of the Republic of Indonesia to strengthen and enhance South-South cooperation. The Practical Arrangements facilitate cooperation between the IAEA and Indonesia in the areas of training and capacity building assistance, provision of experts and lecturers, and utilization of laboratory and analytical facilities to support other developing countries, including LDCs and SIDSs. In April, the Agency signed a memorandum of understanding (MOU) with the Ministry of Science, Technology and Higher Education and the Ministry of Health of Portugal to promote triangular cooperation among Portuguese-speaking countries with the aim of enhancing collaboration in the field of health, specifically nuclear medicine and radiation oncology.

The Agency is facilitating South-South cooperation between Viet Nam and its neighboring countries Cambodia and Lao People's Democratic Republic. A roadmap to guide the development of collaboration has been established, and priority areas for cooperation agreed. At a meeting hosted by the IAEA in June, the three countries identified concrete activities for cooperation and outlined implementation arrangements that could be supported through projects in the 2018–2019 TC cycle. Potential areas to be considered under the 2020–2021 TC cycle were also discussed. The Government of Viet Nam pledged its support for the implementation of the prioritized activities.

Substantial progress has been made in several regions regarding the sustainability and networking of national institutions and commissions working on research and development and training in relevant nuclear technologies, with significant support from the technical cooperation programme. In Latin America and the Caribbean, for example, a Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) project, RLA0062, 'Promoting the Sustainability and Networking of National Nuclear Energy Institutions (ARCAL CLXIII)', is assisting national nuclear institutions (NNIs) to strengthen their institutional sustainability through enhancing their client-orientation and their provision of suitable products and services to end-users, with the eventual goal of achieving technical and financial self-reliance. South-South cooperation is an important aspect of these initiatives, both between countries and more specifically between NNIs working in the area of research and development. With

"In response to the strong interest from Member States with respect to South-South and triangular cooperation, the Agency took part in the Global South-South Development Expo in New York in November to showcase how nuclear science and technology can promote development by leveraging the knowledge and capacities of the Global South."

IAEA support, several agreements were developed and signed by NNIs in Latin America and the Caribbean in 2018 which aimed to promote closer cooperation and networking in research and the application of nuclear science and technology, and in the exchange of knowledge and transfer of technology, thus promoting sustainability. These agreements will help to spur cooperative endeavours in capacity building and joint research, ultimately contributing to socioeconomic development in the countries of the region.

Developing human resources and building capacities^{12 13}

Human resource development and capacity building are two of the most important components of the IAEA technical cooperation programme. Support is delivered through national and regional training courses, meetings, fellowships and scientific visits, and the provision of expert advice. To meet Member State needs, the Agency also supports e-learning, curriculum development and other innovative learning approaches, as well as supporting science, technology, engineering and mathematics (STEM) initiatives in schools.

A shortage of qualified workers in nuclear science and technology remains a significant challenge in several African IAEA Member States. Additionally, education and training often rely on foreign educational institutions and on training provided in other regions. An IAEA meeting in June, hosted by the Government of Kenya through the National Commission for Science, Technology and Innovation, brought together Vice-Chancellors of African universities and representatives of regional bodies involved in education and training. The meeting participants discussed practical collaboration to promote and implement graduate and postgraduate academic programmes related to nuclear science and technology in accredited African universities. Measures to implement a PhD Sandwich Fellowship Programme that will complement ongoing efforts by African universities and partner institutions to address the shortage of human resources were also agreed. The goal is to train a critical mass of PhD holders in different nuclear science and technology disciplines relevant to Africa who will be able to lead academic programmes in nuclear science and technology in tertiary institutions, to promote research and development, and to contribute to the effective management of the TC programme in Africa. Twenty Vice-Chancellors of accredited universities from the following Member States participated in the meeting: Algeria, Benin, Botswana, Burkina Faso, Democratic Republic of the Congo, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Rwanda, Senegal and Tunisia. In addition, the Executive Directors of The World Academy of Sciences, the African Academy of Sciences and a representative from the Department of Human Resources, Science and Technology, African Union Commission, also participated.

In November, the latest cohort of students completed their Masters in Medical Physics and graduated from the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. The two years Masters programme, supported by the IAEA through an interregional TC project, is designed to provide young, promising graduates from developing countries who are working in physics or related fields with postgraduate academic and clinical training. The programme is organized in collaboration with IAEA, ICTP, the University of Trieste, the International Organization for Medical Physics (IOMP), the European Federation of Organisations for Medical Physics (EFOMP), the Italian Association of Medical Physics (AIFM) and eighteen clinical hospitals in Italy.

In November, 34 representatives from universities, research and nuclear institutions in the Latin American and the Caribbean region met at IAEA headquarters to explore ways to promote the benefits of nuclear technologies in the region and to identify potential areas of collaboration between universities and NNIs. Deans and Directors of universities and academic institutions were introduced to the numerous applications of nuclear science and

¹² This section responds to section 2, operative paragraph 1 of resolution GC(62)/RES/8 on facilitating and enhancing the transfer of nuclear technology and know-how among Member States.

¹³ For PACT's contribution to this area, please see section C.6.

“To meet Member State needs, the Agency also supports e-learning, curriculum development and other innovative learning approaches, as well as supporting science, technology, engineering and mathematics (STEM) initiatives in schools.”

technology and entered into dialogue with NNI representatives. Together they identified the need to integrate nuclear subjects into engineering and science degrees, to raise the interest of young scientists in research and development in the field, and to raise awareness in the general public of the benefits of nuclear science and technology. The meeting was held under regional project RLA0062, and resulted in the elaboration of recommendations on how to further the cooperation between NNIs and academia, including mapping technical installations, strengthening knowledge management, collaboration with the private sector, and fostering cooperation and connectedness at the national and international levels. The participants underlined the importance of cooperation networks, such as ARCAL and the Latin American Network for Education in Nuclear Technology (LANENT) in pursuing these objectives.

Under Practical Arrangements signed between the IAEA and the China Atomic Energy Authority, 16 students were selected to start a Master's and Doctoral Degree on Nuclear Science and Technology at Harbin Engineering University in 2018, supporting the development of a new generation of professionals in the planning, design, construction operation and management of nuclear power plants.

Third level and post-graduate education

In Africa, under TC project RAF0052, 'Supporting Human Resource Development in Nuclear Science and Technology (AFRA)', ten candidates from ten Member States (including 8 LDCs) were awarded a PhD Sandwich Fellowship Programme in 2018 to enable them to pursue their PhD research work at foreign universities. The same project also supports the next intake of students for the regular Masters Programme in Nuclear Science and Technology. Fifteen candidates from 15 African Member States were pre-selected for the two-year fellowship for the period 2019–2020. The training is hosted by the Graduate School of Nuclear and Allied Sciences, University of Ghana, and the Department of Nuclear Engineering, University of Alexandria, Egypt. Ten students from 10 African Member States completed this two-year Masters Programme in 2018, supported through RAF9056, 'Strengthening Education and Training in Radiation Safety and Sustaining Human Resources Development and Nuclear Knowledge Management (AFRA)'.

A second intake of students from Argentina, Colombia, Costa Rica, Cuba, Ecuador, Mexico and Uruguay have embarked on a Master's programme in Advanced Radiotherapy Techniques under TC project RLA6077, 'Taking Strategic Actions to Strengthen Capacities in the Diagnostics and Treatment of Cancer with a Comprehensive Approach (ARCAL CXLVIII)', supported by the IAEA in collaboration with the Arturo López Pérez Foundation (FALP) and the University of the Andes with the aim of accelerating and improving the training of radiation oncologists in the region. The programme, first delivered in 2017, offers students the opportunity to improve and update their knowledge of the industry by providing a global overview of recent developments in the field of radiation oncology. It is the first regional programme in advanced radiotherapy techniques in the region. The academic programme and the study plan, created in consultation with FALP, the University of the Andes, and the IAEA's Division of Human Health, provides participating students with the tools to implement the newest technologies effectively and safely in their home country.

New university teaching modules on isotope hydrology were disseminated and piloted at a regional meeting held under RAF7013, 'Enhancing the Use of Isotope Hydrology in Planning, Management and Development of Water Resources (AFRA)'. The pilot confirmed the completeness and usefulness of the material which is to be incorporated in university curricula including those of the three AFRA regional designated centres (RDCs) in Egypt, Morocco and Tunisia.

Building competence in radiation protection through postgraduate training

Postgraduate educational courses (PGECS) in Radiation Protection and the Safety of Radiation Sources build the competency of young professionals, primarily from national

regulatory bodies, enhancing their knowledge and understanding of radiation protection. Upon completion of the six-month course, participants can contribute to establishing a sustainable national infrastructure for radiation protection in their home countries. PGECs are offered on a regional basis.

Five PGECs were conducted in 2018. In Africa, under RAF9056, 'Strengthening Education and Training in Radiation Safety and Sustaining Human Resources Development and Nuclear Knowledge Management (AFRA)', Ghana and Morocco hosted two PGECs from January to June 2018, while in Asia and the Pacific, participants successfully completed the 15th PGEC held in the region. The course was held in Kajang, Malaysia, within the framework of project RAS9081, 'Providing Education and Training in Radiation Safety in the Asia-Pacific Region', and supported the implementation of the IAEA Strategic Approach to Education and Training in Radiation, Transport and Waste Safety 2011–2020. In Europe, the English-language PGEC started in October, with an intake of 19 students from 16 Member States, including two participants from the United Arab Emirates who are attending to learn about the organization of a PGEC. The course is supported by project RER9142, 'Establishing Sustainable Education and Training Infrastructures for Building Competence in Radiation Safety', and is being hosted by Greece. In Latin America, the PGEC was hosted in Buenos Aires, organized in cooperation with the Argentinian National Atomic Energy Commission and the Nuclear Regulatory Authority, and supported by RLA9084, 'Strengthening the Regulatory and Radiation Safety Infrastructure'.

Nine participants attended a Basic Professional Training Course on Nuclear Safety (BPTC), hosted by the same organizations and also supported by RLA9084. While PGECs target young professionals at the graduate level or equivalent, the BPTC provides junior professionals recently involved in nuclear safety-related activities with a broad overview of all the safety concepts and their application to nuclear power plants and research reactors design and operation.

Specialized Schools

In November, the Agency conducted the first School in the Latin America and Caribbean region on Nuclear and Radiological Leadership for Safety under project RLA9084 in Mexico



Caribbean students are trained in the use of radiation detection equipment. Photo: K. Ragusa/TAMU

City. The two-week training event, designed for early to midcareer professionals, aimed to develop their safety leadership potential by building their understanding of what leadership for safety means in practice in nuclear and radiological working environments, with their inherent complexities and often competing considerations. Participants heard theoretical lectures, visited a radiotherapy facility and participated in round tables. A dedicated round table discussion to promote gender equality in safety leadership was conducted at the opening of the programme.

The first IAEA School of Radiation Emergency Management for Caribbean Community (CARICOM) States and a training event for first responders to prepare for a potential radiological emergency in the Caribbean were supported under RLA9082, 'Establishing and Strengthening Sustainable

National Regulatory Infrastructures for the Control of Radiation Sources'. The School of Radiation Emergency Management was held at Texas A&M University, United States of America, from 26 November to 7 December 2018, attended by 24 participants from eight Caribbean Member States, as well as the Caribbean Disaster Emergency Management Agency. The two-week training course focused on strengthening national and regional capacity to respond to nuclear and radiological incidents and emergencies. Knowledge



School of Leadership in Safety, Mexico City, 5 – 16 November 2018. Photo: Carlos Gonzalez Campos/ National Commission or Nuclear Safety and Safeguards

gained from the training will support participants to develop and manage sustainable emergency preparedness and response (EPR) programmes, based on the IAEA Safety Standards, technical guidelines, EPR tools and training materials. The training included lectures, practical exercises, field visits, group work and knowledge sharing sessions. The skills development sessions covered the use of radiation detectors, personal protective equipment and public communication in emergencies. Two other editions of the School of Radiation Emergencies Management also took place in 2018, a three-week version held in Tulln, Austria, in October for the Europe region, and another in Rabat, Morocco, for Africa, in November. The training for first responders offered specific support to CARICOM countries on responses to radiological emergencies. Held in Barbados in June, this regional event focused on building understanding of the science behind radiological emergencies and of the actions to take in emergency situations.

Regional training courses and ‘train the trainer’ courses

The Agency continued to build capacities in Member States in the Asia and the Pacific region and to strengthen radioactive waste management infrastructure, under project RAS9085, ‘Enhancing the Radioactive Waste Management Infrastructure in the Asia-Pacific Region’. In 2018, 32 national personnel were trained through a Regional Training Course on Management Options for Disused Sealed Radioactive Sources (DSRSs) of Category 3-5 that included a practical demonstration of conditioning procedures. The training and practical skills they acquired will enable them to address issues related to waste categorization, technical conditioning procedures and pre-disposal considerations in their home countries. A Regional Workshop on Disposal of Radioactive Waste including DSRS, held in Isfahan, Islamic Republic of Iran, also served as a platform to share experiences among the participating countries.

A regional workshop for regulators on Organization, Staffing and Competency of the Regulatory Body, organized in Doha, Qatar, in August under project RAS9089, ‘Strengthening Radiation Safety Infrastructure’, addressed the requirements for organizing and establishing a competency management system for regulatory bodies to effectively control radiation facilities and activities. Workshop material for this workshop has been developed to assist Member State in effectively organizing their regulatory bodies and in implementing an adequate competency management system to deliver their regulatory functions efficiently.

As part of the IAEA Strategic Approach to Education and Training (E&T) in Radiation, Transport and Waste Safety 2011–2020, three regional workshops on the implementation of national strategies on E&T in Radiation Transport and Waste Safety and the establishment of qualification requirements for qualified experts and radiation protection officers were organized in Amman, Jordan, in Sliema, Malta, in October and in Panama City in November. In total, 57 senior staff from 53 Member States discussed their progress in developing a national E&T strategy, noting the benefit of developing and maintaining a sound qualification framework for radiation protection officers and qualified experts. The workshop also supported the exchange of information to update Member States' TSA6 profile in Radiation Safety Information Management System (RASIMS).

In Africa, under RAF9056, 'Strengthening Education and Training in Radiation Safety and Sustaining Human Resources Development and Nuclear Knowledge Management (AFRA)', two Train the Trainers Regional Training Courses for Radiation Protection Officers (English and French) were held in November in Rabat, Morocco. This training provided participants with theoretical knowledge of the roles, duties and competencies of a radiation protection officer of medical and industrial facilities; and practical skills to act as trainers of radiation protection officers in their countries.

A 'train the trainers' course for radiation protection officers working in medical and industrial facilities was held in Hanoi, Viet Nam, in May, within the framework of project RAS9081, 'Providing Education and Training in Radiation Safety in the Asia-Pacific Region'. The course, attended by 25 participants from 23 countries in the region, has contributed to the creation of a pool of potential instructors of great use to the region.

Two regional 'train the trainers' courses for radiation protection officers were held in English and Russian under TC project RER9142, 'Establishing Sustainable Education and Training Infrastructures for Building Competence in Radiation Safety'. The participants learned to conduct practical exercises on the design and delivery of training programmes that will enable them to train radiation protection officers in their home countries. Furthermore they learned about the role, duties and qualifications of Radiation Protection Officers (RPOs) and qualified experts, and could discuss how adequate provisions (education, training, competence and qualification requirements) for RPOs and qualified experts can contribute to establishing and strengthening the national radiation safety and regulatory infrastructure.

The roles and responsibilities of RPOs and their duties were also covered by a train-the-trainers course held in March in Montevideo, Uruguay, under project RLA9084. During this course, more than 20 participants from medical and industrial facilities learned how to train RPOs, who are responsible for the safe use of radiation sources at their workplaces.

E-learning and other training

The Asian Network for Education in Nuclear Technology (ANENT) is a regional partnership, supported by the IAEA under the regional project RAS0075, 'Networking for Nuclear Education, Training and Outreach Programme in Nuclear Science and Technology in the Framework of ANENT'. The ANENT supports cooperation in capacity building, human resource development and knowledge management in nuclear science and technology in the Asia and the Pacific region, and currently has 21 members from the region. The regional project consolidates the joint efforts of all participating universities, research and development organizations and training institutes to enhance regional education and training capacity, fostering cooperation using the existing ANENT framework. Activities focus on the development of the ANENT web-portal and Regional Learning Management System (RLMS), the organization of e-learning courses, the sharing and development of outreach materials, the provision of access to the Internet Research Reactor Laboratory (IRL), and partnerships between ANENT members and beyond. In 2018, the ANENT learning management system (LMS) was moved from a physical server to a cloud-based server hosted under the IAEA cloud. It provides the network and users with

improved accessibility, security, cost-benefits and long term sustainability. Also in 2018, a new ANENT-RLMS feature, the Learning Object Repository (LOR), was developed and deployed. The LOR enables the hosting of a variety of educational, training and outreach materials from Member State organizations and educational institutions, including training materials of TC Asia and the Pacific regional projects, and has various benefits, including long term access and preservation of institutional and organizational knowledge. To support and enhance the operation of the RLMS, the structure of the ANENT RLMS team was addressed, and guidelines and ANENT RLMS- Cyber Learning Platform for Nuclear Education and Training (CLP4NET) site policy were developed. Methodologies and guidance on the design and sharing of e-learning materials and outreach activities on the LMS were also developed. In addition, the ANENT web portal interface has been improved in order to support LOR and its related web applications.

Twenty-two participants from 11 Member States in the region attended a five-day workshop in November at Yogyakarta, Indonesia to enhance capacity building using LOR. Two international experts demonstrated the use of LOR and its benefits with examples to participants. The workshop promoted useful discussions and exchange of information on infrastructure, collection and sharing of materials, as well as on the use of RLMS for capacity building. Recognizing the importance of having quality, interactive and responsive e-learning educational, training and outreach materials in the area of nuclear science and technology, a fellowship programme was established. Through this fellowship, participants from Member States with relevant educational, training and outreach material will learn how to convert this material into quality e-learning material which will be shared on ANENT LMS/LOR for the larger use and benefit of Member States. Indonesia, Philippines, Thailand, and the Republic of Korea have offered to host 2 to 4 fellowships each, which will be conducted in 2019.

Legislative and drafting assistance

The Agency continued to provide assistance to 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. In 2018, this assistance was mainly provided through the interregional project INT0096, 'Establishing and Enhancing National Legal Frameworks for the Safe, Secure and Peaceful Use of Nuclear Energy and Ionizing Radiation'. Within the framework of this project, the eighth session of the IAEA Nuclear Law Institute was conducted in October in Baden, Austria. The training was attended by more than 60 participants from 52 Member States from Africa, Asia and the Pacific, Europe and Latin America and the Caribbean, and enabled participants to acquire a solid understanding of nuclear law and to develop the necessary skills to draft, amend or review national nuclear legislation. The project also supported the participation of several fellows in the Nuclear Energy Agency (OECD/NEA) International School of Nuclear Law, held in August-September in Montpellier, France.

Other activities implemented under the project include a Regional Workshop on Nuclear Law conducted for the Latin America and the Caribbean region in Santiago, Chile, which was attended by 33 participants from 18 Member States of the region. The event provided a venue to discuss latest developments in international nuclear law, as well as the status of the national nuclear legal framework in participating Member States and their plans for enhancement, and to identify the support needed from the Agency in this regard. During 2018 the Agency also provided bilateral assistance under the project to 17 Member States from the different regions in the form of written comments and advice on drafting nuclear legislation, as well as through the conduct of national workshops and legislative assistance missions and meetings to advice on the development and revision of national legislation in the areas of safety, security, safeguards and civil liability for nuclear damage. For instance, national workshops were organized in the Plurinational State of Bolivia, the Lao People's Democratic Republic, Lesotho, the Philippines and the Sudan, which allowed officials from these Members States to improve their knowledge on all aspects of nuclear law in

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support of the national legislative process for adhering to the relevant international legal instruments and/or for developing and eventually enacting national nuclear legislation.

The Agency also continued to provide assistance to Member States in drafting regulations. A Regional School on Drafting Regulations for Radiation Safety was held in Vienna under the umbrella of RER9148, 'Strengthening the Regulatory Infrastructure for Radiation Safety'. The event enabled the 21 participants attending the school to make a peer review of their draft regulations and to conduct a gap analysis of their texts in relation to the IAEA safety standards.

Building awareness of the TC programme

Outreach to Member States, current and potential partners, donors and the international development community remains an essential area of activity for the Agency, and throughout 2018 extensive efforts continued to build awareness of the TC programme at all levels. Participation in relevant conferences, attendance at events focused on special topics, and concerted outreach efforts online and via social media were all leveraged in support of this goal.

The Department of Technical Cooperation organized three side events at the 62nd regular session of the IAEA General Conference, on 'Technical Cooperation: Delivering Results – Together we can make a change in fighting cancer', 'The Intercontinental Nuclear Institute (INI): How it Benefits Member States', and 'Women in Nuclear: Leadership for TC Programme in Africa'. The events were well attended, and were selected to showcase the breadth of IAEA technical cooperation support to Member States. The Agency also attended the Global South–South Development Expo in New York and participated at 'The RoK-UNOSSC Facility: Innovation in Practise, Challenges and Solutions' side event.

The technical cooperation programme was also represented at the International Conference on the Security of Radioactive Material: The Way Forward for Prevention and Detection, and the International Symposium on Understanding the Double Burden of Malnutrition for Effective Interventions. Exhibitions on the TC programme were installed during the Ministerial Conference and at the Nutrition Symposium.

A further keynote speech was delivered on behalf of the Agency at the International Growth and Development Conference in Dubai, United Arab Emirates, in March, on the topic 'The IAEA Technical Cooperation Programme in Health and Nutrition'. The conference, inaugurated by the United Arab Emirates Minister of Tolerance, provided a platform for multidisciplinary exchanges between medical professionals, scientific and public health researchers from the Middle-East region, and was attended by more than 400, mostly female, participants from the region. The conference provided a good opportunity to interact with many participants from IAEA Member States, particularly from the Middle East region, and to discuss opportunities for collaboration through the TC programme.

The Agency attended the Asian Development Bank's 2018 Asia Water Forum in October, reaching out to government institutions, international organizations, the private sector, academia, research institutions and civil society from Asia and the Pacific and Central Asia to raise awareness of the role of nuclear technology in addressing the challenges of the water-agriculture-energy nexus.

The Agency participated in the 63rd Annual Health Research Conference of the Caribbean Public Health Agency in St. Kitts and Nevis in June, aiming to raise awareness of nuclear technology and to disseminate information about its role in human health. At a side event, the Agency focused on sharing information about the support provided through the TC programme to enhance the prevention, diagnosis, treatment and control of diseases. Agency support for safety and quality assurance in radiation medicine was also presented. The audience included chief medical officers, researchers and related experts, and other conference participants. An exhibition booth focusing on IAEA activities in human health was well attended.

“The Agency attended the Asian Development Bank’s 2018 Asia Water Forum in October, reaching out to government institutions, international organizations, the private sector, academia, research institutions and civil society from Asia and the Pacific and Central Asia.”

Highlighting the Agency role in combatting cancer

The Agency's efforts to support Member States in addressing their cancer control priorities and needs was highlighted at key global health events. In 2018, the Agency participated at the World Health Assembly, the World Health Summit, the World Cancer Leaders' Summit and the World Cancer Congress where the Agency highlighted its commitment to support Member States advance access to quality radiation medicine services. As a member, the Agency also participated in meetings of the UN Interagency Task Force on the Prevention of Non-Communicable Diseases, a global initiative which coordinates activities of relevant UN agencies and other inter-governmental organizations to support countries meet high-level commitments in response to the non-communicable disease global epidemic. The Agency also participated at the World Health Summit and spoke at the 'Managing the Next Decade in Cancer' panel discussion.

Communication and outreach

Outreach to the diplomatic community continued, with the annual Seminar on Technical Cooperation for Diplomats in Vienna, and for the first time, in Geneva as well, both held in October. More than 60 diplomats attended the Vienna Seminar and 19 attended the Geneva event. The seminars provided participants with a comprehensive overview of the technical cooperation programme.

Throughout the year, the Agency posted targeted outreach material of relevance to specific United Nations international days using social media and the Web to promote relevant technical cooperation activities. In 2018, 155 news items on technical cooperation were posted online, including 7 photo essays and 15 videos. During the year, more than 770 tweets were sent out from the @IAEATC Twitter account, which now has over 4500 followers. The LinkedIn TC Alumni Group now has over 1700 members.

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A.2. BUILDING A MORE EFFICIENT, MORE EFFECTIVE TECHNICAL COOPERATION PROGRAMME¹⁴

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

Revised Supplementary Agreements Concerning the Provision of Technical Assistance by the IAEA (RSAs) govern the provision of technical assistance by the Agency. RSAs for two Member States, Liberia and Turkmenistan, entered into force in 2018. As of 31 December 2018, 136 Member States had signed an RSA.¹⁵

Country Programme Frameworks (CPFs) are the main strategic planning tool of national TC programmes for Member States. CPFs help Member States to define mutually agreed development needs and priorities, that align with relevant SDGs as appropriate, and can be supported through the technical cooperation programme. The latest, revised version of the CPF template now features a clear, thematically-oriented results matrix supported by measurable data in addition to a partnership matrix which defines links – where relevant – to UNDAF outcomes to facilitate synergies in programming and outreach. In 2018 the IAEA co-signed 24 CPFs. There was a total of 100 valid CPFs by the end of the year.

¹⁴Section A.2. responds to section 3, operative paragraph 1 of resolution GC(62)/RES/8 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.

¹⁵This paragraph responds to section 1, operative paragraph 1 of resolution GC(62)/RES/8 on adhering to the Statute and document INFCIRC/267; and to operative paragraph 2 on the importance of RSAs.

CPFs signed in 2018	
Antigua and Barbuda	Kyrgyzstan
Armenia	Lesotho
Bahrain	Malta
Bangladesh	Morocco
Bolivia, Plurinational State of	Nicaragua
Botswana	Nigeria
Brunei Darussalam	Peru
Bulgaria	Slovenia
Democratic Republic of the Congo	Tajikistan
Cyprus	United Republic of Tanzania
Ethiopia	Turkey
Jamaica	Venezuela, Bolivarian Republic of

The UNDAF is a medium-term planning framework for coordinating UN system actions in support of national development goals and priorities. The Agency places considerable importance on participating, where relevant, in common country programming processes for development, and in supporting greater efficiency and effectiveness at the country level among UN entities. UNDAFs offer an important avenue for the Agency to raise awareness about its technical cooperation work, and facilitate access to key ministries and decision makers at country level. The IAEA co-signed seven new UNDAFs in 2018, with Burkina Faso, Ghana, Lesotho, Malawi, Mauritania, Rwanda and Seychelles¹⁶, bringing the total of valid UNDAFs co-signed by the IAEA to 56.

Maximizing programme impact through strategic partnerships¹⁷

The Agency works in close partnership with Member States, UN agencies, national institutes and 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.

In 2018, the Technical Cooperation Partnership Review and Resource Mobilization Committee (TC-PRC) continued to ensure a coherent and coordinated implementation of the Strategic Guidelines on Partnerships and Resource Mobilization, GOV/2015/35. The TC-PRC is a forum for knowledge-sharing on past, current or potential partnerships, and aims to enhance the scope, sustainability and impact of these partnerships. The Committee enhances coordination and cross-divisional learning within the Department of TC, and increases synergies and promotes an integrated approach to partners. In 2018, the TC-PRC reviewed 18 proposed partnership agreements, with a total of 15 being signed by the end of the year.

The long-standing partnership between the Agency and the European Commission continued through the implementation of the 2016 Delegation Agreement, under the Instrument for Nuclear Safety Cooperation. Activities in 2018 included a regional training course on conditioning of spent low activity gamma-emitting and neutron sources in Dakar, Senegal; training at Argonne National Laboratories, Chicago, USA, on software tools to ensure protection of the public and the environment from radioactive contamination; and a course on the management of disused sealed radioactive sources in Vienna, Austria.

In April, the Agency signed a MOU with the Ministry of Science, Technology and Higher Education and the Ministry of Health of Portugal. The MOU sets forth the framework for non-exclusive cooperation between the Signatories in the areas of nuclear medicine, diagnostic imaging and radiotherapy; radiation monitoring and oncology; the decommissioning of the research reactor; the set up and implementation of the new proton therapy research and training centre; and the strengthening of the national legal and regulatory infrastructure for nuclear and radiation safety. The cooperation includes the provision of short and long term education for professionals from developing countries,

“The Agency works in close partnership with Member States, UN agencies, national institutes and 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’.”

¹⁶ Seychelles Strategic Partnership Framework

¹⁷ This section responds to section 5, operative paragraph 1 of resolution GC(62)/RES/8 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 operative paragraph 3 on developing and facilitating cost sharing, outsourcing and other forms of partnership in development.



and in particular from Portuguese speaking countries, in the areas of nuclear medicine, diagnostic imaging, radiotherapy, radiation monitoring and radiation oncology mainly through the organization of fellowships and scientific visits and training courses. The accompanying Action Plan sets out that Portugal will provide up to 50 fellowships and scientific visits, implemented through the TC programme, on a cost-free basis during the period 2019–2023, particularly but not exclusively for Portuguese-speaking Member States.

The Agency signed Practical Arrangements with the Spanish radioactive waste management organization, Enresa on 23 May. The arrangements govern cooperation between the two organizations in the field of radioactive waste management and decommissioning. Under the Practical Arrangements, Enresa will make available qualified experts for the implementation of IAEA activities in the areas of radioactive waste management, decommissioning of nuclear installations, spent nuclear fuel management and environmental remediation. Enresa will also host capacity building activities, including training courses, scientific visits and fellowships within the framework of the IAEA's TC programme, or in collaboration with specific IAEA technical Departments. The arrangements will be of particular benefit to TC projects in the Latin American and Caribbean region due to the common language.

Six years of on-going cooperation in medical physics and cancer control in partnership with two institutions in the Russian Federation is supporting countries that need training opportunities in the Russian language. In 2018, five regional training courses were hosted by the Association of Medical Physicists in Russia at the Russian Cancer Research Centre, and by the Federal Medical Biophysical Center of the Federal Medical Biological Agency, financed by ROSATOM.

Partnerships in health

The Agency signed Practical Arrangements in November with a consortium of 11 Japanese universities and institutions to strengthen human resources development in the field of nuclear medicine around the world. The Practical Arrangements will boost training opportunities for medical professionals in IAEA Member States in the use of imaging techniques to diagnose and manage non-communicable diseases, with a special emphasis on degenerative brain disorders such as dementia, Alzheimer's disease and Parkinson's disease, and focuses on fields where Japan can offer expertise in support of Member States. The consortium includes leading Japanese institutions in the field of nuclear medicine: Osaka University Graduate School of Medicine, Fujita Health University School of

Medicine, Hokkaido University Graduate School of Medicine, International University of Health and Welfare, Kanazawa University Institute of Medical, Pharmaceutical and Health Sciences, Kyoto University Hospital, National Cancer Center, National Center of Neurology and Psychiatry, Southern Tohoku Research Institute for Neuroscience, Tohoku University Graduate School of Medicine and Tokyo Medical and Dental University.

The Agency signed Practical Arrangements with Childhood Cancer International (CCI) to complement efforts in providing paediatric radiation oncology activities in low and middle income countries (LMICs). Under the arrangements, CCI and the IAEA will work together to provide specialized training for professionals working in paediatrics, increase awareness and mobilize resources to benefit children with cancer in IAEA Member States.

Partnerships by region

“On 15 February 2018, the IAEA and the African Union Commission concluded Practical Arrangements for the safe, secure and peaceful use of nuclear technologies for sustainable development in Africa.”

On 15 February 2018, the IAEA and the African Union Commission concluded Practical Arrangements for the safe, secure and peaceful use of nuclear technologies for sustainable development in Africa. AUC Chairperson H.E. Moussa Faki Mahamat and IAEA Director General Yukiya Amano signed on behalf of their respective organizations. The Practical Arrangements are the first signed between the Agency and the African Union Commission and cover a four-year period (2018–2022). They provide a framework for cooperation in the areas of human health, food and agriculture, water and the environment, industrial application of nuclear technology, energy planning and nuclear power infrastructure building, and radiation and nuclear safety and security.

The Agency also signed a Cooperation Framework Agreement with the Asian Development Bank in October. This aims to enhance opportunities for deeper cooperation between the parties in the areas of science and technology, capacity development, and leveraging project lessons for wider knowledge sharing. Cooperation will include the organization of events, consultations, analytical work, publications and knowledge products, as well as training and capacity building to meet development challenges in the areas of agriculture and food safety, climate change and disaster risk management, environment, health and water.

The Practical Arrangements between the IAEA and the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) Regional Office, signed in September 2017, had significant positive outcomes throughout 2018. The RCA Regional Office provided assistance in the preparation of the 40th RCA National Representatives Meeting, the 47th RCA General Conference Meeting, and the RCA Annual Project 2018.

Indonesia and the Agency signed Practical Arrangements in February 2018 to establish a framework for non-exclusive cooperation in enhancing TCDC and strengthening South-South cooperation. The arrangements facilitate training and capacity building support, provision of experts and lecturers and utilization of laboratory and analytical facilities in support of other developing countries including LDCs and SIDSs. A short-term action plan has been developed and cooperative activities are being implemented. Training under this action plan has already taken place: a two-week Regional Train the Trainers Course on the Preparation and Quality Control of Tc-99m Radiopharmaceuticals, including good manufacturing practices (GMP) aspects, was held in Jakarta, Indonesia, within the framework of regional project RAF6054, ‘Strengthening and Improving Radiopharmacy Services (AFRA)’.

In Europe, partnerships make an important contribution to the education and training of medical practitioners in the region. The Agency has been collaborating with the European Society for Radiotherapy and Oncology since 1997, and with the European Association of Nuclear Medicine (EANM) since 2005, to provide specialized training opportunities to medical practitioners working in the areas of radiotherapy and nuclear medicine.

Strategic partners are also providing recurrent support to key projects for the development of the region. Partners such as the State Office for Nuclear Safety (SUJB) of the Czech Republic support activities to enhance nuclear safety in the region. As a key partner, SUJB was actively involved in the planning and design phase of the 2018–2019 project cycle for one of the countries that they support.

The partnership between the Agency and State Atomic Energy Corporation (Rosatom) is being implemented through the ongoing regional TC project RER9145, 'Supporting Human Resource Capacity Building for Developing and Implementing Integrated Programmes for Remediation of the Areas Affected by Uranium Mining'. IAEA technical cooperation activities complement regional efforts made within the framework of the inter-State programme 'Reclamation of Territories of EurAsEC Member States affected by Activities at Uranium Production Facilities'. Implementation of this inter-State programme started in 2013 and will continue through to the end of 2019, supporting the reclamation of uranium tailing sites in Central Asia. Within the framework of the regional TC project RER9145, the Russian Federation provides support by hosting regional training courses through which over 100 environmental remediation professionals from Central Asia Member States have been trained in various aspects of site remediation. Six regional training courses were organized, in the Russian language, at the Rosatom Technical Academy from 2016 to 2018.

The Agency signed Practical Arrangements with the CCCCC in August 2018, on cooperation in the use of nuclear science and technology to combat climate change. Within the framework of the arrangements, the IAEA and the CCCCC organized a workshop on the 'Contribution of Nuclear Science and Technology to Building Climate Resilience in the Caribbean Region' in August in Vienna. This meeting was attended by 24 participants from 11 Caribbean countries, drawn from Caribbean Ministries of Environment, Health, Agriculture (amongst others) and from regional organizations including the CCCCC, the Caribbean Agricultural Research and Development Institute, the Caribbean Regional Fisheries Mechanism and the Caribbean Public Health Agency. The workshop built awareness among the participants of the contribution of nuclear science and technology to building climate resilience in the region, and supported the identification of areas of cooperation under a regional project for the next TC programme cycle. Furthermore, CCCCC participated in the workshop on project design in Jamaica in November, with a view to further support the project design submitted by Belize. The proposed regional project will cover the areas of energy, marine environment, and water management.



Cornel Feruta, Assistant Director General and Chief Coordinator at the IAEA's Director General's Office for Coordination, signs the Practical Arrangements in the presence of Simeon Collins, CEO of CAHFSA. Photo: O. Yusuf/IAEA



Kevin Allen, CEO of the University Hospital of the West Indies, and Luis Longoria, Director of the Division for Latin America and the Caribbean, exchange congratulations at the signing ceremony for the first Practical Arrangements agreement between the IAEA and the University of the West Indies. Photo: D. Calma/IAEA

In November, the IAEA and the Caribbean Agricultural Health and Food Safety Agency (CAHFSA) signed Practical Arrangements that provide a framework for cooperation in the areas of human health, sustainable agriculture and food safety. Signature of the Arrangements followed the visit of a delegation of experts from CAHFSA to IAEA headquarters in August, during which the members of the delegation learned about the potential contributions of nuclear science in the areas of animal health, plant mutation breeding, crop productivity, soil and water management, and food safety, and visited the IAEA Laboratories in Seibersdorf.

A signing ceremony for the first Practical Arrangements between the University of the West Indies Mona Campus and the IAEA was held at IAEA headquarters in Vienna on 31 May, in the presence of a delegation of Members of the Board of the University Hospital of West Indies. The new arrangements will underpin collaboration between the two organizations in training on radiology, nuclear medicine, radiotherapy, medical radiation physics, the use of stable isotopes in nutrition, and radiation safety, among others. The arrangements also support collaboration for the creation of nuclear knowledge and information management programmes at the University of the West Indies.

Female participation in the TC programme¹⁸

The TC programme strongly encourages the expansion of female participation in the programme, and Member States are encouraged to nominate female NLOs, meeting and workshop participants, fellows and scientific visitors, and counterparts. In support of this approach, a side event titled 'Women in Nuclear: Leadership for the TC Programme in Africa' was held on the margins of the 62nd General Conference of the IAEA. A panel of leading women nuclear scientists drawn from Women in Nuclear (WiN) chapters in the Middle East and Africa discussed the challenges and opportunities they faced in their professional careers, and the importance of strengthening the role of women in technical cooperation activities in Africa.

¹⁸ This section responds to section 2, operative paragraph 3 of resolution GC(62)/RES/8 on advancing gender mainstreaming and gender balance in the TC programme.

“The TC programme strongly encourages the expansion of female participation in the programme, and Member States are encouraged to nominate female NLOs, meeting and workshop participants, fellows and scientific visitors, and counterparts.”

In 2018, 6128 women from all regions participated in the programme as counterparts, fellows, scientific visitors, meeting and training course participants and international experts and lecturers.

While all TC projects are expected to benefit both men and women, several are specifically targeted at women. Seven projects are currently focused on women's health, and on nutrition for mothers and infants, while a further two focus on women in farming, and women and environmental hazards. In addition, every TC project design includes a section on cross-cutting issues, including gender, where the team working on the design of the project is expected to describe, where relevant, any efforts to assess the different implications for women and men of any planned action, including with regard to legislation, policies or programmes, and to indicate if a gender analysis has been conducted and/or whether the project is linked to any national, thematic or institutional gender strategy.

Of the 22 members of the Standing Advisory Group on Technical Assistance and Cooperation, nine are women. Within the Department of Technical Cooperation, women make up 67% of the staff overall, with 47% of professional and higher categories staff. At Director level, 50% of staff are female.

During the XIX Meeting of ARCAL's Technical Coordination Board in May, all National Coordinators agreed to provide statistics on the numbers of women taking part in ARCAL projects in their countries, in order to measure, monitor, and improve the participation of women in the programme. National Coordinators also agreed to promote events for the training of young professional leaders, especially women, in areas related to nuclear and isotopic techniques.

The regional School of Nuclear and Radiological Leadership for Safety, held in Mexico in November, included a half-day session on promoting gender equality in safety leadership for the young generation. This was facilitated by the chair of the Mexican regulatory body and included a round table discussion. Key note speeches and presentations were made by three current and former high-level female regulator managers from Argentina, Cuba and Spain.



Panelists at the side event titled 'Women in Nuclear: Leadership for the TC Programme in Africa'.
Photo: H.Pattison/IAEA

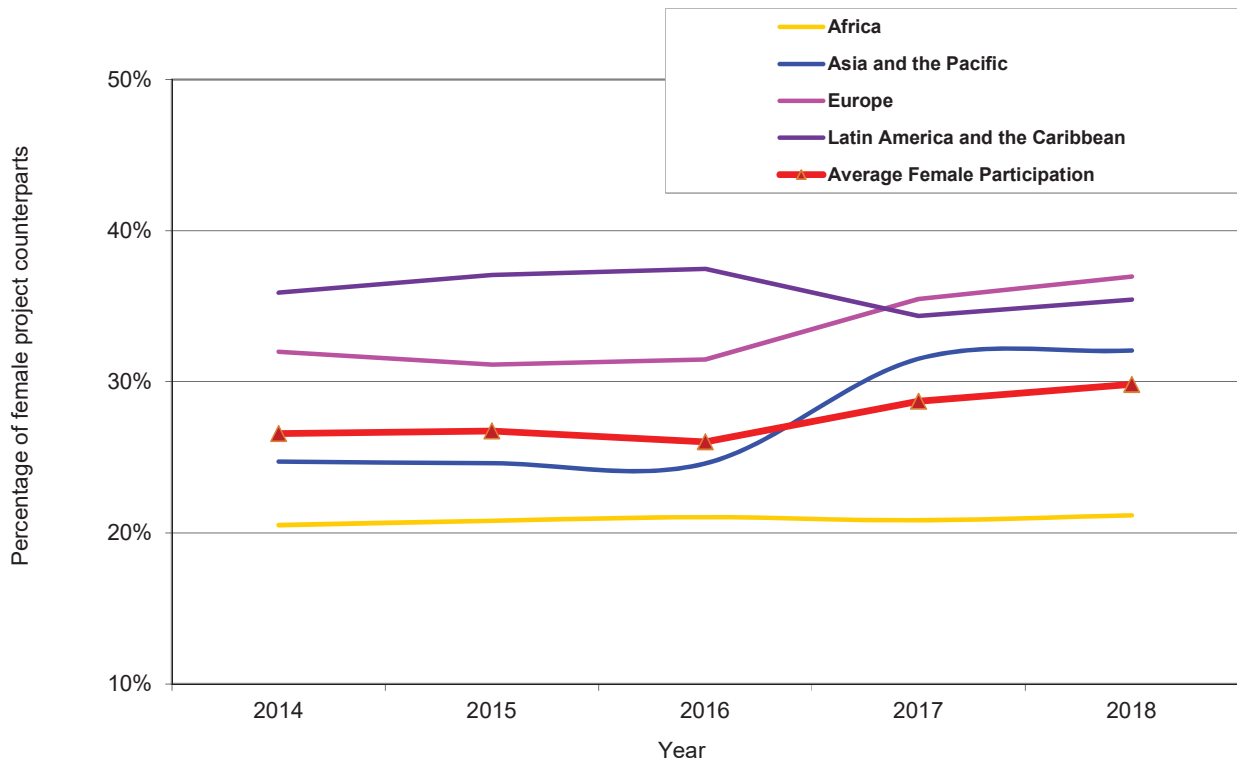


Figure 2: Female project counterparts by region, 2014–2018.

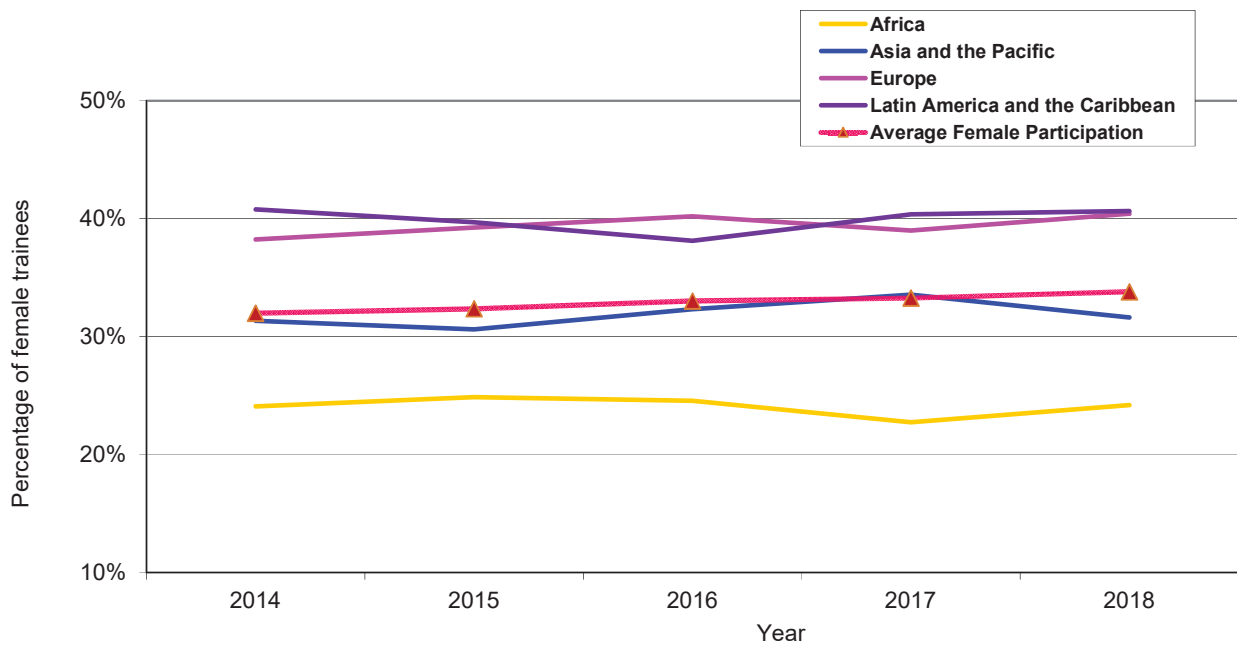


Figure 3: Female participation in training as fellows, scientific visitors, training course participants, meeting participants and other project personnel, 2014–2018.

Ensuring the continual improvement of the TC programme¹⁹

The continual improvement of the TC programme is guided by the results-based approach and the TC Quality Criteria, which are applicable across all phases of the TC programme cycle, including the planning stage, throughout implementation, progress monitoring and reporting, and at the assessment of achievements prior to project closure. Quality assurance activities in 2018 aimed to increase the efficiency, effectiveness and results orientation of the 2018–2019 TC programme and the 2020–2021 TC programme currently under preparation.

A new electronic platform for submission of mandatory annual Project Progress Assessment Reports (PPARs) was successfully piloted and rolled out in 2017. A detailed analysis of the reports revealed a remarkable increase in the rate of engagement by counterparts, NLOs, Programme Management Officers and Technical Officers in project monitoring. There is now positive momentum for e-PPARs to move beyond a reporting tool to become an instrument for better implementation, monitoring and management, and improved project performance, while also supporting team communication. The PPAR process, covering the activities conducted and results achieved in 2018 of over 900 ongoing TC projects, will be completed in 2019. An enhanced focus on the quality of the information provided in the PPARs will further contribute to the continual improvement of the TC programme.

To further enhance the results-based approach to the TC programme by all TC stakeholders, seventeen workshops, training events and programme briefings were conducted. These were organized both in-house and in Member States and included TC Orientation Workshops, training in the use of the logical framework approach (LFA) for the design of new projects, country and regional project design workshops, and specific discussion groups on relevant issues. Targeted training in monitoring and evaluation was included, with a particular focus on PPAR reporting. The updated online LFA training module, which can be accessed through the IAEA website and through the Programme Cycle Management Framework (PCMF), is receiving widespread attention and has been used by close to 900 TC stakeholders since its launch in late 2017.

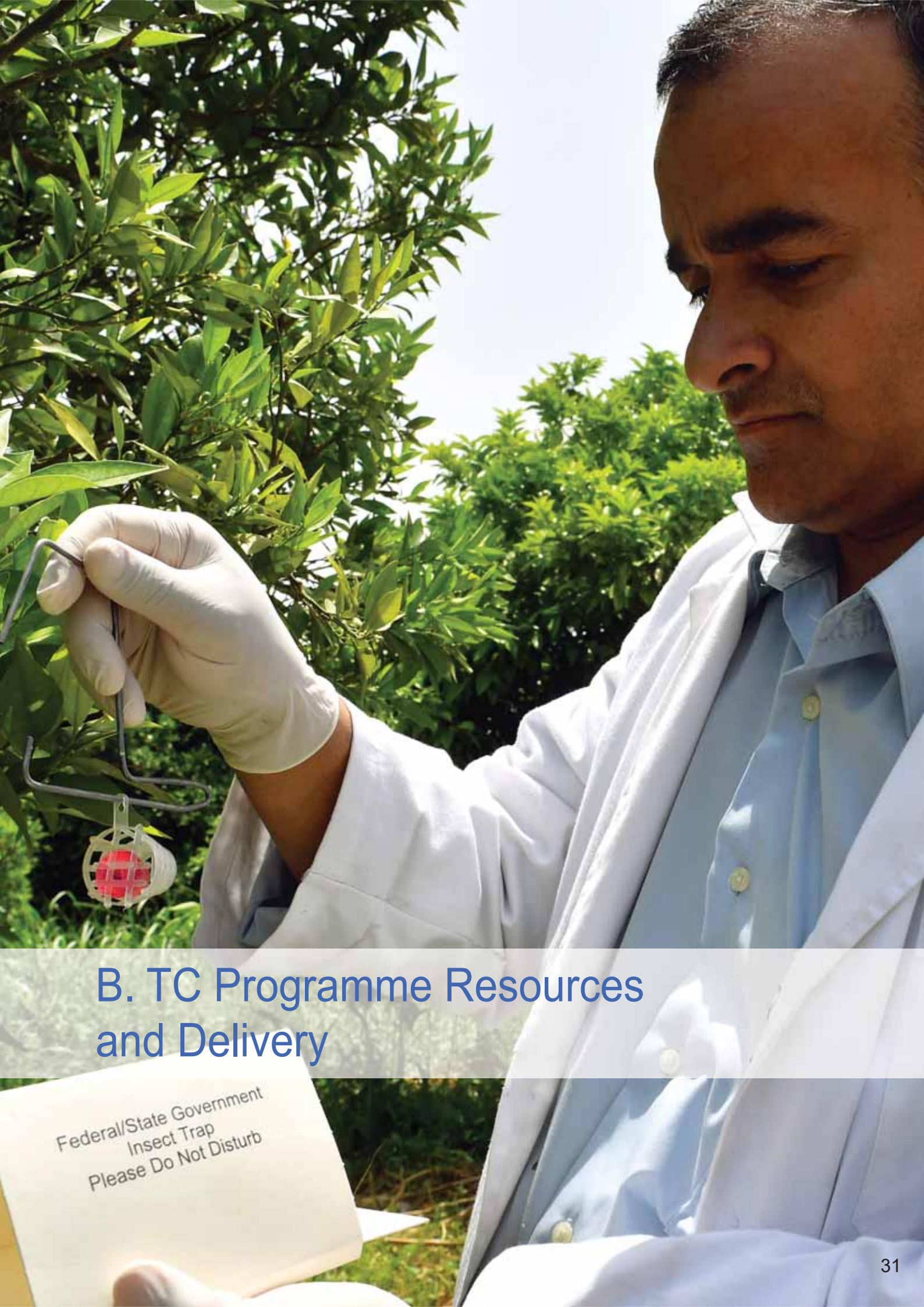
Field Monitoring Missions to Albania, Costa Rica, Israel, South Africa, and United Republic of Tanzania were conducted in the context of the pilot project on outcome monitoring to obtain further insight into the development of an approach to monitor the outcomes of TC projects systematically and effectively, rather than the inputs, activities and outputs only.

The Guidelines for the Planning and Design of the IAEA 2020–2021 Technical Cooperation Programme were issued in January 2018. The project design templates and guidance were reviewed and updated as appropriate, based on the experience of previous TC cycles and in order to address recommendations from internal and external audits and evaluations.

As in previous years, the Department of TC is working closely with the Office of Internal Oversight Services (OIOS). In 2018, 57 recommendations were either closed or considered implemented. The Department of TC has developed comprehensive action plans to address TC-related recommendations from new OIOS audits and evaluations conducted in 2018. These were prepared in close interaction with OIOS, particularly with regard to identifying key deliverables and to consolidating the individual recommendations into thematic areas to ensure their most effective and efficient implementation.²⁰

¹⁹ This section responds to section 2, operative paragraph 9 of resolution GC(62)/RES/8 on PCMF implementation, and making it simpler and user-friendly for effective use; 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

²⁰ This paragraph responds to section 3, operative paragraph 10 of resolution GC(62)/RES/8 on OIOS evaluation of projects.



B. TC Programme Resources and Delivery

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B. TC Programme Resources and Delivery

B.1. FINANCIAL OVERVIEW

Resources for the technical cooperation programme²¹

At the end of 2018, €79.3 million of the €85.7 million target for the 2018 Technical Cooperation Fund (TCF) had been pledged and €78.3 million in payments had been received. Total TCF resources including National Participation Costs (NPCs), assessed programme costs (APCs) arrears, and miscellaneous income amounted to €82.6 million (€78.3 million TCF, €3.6 million NPCs and €0.7 million miscellaneous income. No APCs arrears were received). New extrabudgetary resources for 2018 came to €17.2 million and in-kind contributions amounted to €0.3 million.

The rate of attainment on pledges, as at 31 December 2018, was 92.6% and the rate of attainment on payments on the same date was 91.4% (Fig.5). One hundred and twenty-nine Member States, including 20 LDCs, paid their TCF target in full or partially. Total payments received in 2018 include €0.4 million either of deferred or of additional payments by 10 Member States. Excluding these payments, the 2018 rate of attainment on payments would have been lower by 0.4%.

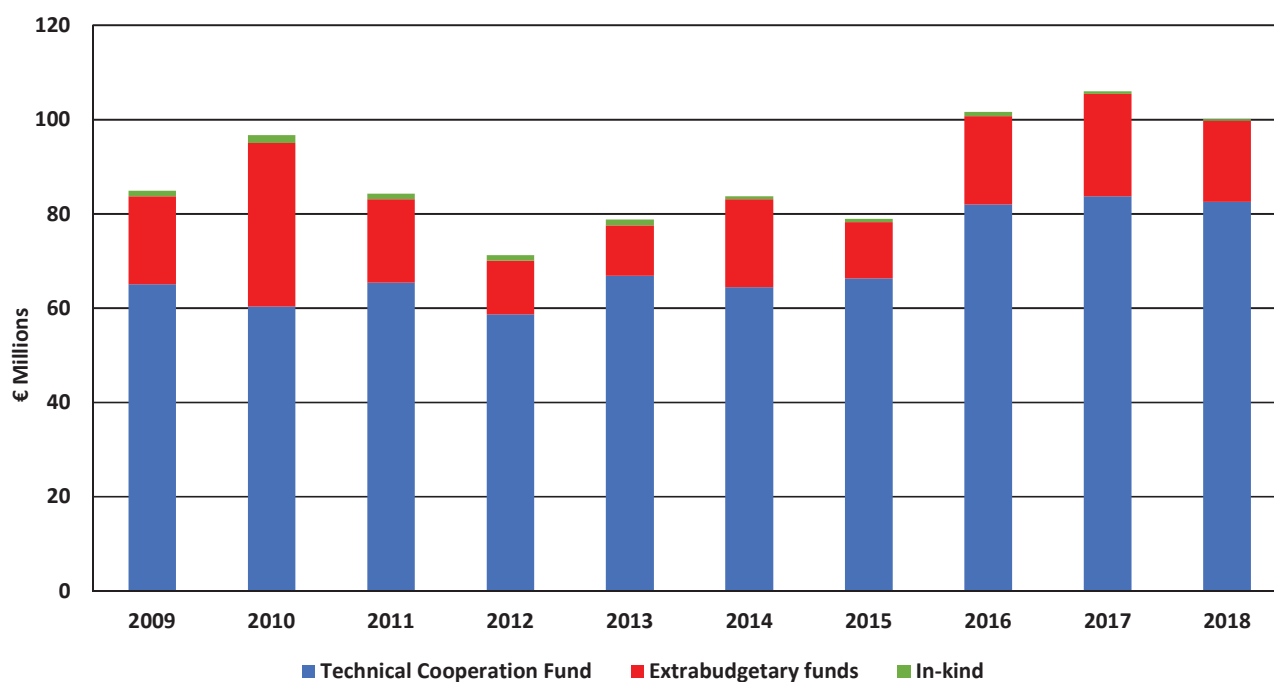


Figure 4: Trends in TC programme resources, 2009–2018.

²¹ This section responds to section 4, operative paragraph 2 of resolution GC(62)/RES/8 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 2018

2018 target for voluntary contributions to the TCF	€85.7 million
Technical Cooperation Fund, NPC, APC, miscellaneous income	€82.6 million
Extrabudgetary resources ²²	€17.2million
In-kind contributions	€0.3 million
Total new resources for the TC programme	€100.1 million

Table 2: Payment of National Participation Costs (NPCs) and assessed programme cost (APC) arrears

	Received in 2018	Outstanding payments at end 2018
NPCs	€3.6 million	€0.7 million
APCs	-	€0.9 million

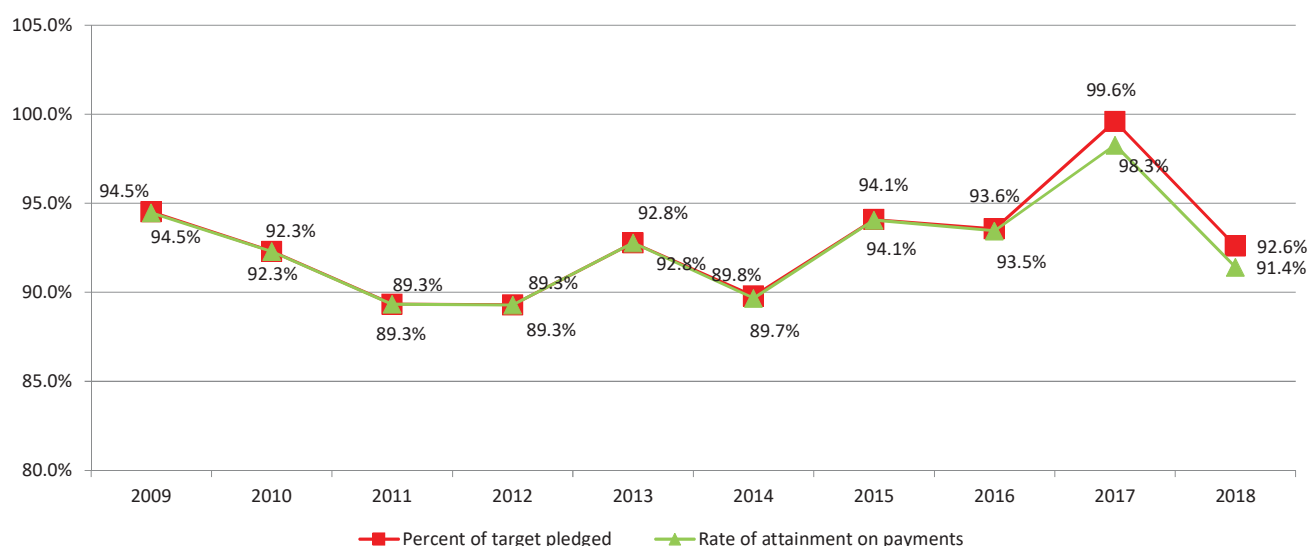


Figure 5: Trends in the Rate of Attainment, 2009–2018.

Extrabudgetary and in-kind contributions²³

Extrabudgetary contributions from all sources in 2018 (donor countries, international and bilateral organizations, government cost sharing) accounted for €17.2 million. The breakdown of the €17.2 million is as follows: €8.8 million funding for activities where the donor is the recipient (commonly referred to as Government Cost Sharing); €8.4 million from donors, of which €4.1 million was received through the Peaceful Uses Initiative mechanism. Twenty-one African Member States provided extrabudgetary contributions amounting to €788 967 for regional technical cooperation projects through the AFRA Fund. More detail is contained in Table 3 (extrabudgetary contributions by donor), Table 4 (government cost sharing) and Table 5 (contributions to PACT). In-kind contributions accounted for €0.3 million in 2018.

²² Please refer to Table A.5 of the Supplement to this report for details.

²³ This section responds to section 4, operative paragraph 8 of resolution GC(62)/RES/8 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 2018, by donor (in euros)

Australia	56 250	Pakistan	20 000
Chile	8640	Philippines	4185
China	15 865	Russian Federation	316 285
Hungary	60 000	Spain	180 000
Indonesia	28 643	Sweden	192 123
Israel	37 429	United States of America	4 982 422
Japan	826 975	AFRA Fund	788 967
Korea, Republic of	482 755	OPEC Fund (OFID)	125 550
Malaysia	10 000	Total	8 136 089

Table 4: Funding where the donor is the recipient (Government cost sharing) allotted to TC projects in 2018 (in euros)

Albania	130 000	Montenegro	206 000
Botswana	16 515	Namibia	30 000
Costa Rica	122 771	Pakistan	139 840
Iran, Islamic Republic of	16 800	Philippines	645 741
Jordan	322 550	Serbia	326 209
Latvia	10 500	Sudan	25 205
Lesotho	113 285	Tajikistan	187 644
Malawi	6 334 400	Uzbekistan	45 000
Malta	154 500	Total	8 826 960

Table 5: Extrabudgetary contributions to PACT, 2018

Donor	Amount (euros)
Monaco	40 000
Korea, Republic of	30 135
Russian Federation	167 440
United Nations Federal Credit Union	4275
United Nations Women's Guild	26 378
Total	268 228

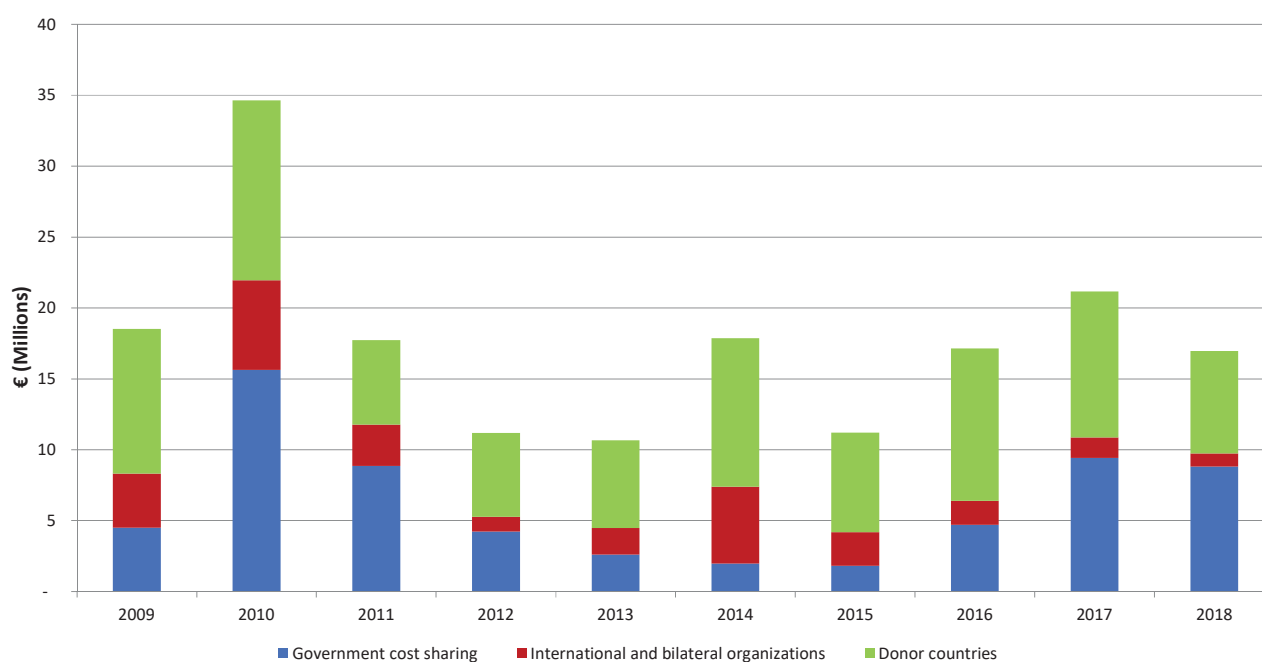


Figure 6: Trends in extrabudgetary contributions by donor type, excluding contributions to PACT, 2009–2018.

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 actuals²⁴ and encumbrances. Non-financial delivery (i.e. outputs) can be expressed numerically in terms of, for example, experts deployed, training courses conducted and purchase orders obligated.

Financial implementation for the TCF, measured against the budget for 2018 as at 31 December 2018, reached 85.7% (Table 6).

Table 6: TCF financial indicators for 2016, 2017 and 2018

Indicator	2016	2017	2018
Budget allotment at year end ²⁵	€93 737 513	€106 136 533	€106 612 040
Encumbrances + actuals	€79 294 249	€91 570 710	€91 377 251
Implementation rate	84.6%	86.3%	85.7%

Unallocated balance

By the end of 2017, the total unallocated balance²⁶ had amounted to €8.3 million. The total unallocated balance for 2018 as at 31 December 2018 amounted to €0.0 million. In 2018, €11.9 million were received as advance payments for the 2019 TCF. Some €0.5 million of cash is held in currencies which are difficult to use in the implementation of the TC programme.

²⁴ Terminology has changed with the implementation of the Agency-wide Information System for Programme Support (AIPS/Oracle). Actuals are the equivalent of disbursements.

²⁵ 2018 budget allotment at year end includes carry-over from previous years of €7.4 million, already allotted to projects.

²⁶ Total funds not allocated to TC projects.

Table 7: Comparison of the unallocated balance of the TCF (in euros)

Description	2017	2018
Total unallocated balance	8 252 741	-
Advance payment in 2017 and 2018 for TCF for following year	8 780 336	11 928 415
Non-convertible currencies that cannot be utilized	1 377 908	1 503 190
Currencies that are difficult to convert and can only be used slowly	3 069 597	455 225
Adjusted unallocated balance	21 480 582	13 886 830

Human resources and procurement

Human resource and procurement indicators show the non-financial delivery of the TC programme. Regarding procurement, a total of 1423 purchase orders were issued in 2018, to a value of €27 929 343 million.

Table 8: Delivery of outputs: non-financial indicators for 2018

Indicator	
Expert and lecturer assignments	3640
Meeting participants and other project personnel	6739
Fellowships and scientific visitors in the field	1816
Training course participants	3282
Regional and interregional training courses	196

Table 9: TC procurement in 2018

Division	Requisitions	Purchase orders issued	Value of Purchase Orders issued
TCAF	527	482	€8 444 618
TCAP	390	346	€6 850 077
TCEU	217	186	€ 5 504 727
TCLAC	417	409	€ 7 129 921
Total	1551	1423	€ 27 929 343

At the end of 2018, 1016 projects were active, and an additional 508 projects were in the process of being closed. During 2018, 182 projects were closed. One project was cancelled in consultation with the relevant Member State.

Programme Reserve projects

No Programme Reserve projects were requested in 2018.



C. Programme Activities and Achievements in 2018

C. Programme Activities and Achievements in 2018²⁷

C.1. AFRICA

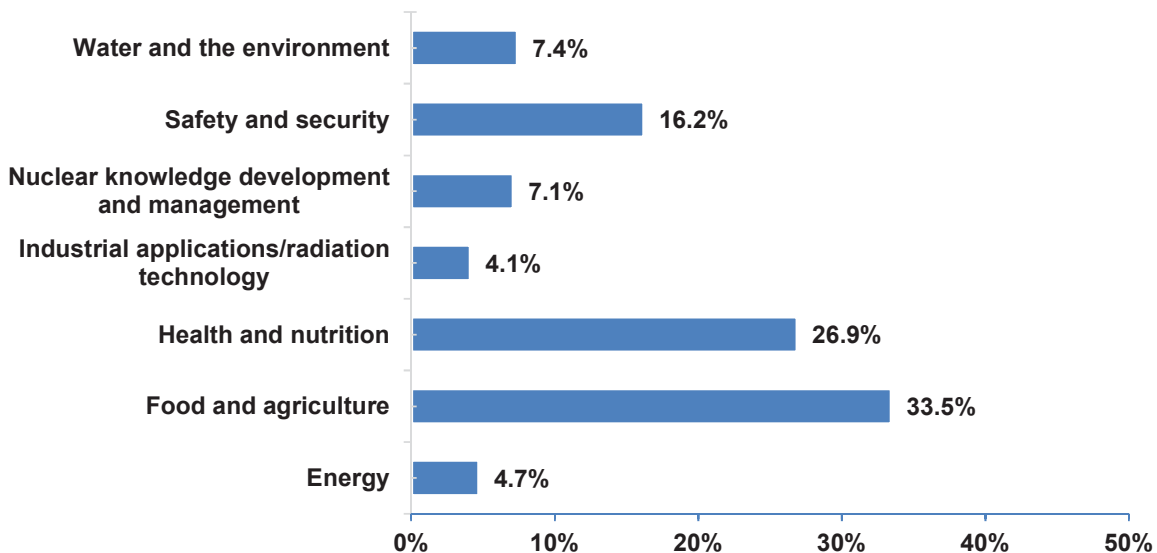
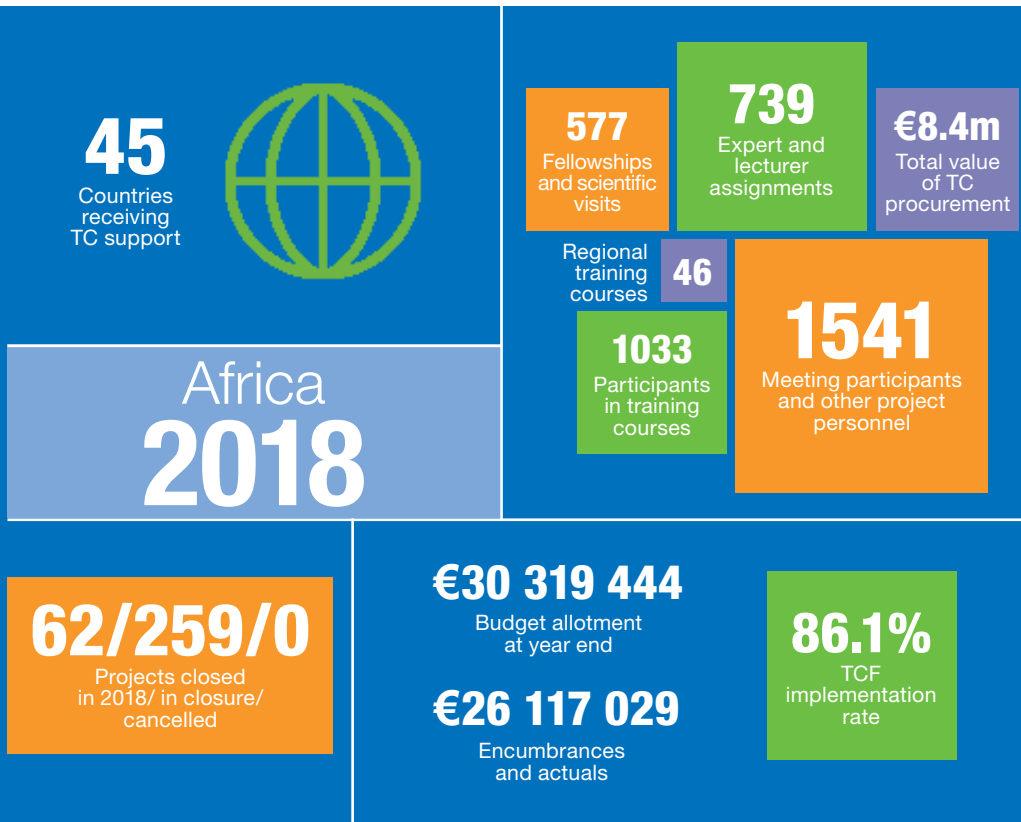


Figure 7: Actuals in the Africa region in 2018 by technical field.

²⁷ Section C responds to section 2, operative paragraph 1 of resolution GC(62)/RES/8 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, 2018

In 2018, 45 Member States in the Africa region participated in the TC programme through 383 national and 56 regional projects. There are 26 LDCs in the region. The programme achieved an implementation rate of 86.1%.

In 2018, seven Member States successfully developed and signed their CPFs. CPFs for

CPF signed in Africa in 2018	
Botswana	Morocco
Democratic Republic of the Congo	Nigeria
Ethiopia	United Republic of Tanzania
Lesotho	

Angola, Chad, Congo, Eritrea, Eswatini²⁸, Gabon, Mauritania, Mauritius, Mozambique, Sierra Leone and South Africa are at an advanced or final stage of preparation, and are planned for signature in 2019.

In 2018, the IAEA co-signed the UNDAFs of Burkina Faso, Ghana, Lesotho, Malawi, Mauritania and Rwanda, and the Seychelles Strategic Partnership Framework.

In 2018, the TC programme in the Africa region focused on the six major priority areas highlighted in the AFRA Regional Strategic Cooperative Framework (RCF) 2014–2018, and the draft Regional Programme Framework (RPF) for Africa 2018–2023. These are food and agriculture, human health, environment protection and water resource management, industrial applications, sustainable energy development, and radiation and nuclear safety. The development of human resources through education and training formed a major component of TC assistance provided in 2018, supporting Member States' efforts to build capacities and ensure the availability of skilled staff in African Member States.

Project highlights

In January, Uganda inaugurated a new radiotherapy machine, provided with the support of the IAEA TC project UGA6018, 'Establishing Radiotherapy Services at the Cancer Institute', to resume essential treatment services for cancer patients after the country's only radiotherapy machine broke down in 2016. The Agency also contributed to the decommissioning of the old machine.

In the United Republic of Tanzania, under URT6028, 'Strengthening the Cancer Control Programme', and URT6031, 'Strengthening and Expanding the Cancer Control Programme', IAEA support was provided through human resource development, expert advice, and the provision of equipment to the Ocean Road Cancer Institute (ORCI) to improve cancer treatment services, moving from 2D to 3D radiotherapy while Bugando Medical Centre started providing radiotherapy services following the successful commissioning of equipment. This centre is expected to serve a population of approximately 13 million people in the North and North-west part of United Republic of Tanzania, and will ease the pressure on the only existing radiotherapy facility at the ORCI in Dar Es Salaam.

The first joint IAEA/Argonne National Laboratory training of nuclear medicine professionals on 'Strengthening Nuclear Medicine in Africa', using a multidisciplinary team approach, was implemented in January 2018 at the M.D. Anderson Cancer Center in Houston, USA. The training, designed for senior nuclear medicine personnel, focused on strategic planning and quality management, and was supported through RAF6051, 'Strengthening Education and Human Resources Development for Expansion and Sustainability of Nuclear Medicine Services in Africa'.

In 2018, Benin, Lesotho and Rwanda promulgated their first nuclear laws and Malawi and Rwanda established their national regulatory bodies. Mauritius revised and enhanced its national legal framework by enacting the new Radiation Safety and Nuclear Security Act, 2018. In addition, progress was made in safety: Mali, Mauritius, Uganda and Zimbabwe attained 'good progress' status for Thematic Safety Area 1, Regulatory Infrastructure, while Malawi and Mozambique moved to 'medium progress' status. Mauritania attained

²⁸ The name 'Eswatini' replaces the former name 'Swaziland' as of 29 June 2018.



Participants of the first joint IAEA-Argonne National Laboratory training in nuclear medicine. Photo: A. Grigoryan/IAEA

'good progress' status for Thematic Safety Area 2, Radiological Protection in Occupational Exposure.

Under TC project ZIM5021, 'Assessing and Promoting Sustainable Agricultural Production in Communal and Newly Resettled Farms', Zimbabwean farmers have seen an increase of between 10 and 20 percent in their cowpea yields, thanks to the use of a new variety bred using nuclear techniques. The new variety has shown increased drought tolerance and insect resistance, enabling farmers to better cope with the effects of climate change, particularly in more drought prone areas.

Small scale farmers living along the valley of the Senegal River in the southern central and south-eastern parts of Mauritania are now using drip irrigation to maximize crop productivity while saving water and fertilizer resources, supported by MAU5006, 'Contributing to the Improvement of Rice Crop Yields through the Application of Nuclear Techniques To Water Management and Soil Fertility'. Farmers who had been facing water scarcity have witnessed positive changes, including increased crop productivity and higher incomes.

The capacities of radioanalytical laboratories in the Africa region to measure polonium-210 and uranium isotopes using alpha-particle spectrometry, and naturally-occurring radionuclides in environmental samples using gamma-ray spectrometry, were strengthened in 2018 through regional training courses and an interlaboratory comparison exercise under regional projects RAF7015, 'Strengthening Regional Capacities for Marine Risk Assessment Using Nuclear and Related Techniques', and RAF7017, 'Promoting Technical Cooperation among Radio-Analytical Laboratories for the Measurement of Environmental Radioactivity'. The projects also supported environmental risk assessments for seafood safety.

Twenty-five managers from national atomic energy commissions, research facilities and laboratories participated in a regional workshop on quality management systems (QMSs) hosted by the Nigerian Atomic Energy Commission in February, supported by RAF0047, 'Promoting the Sustainability and Networking of National Nuclear Institutions for Development, Phase II'. The workshop enhanced the participants' understanding of quality management systems in accordance with international norms and standards. Participants were also trained on the economic aspects of quality assurance/ quality control (QA/QC) in service laboratories. The workshop helped to foster awareness of international requirements for effective QMSs.

Senegal has established its first radioactive waste processing and storage facility using the ISO container design within the framework of RAF9062, 'Strengthening Radioactive Waste Management (AFRA)'. A regional training course on conditioning spent, low activity radioactive sources was conducted in Dakar, Senegal in July 2018, and twelve participants from five countries (Democratic Republic of the Congo, Morocco, Senegal, Uganda and Zimbabwe) were trained.

"Farmers who had been facing water scarcity have witnessed positive changes, including increased crop productivity and higher incomes."



Participants at the 29th AFRA TWGM. Photo: IAEA

Regional cooperation

AFRA continues to be the principal framework for promoting TCDC in Africa and for enhancing regional cooperation among its State Parties. Djibouti is the newest AFRA State Party, following its acceptance of the Agreement on 12 December 2018.

In early 2018, the AFRA Chairperson, in collaboration with the Secretariat, held a series of meetings with Permanent Representatives of the Vienna-based African Group and donor countries in Vienna to share information on AFRA project-related achievements and success stories, and to seek further support for the implementation of the unfunded portion of the AFRA programme, leading to an increase in extrabudgetary contributions. The AFRA Chairperson also encouraged AFRA State Parties to pay their shares to the AFRA Fund, resulting in an increase in contributions.

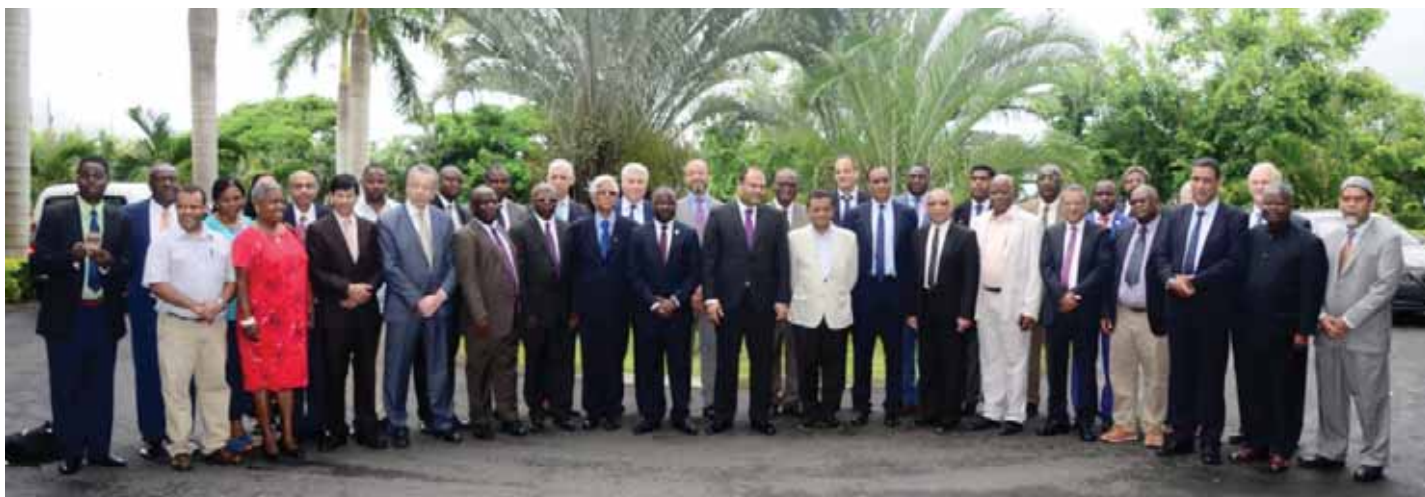
The Government of Ghana hosted the 29th AFRA Technical Working Group Meeting (TWGM) in Accra in July. The meeting brought together members of AFRA Committees, National Coordinators and IAEA staff to deliberate on issues related to AFRA policy and the AFRA programme. The meeting adopted concrete recommendations to further enhance regional cooperation in Africa, including through the establishment of new RDCs.

In September, the IAEA hosted the 29th Meeting of AFRA Representatives on the margins of the 62nd annual session of the IAEA General Conference. At this meeting, participants endorsed the 2017 AFRA Annual Report, the new members of the AFRA management committees, the preparation for the 2020–2021 AFRA programme and the recommendations adopted by the 29th TWGM.

Throughout 2018, 32 AFRA RDCs provided useful services in different nuclear-related areas in the region, and hosted fellowship training, meetings and training courses. Expert services were also provided by qualified staff from these centres. AFRA RDCs help strengthen relationships and the exchange of information between nuclear institutions in the region.

Development of the Regional Cooperation Framework

In March 2018, a task force composed of representatives from AFRA management committees, together with 27 African and four Asian specialists with expertise in the application of nuclear science and technologies, and IAEA staff, met to develop the new AFRA RCF for 2019–2023. The new RCF has been developed to narrow its focus to food and agriculture, human health, and radiation safety. It also focuses on cross-cutting issues such as human resource development and triangular cooperation to enhance TCDC. The task force also established mechanisms for South-South collaboration and triangular



Experts/participants at the AFRA RCF Task Force Meeting. Photo: IAEA

cooperation to enhance African Member States' capacity to benefit from nuclear science and technology in other areas including energy development, industrial applications, and water resources. The document takes into consideration the recommendations from OIOS and AFRA, including on strengthening the requisite preconditions for participating in regional projects. The draft RCF was finalized during the 29th AFRA TWGM, and endorsed by the 29th Meeting of AFRA Representatives held on the margins of the 62nd IAEA General Conference.

In 2018, the Division for Africa (TCAF) developed a Regional Programme Framework (RPF) for Africa covering the period 2018 to 2023, in order to provide strategic direction for the region's programme development, management and monitoring, and to support the effective delivery of the TC programme in Africa. The document was prepared through a joint consultation process among African Member States and the Secretariat. It is in line with the Agency's Statute, the IAEA Medium Term Strategy 2018–2023, and the 1997 IAEA Technical Cooperation Strategy and its 2002 review. The RPF seeks to achieve a greater alignment of the delivery of the TC programme in Africa with the Global Development Agenda – especially the SDGs and enhanced UN system-wide coherence through participation in UNDAFs. It also takes into consideration the African Union Agenda 2063, the African Development Bank 'High-Five' and the AFRA Regional Strategic Profile (2019–2023). It was endorsed by the African NLOs in April 2018.

The AFRA RCF and the TCAF Implementation Framework have been developed to further improve the delivery and the quality of the TC programme in African Member States in the future. The quality of individual and group training activities is a major consideration, given the need to optimize assistance to best address the major needs for skilled human resources in the region. This will be supported through, among others, pre-training e-learning courses, systematic examinations at the end of training courses, and training events of longer duration (up to two or three weeks).

Contributions to the AFRA Fund

In 2018, AFRA State Parties continued to pay their contributions to the AFRA Fund. The total contribution of AFRA State Parties to the AFRA Fund was approximately €800 000, demonstrating the Parties' continued commitment to AFRA activities and their willingness to further enhance regional ownership of the programme. The funding will be allotted to AFRA projects in 2019 to support the implementation of unfunded activities.

Table 10: Voluntary contributions to the AFRA Fund for TC activities, 2018 (in euros)

Country	Amount received	Country	Amount received
Algeria	57 202	Mauritius	11 510
Botswana	31 505	Morocco	47 116
Central African Republic	4301	Mozambique	4517
Democratic Republic of the Congo	3139	Nigeria	78 784
Egypt	88 941	Rwanda	4503
Eritrea	3662	Seychelles	2093
Ethiopia	3025	South Africa	408 144
Ghana	4195	Tunisia	5324
Madagascar	2973	Uganda	4949
Malawi	6744	Zimbabwe	15 073
Mali	1267	TOTAL	788 967

C.2. ASIA AND THE PACIFIC

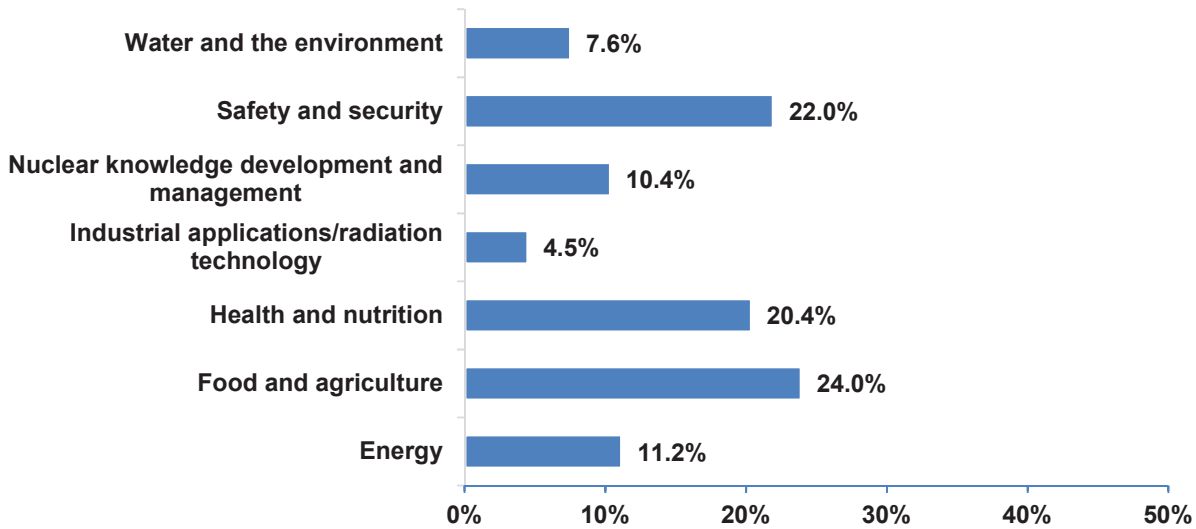
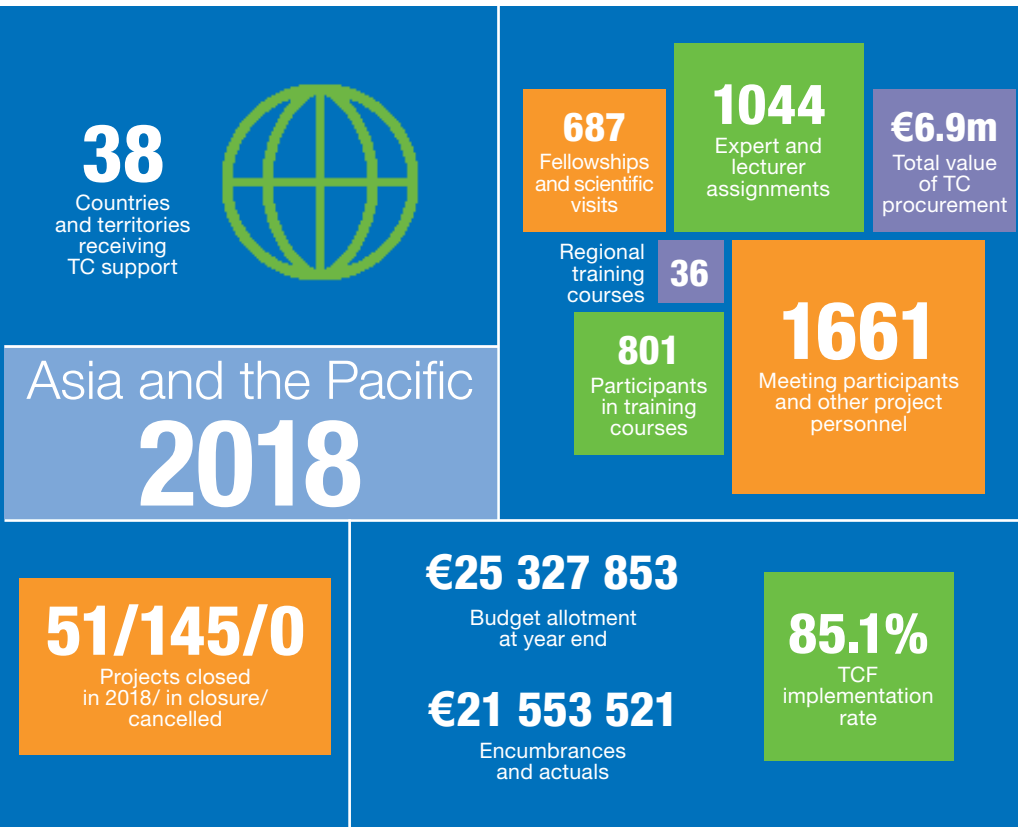


Figure 8: Actuals in the Asia and the Pacific region in 2018 by technical field.

Regional highlights in Asia and the Pacific, 2018

The TC programme provided support to 38 countries and territories in the Asia and the Pacific region in 2018 through 321 national and 75 regional projects. In 2018, the programme achieved an implementation rate of 85.1%.

The TC programme for the Asia and the Pacific region is designed to meet the 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 2018, CPFs were signed by three Member States in the region.

CPF signed in Asia and the Pacific in 2018	
Bahrain	Brunei Darussalam
Bangladesh	

Project highlights

A follow up project to RAS0065, ‘Supporting Sustainability and Networking of National Nuclear Institutions in Asia and the Pacific Region’, which focused on introducing nuclear science and technology in secondary education, was launched in February. The new project RAS0079, ‘Educating Secondary Students and Science Teachers on Nuclear Science and Technology’, aims to reach 1 million students, as beneficiaries of improved understanding and teaching methods to illustrate nuclear science and technology, by 2021. The project builds on the achievements of the previous project, such as the development of innovative, cost effective equipment for classroom demonstrations, including a portable, user-friendly gamma detector (Hakarukun) and a cloud chamber to illustrate natural radiation in the environment. Pilot countries also successfully adapted programmes from countries with more experience in the area, such as ‘Powerful Opportunities for Women Eager and Ready for Science, Engineering and Technology’ developed by Texas A&M, and the Lawrence Livermore National Laboratory’s ‘Science on Saturday’ lecture series. Two regional training courses were organized in 2018 in the National Nuclear Energy Agency (BATAN), Yogyakarta, Indonesia and in Argonne National Laboratory, USA, to provide teachers with innovative and diverse methods for teaching science to children aged from 12 to 18. As a result, Member States requested support from the IAEA for the organization of national workshops and for other initiatives such as the United Arab Emirates’s ‘Nuclear Science for Development Student Competition’. The United Arab Emirates invited the winners of this competition to attend the IAEA Ministerial Conference on Nuclear Science and Technology in November.

“The new project RAS0079, ‘Educating Secondary Students and Science Teachers on Nuclear Science and Technology’, aims to reach 1 million students, as beneficiaries of improved understanding and teaching methods to illustrate nuclear science and technology, by 2021.”

Regional cooperation

The Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) continued to be an effective and efficient mechanism for supporting RCA State Parties in their efforts to achieve national development priorities and the SDGs. The implementation of RCA projects in 2018 was well in line with the defined objectives and work plans. Thirty-five regional events, comprising training courses, meetings and workshops, were carried out during the year. This constitutes an implementation rate of over 92%. The RCA also continued to promote TCDC, South-North and South-South cooperation, and through participation in the Quadripartite Forum.

The Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA) designated the first ARASIA regional resource centres (RRCs) on 30 November 2018, a concrete step forward in promoting TCDC. The designation of these first ARASIA RRCs demonstrated ARASIA’s strategic approach to enhancing and reinforcing the sustainable contribution of nuclear science and technology to development in the region. The new RRCs are Kuwait Cancer Control Centre and the American University of Beirut Medical Centre, both offering support in the area of nuclear medicine. The designated RRCs are expected to play a key role in coming years in supporting active cooperation among ARASIA State Parties, through provision of

training, expert advice and other relevant services. The operational modalities and a plan of action for the systematic utilisation of the designated centres, and for their integration into the implementation of the ARASIA programme, were agreed upon during a five-day technical meeting that took place prior to the designation ceremony.

Regional cooperation between Israel, Jordan and the territories under the jurisdiction of the Palestinian Authority, supported by the regional TC project RAS5076, 'Harmonising and Strengthening Surveillance Systems to Prevent and Control Exotic and Native Fruit Flies Including the Use of the Sterile Insect Technique', builds on the foundations laid by earlier TC projects to strengthen cooperation between project counterparts to address the problem of non-native fruit flies and other pests. Sterile insect technique (SIT) programmes have been successfully implemented in Israel and Jordan, maturing as a major integrated pest management strategy, while classical integrated pest management strategies such as mass trapping and bait spraying have been successfully applied in the territories under the jurisdiction of the Palestinian Authority. A surveillance network has been established for the early detection of pests at high risk locations, using advanced traps for three different fruit flies. The Middle East Non-Indigenous Pests database, designed as a dynamic tool to meet the needs of the region in preparing and enabling quick and effective actions for the prevention, monitoring and eradication of non-native pests to the region, was established under the project.

Following the inauguration of the International Centre for Synchrotron Light for Experimental Science and Applications in the Middle East (SESAME) in 2017, eleven IAEA scientists and fellows were trained at the SESAME in 2018 under INT0092, 'Building Human Capacity for the Construction, Operation and Use of Synchrotron-Light for Experimental Science and Applications for the Middle East'.

Preparing for the 2020–2021 TC programme cycle

An Induction Workshop for new National Liaison Officers (NLOs) and National Liaison Assistants (NLAs) from the Asia and the Pacific region took place in June, providing participants with an overview of the TC programme, potential collaborations, and the mechanism for the implementation of the technical cooperation programme. The workshop was attended by 23 NLOs and NLAs from 16 IAEA Member States, including Bahrain,



NLOs and NLAs from the Asia and the Pacific region hear a briefing on the IAEA TC programme, June 2018. Photo: H.Pattison/IAEA

Bangladesh, China, Indonesia, Islamic Republic of Iran, Lao People's Democratic Republic, Lebanon, Malaysia, Nepal, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Syrian Arab Republic, Thailand and Viet Nam. They also visited the IAEA laboratories at Seibersdorf and held discussions with the implementation team in the Division for Asia and the Pacific, gaining a clear understanding of the support provided by the IAEA to help them carry out their duties as NLO/NLA for their country.

RCA has submitted eight project designs for the 2020–2021 TC programme cycle, demonstrating the Agreement's initiative and ownership in the development and formulation of its programme. Seven project designs have been submitted under the ARASIA agreement for the 2020–2021 TC cycle. The proposed projects are in line with the ARASIA Medium Term Strategy and address common needs and transboundary issues in ARASIA State Parties.

The Division for Asia and the Pacific has embarked on a systematic approach to fully utilize the potential of the IAEA's CLP4NET by creating pages for projects, where appropriate, in order to carry out activities that increase the efficiency and relevancy of training courses, satisfaction surveys for participants and lecturers, as well as the dissemination of documents for participants. Feedback has been very positive, with many participants noting the added value to the platform.

C.3. EUROPE

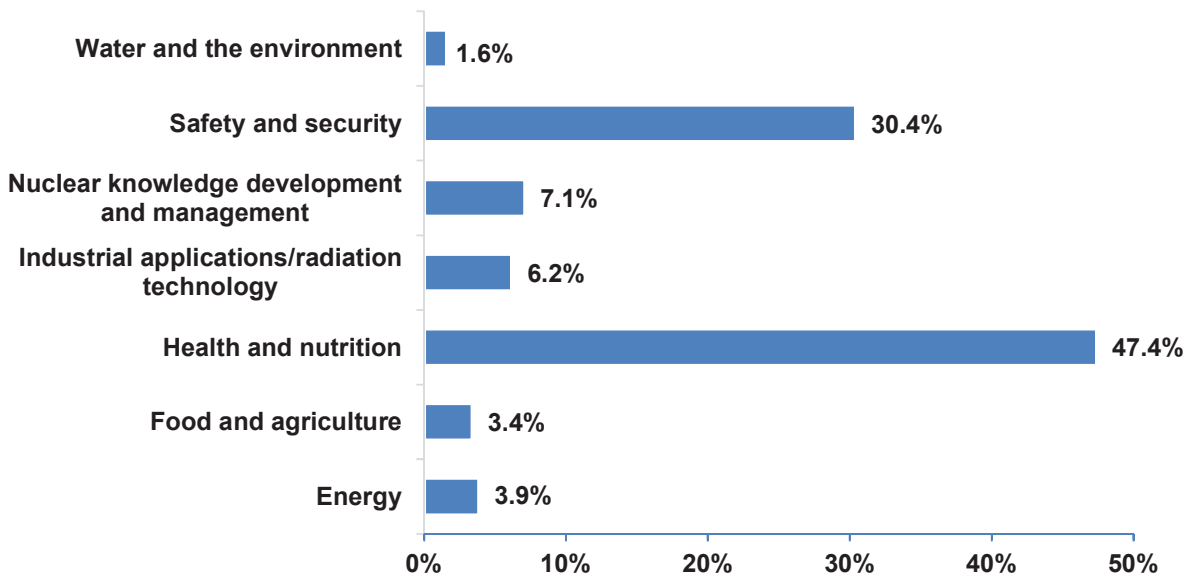


Figure 9: Actuals in the Europe region in 2018 by technical field.

Regional highlights in Europe, 2018

In 2018, the Agency provided support to 33 Member States in the Europe region through 168 national and 50 regional projects. Turkmenistan is the newest Member State in the region, and presently participates in the regional programme only. However, the country has submitted four national project proposals for the 2020–2021 cycle. The year-end implementation rate for the region was 86.1%.

CPFs signed in Europe in 2018

Armenia	Kyrgyzstan
Bulgaria	Slovenia
Cyprus	Tajikistan
Malta	Turkey

Eight CPFs were signed in the Europe region in 2018. CPF Coordinators in the process of updating their CPFs were invited to attend one of two CPF workshops organized in July and August in Vienna, during which the new CPF template was presented.

While no UNDAFs were co-signed in 2018, 12 UNDAFs overall have been signed in Member States participating in the TC Europe programme to date.

Project highlights

In 2018, Agency support to strengthen radiation and nuclear safety in Member States in Europe and Central Asia was provided in numerous areas. For example, a national TC project ROM9037, 'Supporting Radioactive Waste and Spent Fuel Management', helped Romania to strengthen national capabilities in the management of radioactive waste and spent nuclear fuel by training staff in the area of management of radioactive waste, improving knowledge on a geological disposal programme, providing dedicated computer codes to perform safety case analyses, and by supporting the revision of radioactive waste management legislation in line with international recommendations.

The Government of Kazakhstan is conducting work towards the transitioning of the Semipalatinsk test site (STS) to economic use in areas that meet release criteria. The process of transitioning lands takes place in three stages: characterization of the test site through the preparation of comprehensive ecological studies; an independent review of these studies; and the identification of appropriate remedial options. IAEA support, delivered through KAZ9014, 'Supporting the Transfer of the Former Semipalatinsk Test Site Land for Economic Use', currently focuses on the first stage. Last June, an IAEA expert mission to the STS reviewed the eight existing ecological studies and provided Kazakhstan with a list of recommendations and follow-up actions. Suggestions were also made regarding the future integration of the findings of all eight reports.

Demand for a training course on Quality Assurance and Quality Management Systems for Diagnostic Radiology, delivered as part of the regional TC project RER6038, 'Applying Best Practices for Quality and Safety in Diagnostic Radiology', was so high that a second, unplanned, training course was organized to address this regional need. The course offered lectures and practical sessions for specific training of the complete team of professionals involved in quality in diagnostic radiology, comprising medical physicists, radiographers and radiologists. The training strengthened the multidisciplinary approach to developing and sustaining quality systems in diagnostic and interventional radiology.

The capacities of veterinary laboratories participating in project RER5023, 'Enhancing National Capabilities for Early and Rapid Detection of Priority Vector Borne Diseases of Animals (Including Zoonoses) by Means of Molecular Diagnostic Tools', are being enhanced through the development of strategies for control and eventual eradication of priority vector-borne diseases (VBDs) and the provision of training to improve detection and differentiation of priority VBD pathogens in animals and animal vectors. The project will make a substantial contribution to improving the preparedness and response capacities of national veterinary laboratories in early and rapid detection, and of veterinary services in the timely response to priority VBDs in the European region. Specialists in the field of veterinary diagnostics met in Tbilisi, Georgia, in April to discuss the techniques used to detect priority VBDs and the use of advanced technologies to differentiate the causal

pathogens, the harmonization of diagnostic techniques, and the exchange of validated and verified standard operating practices used for detection and differentiation of the causal pathogens.

Regional cooperation

Regional projects in the Europe region are accorded a high degree of importance, and Agency-organized NLO meetings in 2018 have helped to foster regional cooperation. In April 2018, NLOs endorsed the revised *Europe Regional Profile for 2018–2021* which establishes the priority thematic areas in the region. Together with CPFs, the Regional Profile provides guidance for the planning and design of the regional programme. In November, the NLOs also decided to review the Strategic Framework for the Europe Region which will provide high level strategic guidance for the regional programme.

Preparing for the 2020–2021 TC programme cycle

A workshop for new NLOs, NLA, counterparts and Lead Project Coordinators was held in February, attended by 63 participants from 23 Member States. In October and November, project design workshops presenting results-based management and the LFA methodology were held for new counterparts in Vienna, attended by over 40 participants from 18 Member States.

A second NLO meeting took place in November at IAEA headquarters, during which initial information on the new regional project proposals for the cycle 2020–2021 was presented and Member States provided their feedback and input for further development.

“In November, the NLOs also decided to review the Strategic Framework for the Europe Region which will provide high level strategic guidance for the regional programme.”



Participants at the NLO meeting in Vienna, Austria, November 2018. Photo: O. Yusuf/IAEA.

C.4. LATIN AMERICA AND THE CARIBBEAN

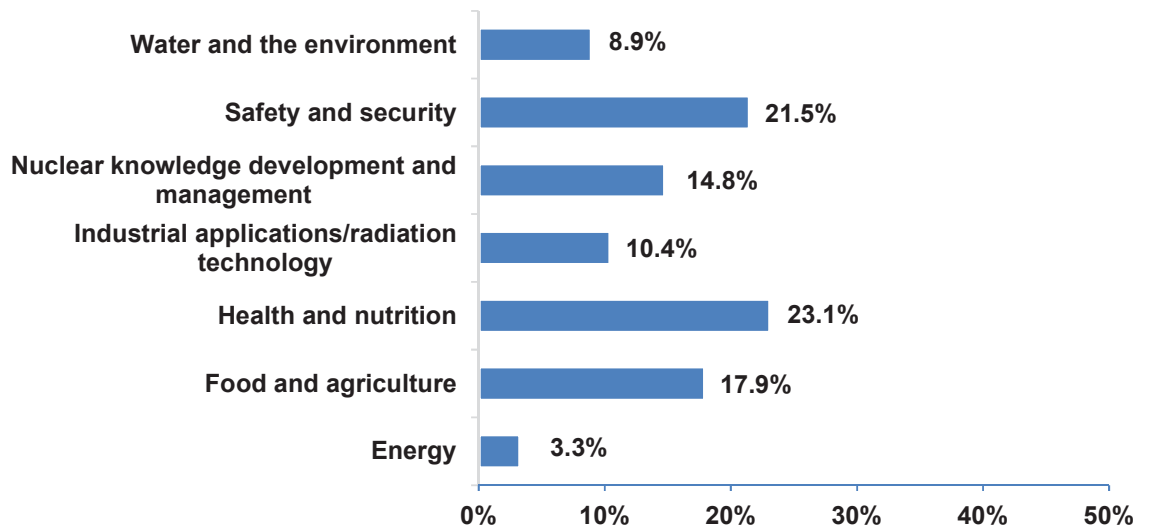


Figure 10: Actuals in the Latin America and the Caribbean region in 2018 by technical field.

Regional highlights in Latin America and the Caribbean, 2018

In 2018, the Agency provided support to 30 Member States in the Latin America and the Caribbean region through 151 national and 53 regional projects. Haiti is the only LDC in the region. The programme achieved an implementation rate of 90.1%. Twenty of the regional projects were initiated as part of the 2018–2019 TC cycle, and all were in line with the priorities established by the Regional Strategic Profile 2016–2021.

Six CPFs in the region were signed in 2018. The IAEA is taking active steps to involve new Member States from the Caribbean in the TC programme, particularly SIDS. The Agency co-signed the UNDAF of Nicaragua in 2018.

The President of Panama, His Excellency Mr Juan Carlos Varela Rodriguez, paid a visit to the Vienna International Centre on 15 October 2018. Discussions during his meeting with senior IAEA representatives included the support of the IAEA TC programme in the areas of health and agriculture, as well as Agency assistance to strengthen the country's capabilities for emergency preparedness and response to radiological incidents and emergencies, in preparation for a major international event in Panama in January 2019.

CPFs signed in Latin America and the Caribbean in 2018

Antigua and Barbuda	Nicaragua
Bolivia, Plurinational State of	Peru
Jamaica	Venezuela, Bolivarian Republic of



Visit of the President of Panama, HE Mr Juan Carlos Varela Rodriguez, to IAEA Headquarters, October 2018. Photo: IAEA

The government of Honduras officially established its Nuclear Energy Commission in 2018, following several years of capacity building supported by the IAEA technical cooperation programme in different fields where nuclear and isotopic techniques play an important role. This inter-institutional body will promote dialogue and coordinate efforts to promote the peaceful use of nuclear science and technology in the country. The establishment of the Commission is an important achievement for Honduras, as it will enable the country to further apply, in an inclusive, coordinated and safe manner, nuclear science and technology for the achievement of its development goals, especially in the fields of human health, water management and food and agriculture.

Project highlights

In 2017, the Government of Ecuador asked for assistance from the IAEA to explore the use of the SIT in the control of *Philornis downsi*, an invasive parasitic fly that is causing significant mortality in some bird species, particularly Darwin's finch nestlings, in the Galapagos Islands. The Agency convened an experts meeting in Vienna in June 2018 to develop an integrated pest management approach that could include SIT. The immediate requirements for advancing towards the control of *Philornis downsi*, using an integrated approach, were identified. The IAEA provided necessary expertise and equipment to the Galapagos National Park and will conduct relevant capacity building throughout 2019.

Ecuador is preparing to validate the use of SIT at a pilot scale with the support of ECU5029 'Improving Integrated Fruit Fly Management in Fruit and Vegetable Production Areas'. A small packing and release sterile fly facility was established with IAEA support for the purchase of equipment, and the first shipment of sterile medflies was received in Quito from the El Pino facility in Guatemala in November. Three million sterile flies are now being released each week in pilot areas where fruits are grown commercially. Half a million sterile files are being shipped to Galapagos to the Agencia de Regulación y Control de la Bioseguridad y Cuarentena para Galápagos (ABG) of the Ministry of Environment, for release in two separate locations on the islands of Santa Cruz and San Cristobal. The purpose of the release in Galapagos is to completely eradicate the fruit fly population from a biosecurity point of view. Agrocalidad personnel are providing training to ABG personnel, duplicating the capacity building they already received from the IAEA – a truly multiplying effect.

Ecuador's National Reference Water Laboratory, located in Ikiam Regional Amazonic University, was inaugurated in October at a ceremony attended by the Minister of Water and Environment and the University Rector. Equipment for the laboratory for the measurement of water isotopes was provided under ECU7007, 'Strengthening the Management and Water Quality Control of the Zamora River Basin through the Application of Isotope Techniques'. This will enable better national understanding of the behaviour of the hydrological cycle, leading to more efficient water usage and management.

The University Clinical Hospital of the Central University of Caracas, Bolivarian Republic of Venezuela, inaugurated its Molecular Biology Laboratory in December. The establishment of the laboratory was supported by VEN6018, 'Strengthening National Capacities in the Field of Radio Biology and Molecular Oncology'. The laboratory will provide services to the National Institute for Cancer Control in the Bolivarian Republic of Venezuela, and will, for the first time, enable the public health service to use radiobiological, genetic and molecular studies that support the provision of personalized treatments to Venezuelan cancer patients.

“Ecuador's National Reference Water Laboratory, located in Ikiam Regional Amazonic University, was inaugurated in October at a ceremony attended by the Minister of Water and Environment and the University Rector.”



Meeting of the ARCAL XIX Board of Representatives. Photo: Claire Karle/IAEA



Lydia Paredes, Director General of ININ, and Susana Petrick, President of IPEN, present the signed copies of the IPEN-ININ agreement to the ARCAL Board of Representatives. Photo: C. Karle/IAEA

Regional cooperation

Twelve new ARCAL projects in several fields of activity began implementation in 2018. The projects are in line with the Regional Strategic Profile for 2016–2021, which was prepared and adopted by ARCAL members to contribute to the fulfilment of the SDGs. At the XIX Meeting of the ARCAL Technical Coordination Board in Vienna in May, National ARCAL Representatives discussed and planned activities for 2019, approved the regional concept note for the 2020–2021 TC cycle, and approved an action plan for the communication strategy of ARCAL’s 35th anniversary.

The XIX Meeting of the Board of ARCAL Representatives was held in September on the margins of the 62nd IAEA General Conference, attended by ARCAL State Party representatives and Spain, as a strategic partner. The representatives reviewed activities carried out by different bodies of the Agreement and endorsed the new projects proposed for the upcoming project cycle.

During the meeting, representatives of the National Institute for Nuclear Research (ININ) of Mexico and the Peruvian Nuclear and Energy Research Institute signed a milestone agreement to foster cooperation between both entities in the areas of capacity building and joint research, particularly in the production of medicinal radio-compounds.

ARCAL officially launched the celebrations for ARCAL’s 35th anniversary, to be marked throughout 2019, during the Ministerial Conference on Nuclear Science and Technology in November 2018.

Preparing for the 2020–2021 TC programme cycle

Four National Design Workshops were held in the Latin American and Caribbean region in 2018 to facilitate the design of national and regional projects for the 2020–2021 TC programme cycle. The comprehensive workshops covered topics that included the TC programme mission, the LFA used for project design, and quality criteria. A Regional Project Design Workshop attended by 60 participants was held in October at the IAEA’s Vienna headquarters to review the proposed regional projects for the 2020–2021 project cycle. The workshop aimed to ensure that project designs met the quality criteria of the technical cooperation programme: commitment, relevance, sustainability and effectiveness; and that they contributed to addressing the development priorities of the participating countries and the region. Fourteen regional project proposals were completed at the workshop. The region has put forward 117 national and 25 regional projects for consideration for the upcoming programme cycle.

A Strategic Planning Tool for National Safety and Radiation Protection projects has been developed within the framework of regional projects RLA9084, 'Strengthening the Regulatory and Radiation Safety Infrastructure', and RLA9085, 'Strengthening Regional Capabilities for End Users/Technical Support Organizations on Radiation Protection and Emergency Preparedness and Response in Line with IAEA Requirements', with the aim of facilitating the identification and prioritization of problems and gaps in the area of safety and radiation protection on a national level. The tool was prepared with the support of experts and country teams from the Latin America and the Caribbean region in coordination with the Division for Latin America and the Caribbean, the Division of Radiation, Transport and Waste Safety and the Incident and Emergency Centre. It covers the seven Thematic Safety Areas and facilitates the identification and prioritization of gaps and problems with regard to the elements of the IAEA RASIMS and the Emergency Preparedness and Response Information Management System (EPRIMS) and, hence, the International Safety Standards. The tool applies a prioritization methodology already successfully used in the elaboration of the ARCAL Regional Strategic Profile for Latin America and the Caribbean 2016–2021.

Aiming to foster dialogue among national stakeholders on the status of national safety and radiation protection and to strengthen ownership of national projects, the tool facilitates the consolidation and evaluation of information provided by national country team members, such as the regulatory body, thematic safety area focal points, end-users, technical support organizations and secondary standards dosimetry laboratories. National country teams used the new tool in 2018 to carry out problem analysis and prioritization in preparing the design of national safety and radiation protection projects for the 2020–2021 TC programme cycle.

New NLOs and NLAs were introduced to TC programme tools such as PCMF and Intouch+ and gained an overview of the LFA at a targeted training event in February. Project sustainability and the importance of establishing strong strategic partnerships to improve the quality and effectiveness of technical cooperation in Member States were also discussed. The Secretariat emphasized the importance of CPFs and of participating in the UNDAF. In this context, the Agency's efforts to support linkages with the SDGs when completing CPFs was highlighted. The new NLOs and NLAs were encouraged to contact their UN Country Teams to identify possible national needs, create cooperation opportunities and to achieve a more active interaction with their UN counterparts. The participants also visited the IAEA laboratories in Seibersdorf and at the Vienna International Centre, taking advantage of the opportunity to see many applications of nuclear science and technology at first hand. Twenty-one representatives from fourteen countries attended the training course: Antigua and Barbuda, Argentina, Plurinational State of Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Jamaica, Panama, Paraguay, Peru, Bolivarian Republic of Venezuela..



A training course for NLOs from Latin America and the Caribbean, held in February 2018, included a visit to the IAEA laboratories at Seibersdorf. Photo: André Ghione/IAEA

C.5. INTERREGIONAL PROJECTS

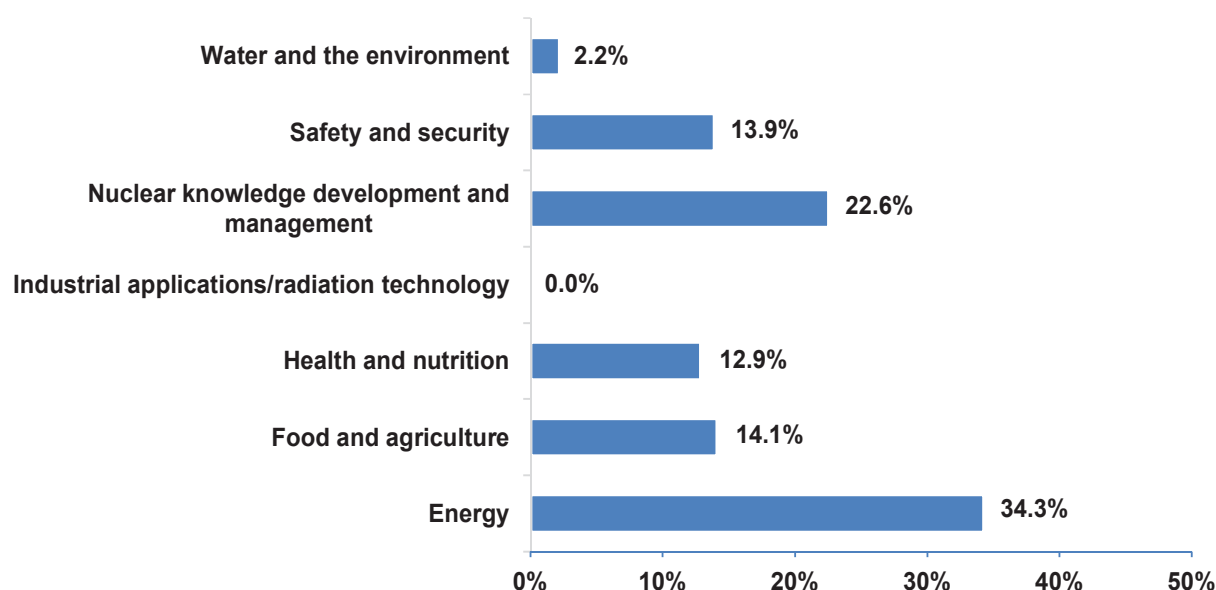


Figure 11: Interregional actuals in 2018 by technical field.

Interregional projects deliver technical cooperation support across national and regional boundaries and address the common needs of several Member States in different regions. In 2018, actuals under interregional projects totalled €6.8 million. Five interregional projects were closed during the course of the year.

Interregional projects are currently being used to deliver support to SIDS and LDCs. The projects are tailored to the specific needs of these groups, recognizing the shared nature of challenges they face, challenges which go beyond national and regional boundaries. INT0093, 'Applying Nuclear Science and Technology in Small Island Developing States in Support of the Sustainable Development Goals and the SAMOA Pathway', brings together countries in Africa, the Caribbean and the Pacific to assist their efforts to achieve the SDGs and the SAMOA Pathway in the marine environment, cancer, nutrition and food security. In 2018, SIDS representatives met to examine commonalities in these fields. INT0097, 'Contributing to the Development of Least Developed Countries by Building Human and Institutional Capacities in Nuclear Sciences and Technology', supports the alignment of the TC programme with the development goals of LDCs. At a meeting in 2018, participating countries discussed modalities to ensure that the TC programme addresses their specific needs in areas including human resource capacity building, strengthening radiation safety and regulatory infrastructure, and the facilitation of TCDC.

A further interregional project, INT0096, 'Establishing and Enhancing National Legal Frameworks for the Safe, Secure and Peaceful Use of Nuclear Energy and Ionizing Radiation', supported, in October, the IAEA Nuclear Law Institute held in Baden, Austria, attended by more than 60 participants from Member States from the different regions, participation of fellows in the OECD/NEA International School of Nuclear Law held in August-September in Montpellier, France, the Regional Workshop on Nuclear Law for Latin America and the Caribbean, held in June in Santiago, Chile, as well as bilateral legislative assistance for 17 Member States through review of draft legislation, national workshops and/or meetings.

INT2018 'Supporting Knowledgeable Decision-making and Building Capacities to Start and Implement Nuclear Power Programmes', now in its third year of implementation, continues to be a very effective mechanism to build capacity in countries embarking or expanding their nuclear power programme in line with the IAEA's Milestones Approach. In 2018, 26 events were implemented to enhance the skills and knowledge of more than 400



INT2018: Training Course on the Implementation of National Requirements for Nuclear Power Programmes, 20-24 August 2018, Finland. Photo: Radiation and Nuclear Safety Authority of Finland

participants who also benefited from the active exchange of information and experience among peers. By aligning donor support with recipient country needs, this year the project focused on topics such as licensing and construction, technology assessment and funding and finance, while still providing general training on nuclear infrastructure development.

Within the framework of project INT9182 'Sustaining Cradle-to-Grave Control of Radioactive Sources', support was provided for source removal activities initiated in Cyprus and Tunisia in 2018.

In June 2018, international students honed their skills in sampling and data interpretation at a two-week training course, supported by INT5153, 'Assessing the Impact of Climate Change and its Effects on Soil and Water Resources in Polar and Mountainous Regions'. The project is carried out in close cooperation with the FAO, to assess the impacts of climate change on land-water-ecosystem interactions.

During European Geosciences Union (EGU) General Assembly in 2018, twenty-eight presentations were made on the scientific results from INT5153's sampling campaigns in seven global benchmark sites. One session, 'Soil, water and sediment tracing for unravelling climate change dynamics in proglacial areas', was dedicated specifically to INT5153 project results. Additionally, a paper '137Cs and Nutrients for Tracking Soil and Vegetation Development on Glacial Landforms in the Lake Parón Catchment (Cordillera Blanca, Peru)' which resulted from the INT5153 expert mission to Peru, was published in *Science of the Total Environment*. Project results were also disseminated through presentations at the 27th International Polar Conference in Germany in March, and at Polar2018 in Switzerland in June.

A workshop on the role of Information Technology in Knowledge Management for Decommissioning was organized in Halden, Norway, in November, hosted by the Norwegian Institute for Energy Technology, under the framework of interregional TC project INT9183, 'Overcoming the Barriers to Implementation of Decommissioning and Environmental Remediation Projects'. Twenty-four participants from 19 Member States were joined by expert lecturers from the host organization, Germany and USA, together with an IAEA staff member. The event made decommissioning professionals aware of the potential

benefits of applying innovative methods to various aspects of nuclear decommissioning projects, taking advantage of recent advances in information technology and its application to knowledge management in decommissioning operations. An important feature of the workshop involved 'hands on' training, including group exercises in which the participants had to develop plant handling strategies for situations involving a potential dose uptake by workers. The participants were trained in the use of 3D modelling software and in the use of tools which enabled the direct estimation of dose levels for different postulated handling scenarios



Training course participants hike to the Pasterze glacier in the Austrian Alps, passing at this point the glacier position of 2015. Photo: IAEA

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

PACT highlights in 2018

In 2018 the Agency, through PACT, continued to support the efforts of low and middle income countries (LMICs) to integrate radiation medicine into national comprehensive cancer control programmes. Activities focused on reviewing national capacities, addressing funding gaps in IAEA cancer-related projects and mobilizing additional resources for sustainable cancer services.

imPACT reviews

imPACT review missions in 2018	
Afghanistan	Mauritius
Guyana	North Macedonia
Indonesia	Ukraine
Mexico	

Seven Member States received imPACT reviews, during which experts reviewed national cancer control capacities and needs. The resulting recommendations focus on strengthening these capacities, facilitate evidence-based decision-making and assist governments to prioritize cancer control interventions and investments. Reviews also form the basis for dedicated follow-up support by the Agency, such as the development of national cancer control plans, in cooperation with partners.

Afghanistan: imPACT review 6-10 May 2018. Access to health services is limited in Afghanistan with the majority of cancer patients being diagnosed at a late stage. Diagnosis and treatment capacities are not adequate to meet the population’s needs, especially as there are no radiotherapy services available. Despite this, Afghanistan has shown its commitment

to national cancer control through the establishment of a dedicated unit within the Ministry of Public Health. The review recommended that the national cancer strategic framework focus on cancer registration and surveillance, prevention and early detection, and on integrated cancer care with an initial emphasis on breast and childhood cancers, and palliative care.

Guyana: imPACT review mission 5-8 December 2018. The expert team concluded that Guyana’s healthcare infrastructure is ready for expansion and a more equitable distribution of diagnostic and treatment services across the country. Areas that would benefit from strengthening measures in the short term are: public sector pathology, immunohistochemistry and

molecular biology testing capacity; human resources for diagnosis; basic cancer services in regional hospitals; and accessibility of radiotherapy services, which are currently available at the private Cancer Institute of Guyana.

Indonesia: imPACT review 22-31 January 2018 (a previous mission was conducted in October 2010). In 2014, the Ministry of Health created the National Cancer Control Committee for the design and coordination of activities. Indonesia has yet to officially endorse a National Cancer Control Plan. The Review highlighted the need to increase the utilization of existing diagnosis and treatment facilities, increase nuclear medicine capacity and strengthen radiation safety infrastructure and practices.



Istiqlal Hospital Mammography Unit in Kabul, Afghanistan.
Photo: Tuuli Hongisto/WHO



Francisca Redondo, diagnosis and nuclear medicine expert, in discussion with Gilberto Medina Escobedo from the Pathology Department, Hospital 'Lic. Ignacio Garcia Tellez De Merida' in Yucatán, Mexico. Photo: A Benedicto/IAEA

Mexico: imPACT review 27 August-4 September 2018. Mexico faces challenges in the delivery of healthcare due to varying geographic access to diagnosis and treatment equipment, and patient access to various health care institutions. Experts provided recommendations related to the development of the comprehensive cancer control plan, increasing the amount of diagnostic equipment and reviewing its distribution, the formulation of a National Radiotherapy Development Plan (in collaboration with relevant institutions within the national health system), and to ensuring that diagnostic reference levels, dose constraints and patient release criteria for radiation safety are adhered to.

Mauritius: imPACT review mission 10-14 December 2018. Mauritius is already providing a number of advanced cancer services to patients. The expert team recommended several measures to further enhance national cancer control capacities. This included the review and finalization of the draft National Cancer Control Plan, the upgrade of diagnostic imaging equipment and strengthening of nuclear medicine services at Victoria Hospital and J Nehru Hospital, the upgrade of radiotherapy capacities, and upgrading regulations on exposure control.

North Macedonia: imPACT review mission 10-14 September 2018. The expert team concluded that the country has sufficient treatment capacity, that coordination and integration of cancer services should be enhanced, and multi-disciplinary tumour boards need to review patient diagnoses and formulate appropriate treatment plans. The radiation safety legal and regulatory framework would also benefit from more regular updates, and patient protection measures could be further strengthened.

Ukraine: imPACT review 14-18 May 2018. Ukraine has embarked on a reform of its national health system to increase access to diagnosis and treatment. The expert team recommended the review and standardization of protocols for diagnosis and treatment of the most common cancers, an increase in radiotherapy and nuclear medicine services, the alignment of educational programmes with international norms, and the institutionalization of the role of medical physicists and radiation technologists.

Information collection and analysis during imPACT reviews was facilitated through improved IAEA Country Cancer Profile documents, enhanced to include additional, specific information on partner activities in cancer control and national health systems.



IAEA radiation safety infrastructure specialist meets medical staff at Hospital Okhmatdyt in Kyiv, Ukraine. Photo: A Benedicto/IAEA

Concise country-specific, cancer-related fact sheets, which provided a snapshot of the cancer control situation in 40 IAEA Member States from the Agency's perspective, were developed to support TC programme planning and to facilitate information sharing within the IAEA.

Supporting national efforts for enhanced cancer control capacities

In close cooperation with the WHO, expert advisory assistance was also provided to Lesotho, Malawi, Mozambique, Namibia, Nicaragua and Viet Nam to support the development of national cancer control plans. An expert also assessed Albania's progress in

cancer control, and the contributions made by PACT partners.

The Agency collaborated with WHO and the International Agency for Cancer Research to convene a meeting of international cancer and public health experts and representatives from Member States to strengthen the current methodology for the conduct of assessments of national cancer control capacities (imPACT reviews). Priority recommendations arising from the meeting addressed the scope of imPACT reviews, the efficiency of tools and processes used for collection and analysis of cancer-related information, the quality and reliability of data gathered, and measuring the effectiveness of imPACT reviews.

The Agency also held a meeting to support Member States on integrated planning and implementation of sustainable radiotherapy services. Seven African Member States (Kenya, Madagascar, Mauritius, Nigeria, Senegal, Uganda and Zambia) participated and developed workplans for the future expansion of their radiotherapy programmes. The country workplans included activities and corresponding cost-estimates for workforce development, planning of appropriate infrastructure and equipment, as well as safety and security considerations for radiotherapy services.

Partnerships and outreach and resource mobilization

Current partners were increasingly engaged throughout the year, including international financing institutions, to raise funds to boost cancer control activities. The partnership

“Current partners were increasingly engaged throughout the year, including international financing institutions, to raise funds to boost cancer control activities.”



Delegates from Madagascar working with the IAEA to develop a workplan for sustainable radiotherapy services. Photo: J. Howlett/IAEA

with the Islamic Development Bank and the Organization for Islamic Cooperation (OIC), for example, was further strengthened through a series of jointly convened events. This included a meeting inviting Austrian-based financial institutions in Vienna to discuss how IAEA Member States can access funds, including through public-private partnerships and for large-scale cancer control infrastructure projects.

The Agency signed new Practical Arrangements with Childhood Cancer International in June. The partnership will combine the efforts of the two organizations in providing paediatric radiation oncology activities in low- and middle-income countries.

In June, the Islamic Development Bank, the African Development Bank and the IAEA organized a high-level seminar in the Philippines on 'Cooperation in Support of Asian Countries' Efforts to Tackle Cancer'. In July, the Agency supported a cancer awareness meeting in Burkina Faso, organized by the OIC and hosted by African First Ladies. The meeting brought together sixteen First Ladies from across the continent. In collaboration with the Commonwealth Secretariat, the Agency supported the organization of a high-level panel on 'Partnering to Tackle Cervical Cancer' at the 67th East, Central, and Southern Africa Health Community Health Ministers' Conference, which took place in November.

The Agency highlighted its active role in supporting Member States' efforts to address cancer through participation at key global health events, including the World Health Assembly in Geneva, Switzerland, the Stop Cervical, Breast and Prostate Cancers in Africa Conference in Maseru, Lesotho, and the World Cancer Leaders' Summit and World Cancer Congress, both in Kuala Lumpur, Malaysia. Speaking at a high-level panel at the World Health Summit in Berlin, Germany, the IAEA Deputy Director General and Head of Technical Cooperation, Dazhu Yang, stressed the critical role of nuclear science and technology for the early detection and treatment of cancer. The Agency's prioritization of assisting Member States to improve access to radiotherapy and nuclear medicine was illustrated with examples of technical cooperation projects to develop human resources and ensure the safety of staff and patients, as well as its efforts to support partnerships and mobilize resources.

At a TC side event on cancer at the 62nd General Conference, 'Delivering Results Against Cancer — Together we can make a change in fighting cancer', senior representatives from cancer centres in Albania, Brazil, Cambodia and Morocco highlighted the support received from the Agency in capacity building, technical advice and procurement of tools and equipment in the fight against cancer.

Collaboration on resource mobilization and awareness raising activities, supporting national strategies and programmes, and building health workforce capacities in comprehensive cancer control in LMICs was extensively explored with potential partners.

Resource mobilization

The government of the Russian Federation provided financial assistance through PACT and technical support for the implementation of five regional training courses in the country, implemented through the regional project RER6033, 'Strengthening Knowledge of Radiation Therapy Professionals (Radiation Oncologists, Medical Physicists and Radiation Therapy Technologists)'. Ninety-eight health professionals from 15 Member States, namely Armenia, Azerbaijan, Belarus, Bulgaria, Estonia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Montenegro, Republic of Moldova, Serbia, Turkmenistan and Uzbekistan, were trained in high accuracy radiotherapy, brachytherapy and commissioning, and quality assurance for radiotherapy treatment planning systems, as well as in protection, safety and accident prevention in radiotherapy.

The Agency also facilitated on-the-job training of two radiation oncologists and two radiotherapy technicians from United Republic of Tanzania as part of ongoing TC project URT6031, 'Strengthening and Expanding the Cancer Control Programme'. The training was hosted by leading cancer care facilities in Israel.



Radiation oncologists and radiation therapy technologist from ORCI attending fellowship at Assuta Hospital. Photo: Assuta Hospital

“The Agency helped secure the donation of an advanced radiotherapy machine from Elekta, an international oncology equipment manufacturer, for the Al-Bashir hospital in Amman, Jordan.”

As an example of a successful public-private partnership, the Agency helped secure the donation of an advanced radiotherapy machine from Elekta, an international oncology equipment manufacturer, for the Al-Bashir hospital in Amman, Jordan..

Member States, intergovernmental and non-governmental organizations, as well as the private sector continued to show support for the Agency’s cancer control activities. Extrabudgetary contributions were received from Monaco, the Republic of Korea and the Russian Federation, and donations from the United Nations Federal Credit Union and the United Nations Women’s Guild in Vienna provided funding for dedicated childhood cancer projects in Albania and Myanmar.

The Agency also provided proactive resource mobilization support to address cancer-related funding needs in Afghanistan, Lesotho and Namibia.

In 2018, as part of resource mobilization efforts, outreach to potential donors and partners began for a large initiative to expand nuclear medicine and radiotherapy services for women’s cancers, for cancer related training in Africa and for childhood cancers.

Audit of PACT and Follow up Actions

An audit by the Office of Internal Oversight Services in 2017 identified several issues related to programmatic, functional and coordination aspects of PACT and made relevant recommendations. In January 2018, the Director General established an Ad Hoc Task Force led by him and comprising the Deputy Directors General, Heads of the Departments of Technical Cooperation, Nuclear Sciences and Applications, and Nuclear Safety and Security to address recommendations concerning a unified approach for cancer control and the organizational structure of PACT. Following the review, a unified approach for cancer control through an enhanced coordination mechanism was established (as described in GOV/INF/2019/2). The objective of PACT is to assist Member States, within the Agency’s one-house approach, in cancer control and, working closely with all relevant Divisions, to introduce, expand and improve Member States’ cancer control capacity by integrating medical uses of radiation into a comprehensive cancer control programme that maximizes its effectiveness and public health impact. The Division of PACT will refocus its work in the following three main areas: comprehensive cancer control assessment, resource mobilization and support for the development of strategic documents.

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	Regional 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
NPCs	National Participation Costs
NPP	nuclear power plant
PACT	Programme of Action for Cancer Therapy
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 2018: Project Examples by Thematic Sector

Annex 1. Achievements in 2018: Project Examples by Thematic Sector

Health and Nutrition

REGIONAL HIGHLIGHTS

Human health and nutrition remains a priority for African Member States and, after food and agriculture, accounts for the highest disbursement of TC Funds. The IAEA also supports several countries in their efforts to establish or strengthen radiotherapy and nuclear medicine services, and strengthens regional capacities in education and training for radiation oncology and medical physics. For nuclear medicine services, the programme has supported the training and qualification of radiopharmacists to address the critical shortage of these skills in the region. The programme also supported strategic planning and quality management in nuclear medicine facilities. The Agency is also supporting assessment of national nutrition programmes to enable better evidence-based decision-making on how these can be improved.

In the Asia and the Pacific region, the TC programme continues to support Member States in addressing challenges related to human health and nutrition, placing a particular emphasis on child nutrition in the region. In 2018, 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 non-communicable diseases, including cerebrovascular and neurological diseases, as well as cancer and cardiovascular diseases. The Agency also transferred knowledge in very advanced nuclear medicine techniques such as proton therapy and boron neutron capture therapy. Regional capacity building supported enhancements in quality and safety for the application of nuclear medicine techniques, as well as dissemination and application of quality management systems.

Human health activities continue to be a major priority for Member States in Europe and Central Asia. The TC programme in the region covers a vast array of topics, including nuclear medicine, radiotherapy, nutrition, medical imaging and medical physics, as well as support for quality control and assurance in all aspects. Capacity building in the form of advisory missions and training, as well as infrastructure development, were addressed through the implementation of national and regional projects. Despite significant differences in the availability of facilities and the quality of medical services in the region, the need for training in the safe and effective use of relevant nuclear technologies remains a major priority in most Member States in Europe and Central Asia. To address the lack of training and continuous professional development opportunities for Russian speaking medical practitioners in the region, some courses have been offered in the Russian language. Finally, the diagnosis of non-communicable diseases, particularly in the field of paediatrics, has emerged as a regional priority in the region. Several national projects are responding to Member States' needs in the areas of diagnostics in paediatrics, positron emission tomography (PET) radiopharmaceuticals, nuclear techniques to evaluate interventions in obesity, and the radiation protection of patients.

The TC programme in Latin America and the Caribbean has a strong emphasis on many areas of health and nutrition. In 2018, several regional and national projects supported the strengthening of cancer centres in all areas, from human resource development to the procurement of equipment for radiotherapy, nuclear medicine and diagnostic imaging. In addition, support was provided to address other non-communicable and communicable diseases. In the area of nutrition, regional and national projects also provided support, for example in the form of activities to test for, monitor and alleviate the double burden malnutrition.



“In the Asia and the Pacific region, the TC programme continues to support Member States in addressing challenges related to human health and nutrition, placing a particular emphasis on child nutrition in the region.”



The commissioning of radiotherapy services at the Uganda Cancer Institute was attended by IAEA DG, Mr Yukiya Amano, and the Hon. Prime Minister of Uganda, Dr Ruhakana Rugunda. Photo: UCI

RADIATION ONCOLOGY IN CANCER MANAGEMENT

In January 2018, supported by TC project UGA6018, ‘Establishing Radiotherapy Services at the Cancer Institute’, Uganda inaugurated a new radiotherapy machine to resume essential treatment services for cancer patients after the country’s only previous such equipment had broken down in 2016. The inauguration ceremony was attended by the IAEA Director General, Mr Yukiya Amano. The IAEA provided technical and financial support for the re-establishment of radiotherapy services, contributing directly to SDG3 on good health and well-being. The IAEA assistance included the decommissioning of the old radiotherapy machine and the purchase of a new one on a cost-sharing basis with the Government. The IAEA also provided training for medical staff and advice on adapting the existing facility to accommodate the new machine.

Under project MLW6006, ‘Establishing a Cancer Treatment Centre’, the IAEA, with support from the OPEC Fund for International Development, assisted Malawi in developing a roadmap to operationalise the cancer treatment facility, which included the finalization of civil works, human resources capacity building and procurement of equipment.

In Lesotho, the IAEA has supported the establishment of the country’s first national radiotherapy facility. Under LES6002, ‘Establishing a Radiotherapy Facility and Building Human Resource Capacity for its Operation, Phase I’, two medical fellowships were launched, with training taking place in Ghana and Italy. Additional training was provided for one radiation oncologist and seven radiotherapy technologists.

As part of RAS6085, ‘Enhancing Stereotactic Body Radiation Therapy for Frequent Cancers in the RCA Region (RCA)’, training in quality assurance and quality control in stereotactic body radiation therapy was organized. Fifty national experts from across the Asia and the Pacific region benefitted from these courses, enhancing the quality and effectiveness of radiotherapy in the region.

In Cambodia, the first ever National Cancer Centre (NCC)—designed to cover up to 60% of the national demand for cancer care—was inaugurated and began operations in January 2018. This major national undertaking in Cambodia’s health sector was supported throughout by the TC programme, from the facility’s initial ground-breaking to the start of routine operations. Through KAM6001, ‘Improving Access to Radiotherapy and



DG Amano attending the Ground-Breaking Ceremony for the Construction of the National Cancer Centre, Phnom Penh, Cambodia in January 2014. Photo: Calmette Hospital

Establishing a Plan for Nuclear Medicine Services’, and KAM6002, ‘Improving the Quality of Radiotherapy and Nuclear Medicine’, the IAEA provided training to professional medical staff and procured state-of-the-art radiation medicine equipment for the diagnosis and treatment of cancer. In his congratulatory address at the inauguration ceremony of the NCC, delivered exactly four years after he participated in the NCC ground-breaking ceremony, Director General Amano said, “This is one of the most important projects we have undertaken together since Cambodia became an IAEA Member State in 2009.”

Following the provision of radiation monitoring, dosimetry and PET scanner equipment through the TC programme, the Royal Hospital (RH) and Sultan Qaboos University Hospital (SQUH), Oman, have significantly enhanced their capacities to quickly and accurately diagnose non-communicable diseases. In 2018, training courses in PET-CT acquisition, processing and QA/QC were provided under the project OMA6008, ‘Enhancing Quality Management Systems for Positron Emission Tomography–Computed Tomography Centres and a Cyclotron’, with a special focus on instrumentation for the detection, measurement, and imaging of radioactivity. In addition, an expert mission supported the development of a Quality Management Manual for cyclotron-produced radiopharmaceuticals. The staff of the Nuclear Medicine Centres in RH and SQUH agreed that their understanding of the Quality Management Audits in Nuclear Medicine Practices (QUANUM) process had improved, and they shared their confidence in preparing for external audits. The expert mission also facilitated a workshop on the use of cyclotrons for the production of radiopharmaceuticals, enhancing the familiarity of participants with the components, underlying physics and operation of cyclotrons. Finally, the workshop participants received guidance in all the remaining aspects of managing a Nuclear Medicine Centre, including record-keeping and documentation, inspections and audits, radioactive waste management and emergency preparedness and response.

To coincide with the support provided through OMA6008, efforts were made to enhance the radiation protection of patients and professionals in nuclear medicine and radioactive waste management through the project OMA6007, ‘Establishing Quality Management Systems for Nuclear Medicine Radiation Oncology and Diagnostic Radiology’. The Quality Management Manual is under finalization by the RH and SQUH but new quality assurance modalities are already being implemented in accordance with the protocols already finalized.

In Romania, considerable efforts have been made to support the country’s improvement of its national human and institutional radiotherapy capacities, and to further ensure the



OMA6008: IAEA experts with the counterpart Dr Naima Khamis Al-Bulushi, and some of the local participants. Photo: S. Somanesan/IAEA expert

sustainability of the national radiotherapy system. In 2014, an important initiative was initiated by the Ministry of Health of Romania, in collaboration with the World Bank, to establish and strengthen public radiotherapy centres. In 2018, the country's first linear accelerator (linac) was supplied to a hospital in Romania under this collaboration, and between 10 and 12 public radiotherapy departments will be established or upgraded in coming years under the Ministry of Health/World Bank project. However, most radiotherapy departments in Romania's hospitals face a shortage of trained, qualified and skilled human resources, especially medical physicists and radiation therapy technologists. Through the IAEA TC project ROM6019, 'Strengthening Radiotherapy Services through Human Resource Capacity Building', the IAEA is helping Romania to train medical specialists to properly use modern radiation oncology equipment for the benefit of patients, to support and supervise the commissioning of such complex equipment and, finally, to provide specialized training to Romanian medical professionals in advanced radiotherapy techniques.

Of the 10 000 new oncological patients registered in Azerbaijan annually, almost 80% need radiotherapy. The National Center of Oncology (NCO) is the only big public oncology centre in the country, and is responsible for the treatment of almost all cancer patients. The Nuclear Medicine Department of the NCO is divided into two units: one is located at the main medical campus and performs single photon emission computed tomography (SPECT) studies and treatment procedures, while the other, located off-campus at a new site, performs PET procedures. Currently, the two gamma cameras in the unit on-campus are fully booked for oncology exams (mostly bone and thyroid scans). In the framework of the project AZB6011, 'Increasing Capacity of External Beam Radiotherapy Service of the National Centre of Oncology by Installing a High Energy Linear Accelerator', a SPECT/CT gamma camera was procured for the new site that will be able to offer cancer patients both PET and SPECT procedures. This will help to meet the increasing need for oncology exams, and patients with other diseases who require nuclear medicine procedures such as cardiology scans can now also be treated in a more effective manner.

In Slovenia, the national project SLO6006, 'Improving Safety and Quality of Radiology Services through the Development of Medical Physics Departments and Enhancing the Theranostic Nuclear Medicine Approach', is working to upgrade the medical physics services available in the country by promoting the important role played by medical physics experts, qualified experts in medical physics (QEMPs), radiation protection experts (RPEs), and qualified experts in radiation protection in the optimization and improvement of the safety and quality of radiological procedures. In 2018, three hospitals in Slovenia received expert support and advice on medical physics and radiation protection issues, such as the involvement of radiation protection experts in the daily clinical work of medical physics departments.

Substantial progress was made in 2018 under the project TAD6006, 'Providing Radiotherapy Services in the Sughd Regional Cancer Centre', as a new radiotherapy machine (Co-60 unit) was installed in Khujand in the Sogd region, in the north of Tajikistan. This was the final activity under TAD6006, under which the Agency provided assistance to support to upgrade and establish radiotherapy services in Tajikistan, both in Dushanbe and in Khujand, through the provision of modern equipment, training and expert advice on technical and clinical aspects. The Government of Tajikistan continues to place a high priority on strengthening its national health services. Reflecting this commitment, in 2018, the IAEA received the first-ever government cost-sharing contribution from the Ministry of Health of Tajikistan in support of upgrading radiotherapy services. With the establishment of the new radiotherapy center in Khujand and enhanced services in the capital, cancer patients in Tajikistan will have greater access to treatment and will benefit from the ongoing support of the IAEA TC programme in strengthening oncology services in the country. A new four year project was launched in 2018, TAD6007, 'Strengthening the Central and Northern Oncology Centres', to assist with advancing radiotherapy service in the northern Sughd region and enhance radiotherapy services in Dushanbe. The effort is focused on capacity building and builds on the earlier TC project.

In 2018, Nicaragua's National Radiotherapy Centre (CNR) installed a cobalt-60 brachytherapy device, acquired under TC national project NIC6019, 'Building Capacity in Cancer Radiation Treatment'. The IAEA provided technical support for the commissioning of the equipment, as well as human resource capacity building to support its use. As of August 2018, the brachytherapy device had been used to treat 80 patients with uterine cervix cancer, one of the most common cancers treated by healthcare professionals at the CNR. In parallel, a linac was delivered to the CNR at the end of 2018, and installation is being completed with the support of the manufacturer.

In 2018, support was provided through project GUA6020 'Establishing a High Dose Rate Brachytherapy Programme for Gynaecological Tumours', to assist the National Cancer Institute 'Dr. Bernardo del Valle' in establishing its new high dose rate brachytherapy programme to treat patients with gynaecological tumours. The project provided the training and equipment required to make this a reality. With the new programme, the



*TAD6006: Delivery of source for the new radiotherapy machine in the regional cancer centre.
Photo: Sogd region Oncological Center*

country increases its annual capacity to treat patients with cervical cancer by 50%, leading to a 60% reduction of the waiting list.

In Colombia, the National Cancer Institute (INC) in Bogotá works as a public institution for the comprehensive control of cancer, conducts specialized research and capacity building, and supports the development of public health policies. More than 6000 new cases of cancer are treated annually, with 70% of the INC patient population belonging to the most vulnerable social groups in the country. The INC nuclear medicine service was established with significant support from a national IAEA technical cooperation project, and now acts as a national training centre. In 2018, a total of 240 professionals—active in three hospitals in Bogotá, Medellín and Cali—received training on good manufacturing practices (GMP), as well as on validation processes and quality assurance for the preparation of radiopharmaceuticals in hospitals.

NUCLEAR MEDICINE AND DIAGNOSTIC IMAGING

In Montenegro, an ongoing project MNE6005, 'Improving Paediatric Diagnostic in Computed Tomography Examinations', has supported the procurement of a new computed tomography (CT) system, to be installed in 2019, that will contribute to the improvement of the national children's health care system – a national priority for Montenegro – as well as capacity building activities to enable the safe and efficient use of the equipment. Prior to the procurement of the equipment, children who required examinations in a spiral mode (necessary for abdomen, chest, spine or cervix examinations) had to be sent to the diagnostic department for adults. The new CT system was procured specifically for the purpose of performing childrens' examinations and will be the only CT system of such specifications in the country. Montenegro has agreed to make the upgraded facility available to children from neighbouring countries, further enhancing regional access for pediatric cancer care.

In Estonia, building on the progress of previous national projects, two national nuclear medicine projects were launched in 2018: EST6019, 'Strengthening Capabilities for Stereotactic Radiotherapy Services in the Tartu University Hospital', and EST6020, 'Upgrading Radiotherapy and Nuclear Medicine Applications'. Under these projects, various specialized training opportunities for medical practitioners were provided to



SRB6011: Participants at the IAEA/EANM European School of Multimodality Imaging and Therapy Autumn.
Photo: Dr. Vera Artiko, Serbia



*Radio-guided Surgery Training Course, Cuba.
Photo: Adlin Lopez/Hospital Hermanos Ameijeiras, Cuba*

assist in the development of an advanced platform for the use of stereotactic radiotherapy services. In addition, the procurement of a linac, supported by government cost-sharing, is in progress. The projects are contributing to an improvement in cancer diagnosis and treatment across in the country.

The project SRB6011, 'Widening Clinical Applications of PET/CT Using FDG and non-FDG Radiopharmaceuticals in the Diagnosis of Chronic Diseases', supported the training of nine nuclear medicine specialists and one electronic engineer between 2016 and 2018, and additionally provided a laminar flow hood, an ultrasound machine and a small field of view gamma camera for the Centre for Nuclear Medicine of the Clinical Centre of Serbia. This assistance contributed to making disease diagnosis more efficient and effective, and has been especially beneficial for patients with thyroid diseases, as the doctors of the Clinical Centre can now prescribe appropriate therapy with more precise doses of radionuclides. The project succeeded in improving clinical care for patients with carcinomas, infections, inflammations, cardiovascular, neurology and endocrinology diseases in Serbia and the whole Balkan region. Following activities organized under the national project, the Centre improved its work in accordance with IAEA/QUANUM requirements.

As a European Association of Nuclear Medicine/ European Union of Medical Specialists (EANM/UEMS) accredited nuclear medicine department and training centre for the period 2016–2020, the Clinical Centre hosted the IAEA/EANM European School of Multimodality Imaging and Therapy Autumn in September, and facilitated the exchange of knowledge among nuclear medicine professionals in the region. In addition, the Centre introduced standards for the accreditation of nuclear medicine professionals in Serbia, through the Agency for Accreditation of Health Care Institutions of Serbia under the Ministry of Health Republic of Serbia. The Centre is expected to be the first nuclear medicine department with such an accreditation in Serbia by the end of 2019.

Nearly 50 professionals from nine hospitals across Cuba participated in a multidisciplinary course in radio-guided surgery, held within the framework of project CUB6027, 'Improving the Diagnosis and Treatment of Cancer by Setting Up and Strengthening Radioguided Surgery Applications'. The course, the first of its kind to be delivered in Cuba, was designed to improve the level of medical care provided to patients with cancer and other related diseases, in line with the highest levels of international recommendations. This project is part of a national programme to control cancer in the country, and aims to ensure the sustainability of human resources as well as infrastructural capacity to establish, develop and optimize the clinical uses of radio-guided surgery for diagnosis and treatment.



RAF6054: Training course participants in the quality control laboratory of pharmaceuticals.
Photo: Centre for Radioisotopes and Radiopharmaceuticals Technology, BATAN

RADIOISOTOPES, RADIOPHARMACEUTICALS AND RADIATION TECHNOLOGY

Under project RAF6054, 'Strengthening and Improving Radiopharmacy Services (AFRA)', IAEA supported a regional training course, entitled 'Train the Trainers on Preparation and Quality Control of Tc-99m Radiopharmaceuticals for AFRA Member States (MSs) with GMP Aspects', in Jakarta, Indonesia for two weeks. The training course was carried out within the framework of the Practical Arrangements between the IAEA and the Government of Indonesia, which was concluded in February 2018. The regional training course is considered to be the first training organized between Indonesia and AFRA, and was designed to enhance TCDC and to strengthen South-South cooperation in the area of radiopharmacy. Through this hands-on training, new radiopharmaceuticals which combat cancer and other infectious diseases were introduced to 20 senior radiotherapists. They were also updated on the latest considerations in the design and performance of Tc-99m radiopharmacy unit services according to GMP criteria.

A final project review meeting on the application of emerging targeted therapeutic radiopharmaceuticals took place in December 2018 in Putrajaya, Malaysia. The meeting, hosted by the National Cancer Institute with the support of the Malaysian Nuclear Agency under project RAS6082, 'Supporting the Applications of Emerging Targeted Therapeutic Radiopharmaceuticals for Radionuclide Therapy', was attended by 25 participants from 16 Member States in the region. In total, around 110 people from participating Member States have been trained in various aspects of therapeutic radiopharmaceuticals under the project. A hands-on training course on the use of alpha emitter radiopharmaceuticals was held in Singapore under the same project.

As new therapeutic radiopharmaceuticals have been developed or clinically tested in recent years, several Member States participating in the project are now conducting tests as part of the drug registration process, including Bangladesh, Indonesia, Islamic Republic of Iran, Jordan, Lebanon, Malaysia, Pakistan, Philippines, Syrian Arab Republic, Thailand and Viet Nam. In addition, two guiding documents have been prepared on the production, quality control and dosimetry of radiopharmaceuticals for radio synovectomy and bone pain palliation applications, for further distribution to Member States as IAEA publications.



Visiting the Nuclear Pharmacy Unit of the National Cancer Institute, Ministry of Health of Malaysia, Putrajaya, Malaysia. Photo: Mykola Kurylchyk/IAEA

The project BYE6011, 'Implementing Positron-Emission Tomography (PET) Including the Production of F-18 and C-11 based Radiopharmaceuticals at the Alexandrov National Cancer Centre', focused on the safe and sustainable radiochemical production of PET-radiopharmaceuticals, and their application in nuclear medicine. In order to decrease the exposure of radiochemical personnel to radiation and to improve national capacities for the synthesis of F-18 labelled molecules, one heavy shielded hot cell and one cassette synthesis module were procured under the project. The Agency also assisted Belarus in organizing training for radiochemical and medical personnel in advanced PET centres in Europe. One on-site, two-week training course, focused on the practical aspects of C-11 and F-18 chemistry, and was conducted using equipment installed at the Minsk PET centre. Following the implementation of the project, the sensitivity and specificity of cancer diagnostics have improved significantly, which has had a strong, positive impact on the state of health of patients in Belarus.



Visiting the TRIGA PUSPATI research reactor at the Malaysian Nuclear Agency, Bangi, Malaysia. Photo: Malaysian National Agency

DOSIMETRY AND MEDICAL PHYSICS

Project ARM6012, 'Strengthening Calibration Services at the Secondary Standard Dosimetry Laboratory', supported the establishment of an x-ray calibration system used for calibrating dosimeters at the secondary standard dosimetry laboratory (SSDL) at the Center for Standardization, Metrology and Certification of Armenia. In 2018, the project enhanced the capabilities of the centre through the installation and commissioning of an X-ray calibration system, and on-site training of staff, enabling the system to become operational. Expert missions on the use of X-ray calibration systems, quality management systems, and radiation protection and diagnostic radiology calibrations were also provided through the project. As a result, the SSDL is now providing calibrations and verifications for dosimetry equipment used in radiation protection and diagnostic radiology in the country.

In Serbia, project SRB6012, 'Upgrading of Calibration Service for Medical Applications of Ionizing Radiation', supported training for four staff between 2016 and 2018 and provided SSDL dosimetry equipment and an X-ray calibration system for the Vinca Institute of Nuclear Sciences. A new water phantom, holders, and dosimetry equipment contributed to improved accuracy of measurements and enabled the calibration of new dosimeter types. A newly commissioned X-ray system, equipped with monitor chamber, dosimetry and auxiliary equipment has enabled the extension of calibration services to mammography dosimeters and radiotherapy chambers for kilovoltage X-rays, and significantly improved overall accuracy measurements. The overall number of calibrations and irradiations in X-ray beam has increased significantly, from 99 in 2017 to over 150 in 2018. The project also supported an expert mission to test the dosimetry audit protocol, leading subsequently to the establishment of a protocol for in-hospital dosimetry audits. The project has made an important contribution to improving the safety and quality of radiotherapy procedures in Serbia.

Until recently, Bosnia and Herzegovina did not have metrology infrastructure in the field of ionizing radiation. Although radiological safety regulations require the calibration and verification of the measuring instruments used for radiation protection, implementation of these regulations was very difficult without an accredited laboratory in the country. Radiation protection equipment had to be sent abroad for calibration, which was costly and time consuming. The Institute of Metrology of Bosnia and Herzegovina initiated the development of metrology infrastructure by preparing laboratory premises in Banja Luka and implementing the Instrument for Pre-Accession Assistance 2008 European Commission project. To support the full operationalisation of the laboratory, IAEA technical cooperation projects have provided equipment and training for laboratory personnel, and supported the preparation of the laboratory for accreditation. As a result of these efforts, calibration services have been established in the SSDL of Bosnia and Herzegovina, and the laboratory has been approved as a full member of the IAEA/WHO SSDL Network as of December 2018.

NUTRITION

During 2018, a regional meeting was held to review the results achieved under RER6034, 'Applying Nuclear Techniques to Design and Evaluate Interventions to Prevent and Control Obesity in Adolescents in South-Eastern Europe', and a regional training course on data management was delivered. Two scientific visits were made to Glasgow, United Kingdom, to enable participating Member States to acquire first-hand experience in an advanced laboratory applying stable isotopes to the assessment of nutritional status. In addition, project counterparts presented the results of their work during two international events: the 25th European Congress on Obesity; and the IAEA Symposium on Understanding the Double Burden of Malnutrition for Effective Interventions.

Eleven countries finalized study protocols under project INT6058, 'Contributing to the Evidence Base to Improve Stunting Reduction Programmes', and all have started data collection.

Food and Agriculture

REGIONAL HIGHLIGHTS

Food and agriculture accounts for the highest disbursement of TC funds in Africa. The strengthening of laboratory capacities for the diagnosis and control of transboundary and zoonotic diseases remains a major focus area in the region. Several Member States are integrating the SIT in area wide integrated pest management programmes against tsetse and fruit flies. The Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC) is an important partner. Progress is also being made in using SIT against malaria mosquitoes. In food safety, the programme has improved the regional infrastructure for measurement and standards, and regional networking. The development of new drought tolerant and disease resistant crop varieties, coupled with improved crop nutrition and soil and water management is contributing to reducing food insecurity and to addressing the adverse effects of climate change.

Food security remains a priority in Member States in the Asia and the Pacific region. Several countries in the region received extensive support through regional projects to eradicate fruit flies and mosquitoes using SIT, and to climate-proof production systems for staples such as rice through the application of nuclear-related techniques in plant breeding and water management. Regional and national projects have enhanced human capacity in using nuclear and related techniques to achieve improved crop yield. The management of water and soil using nuclear and other analytical techniques was also an area of focus in 2018.

While there are fewer national and regional projects in the area of food and agriculture in Europe, Member States recognize the benefits nuclear and nuclear-derived technologies can offer. Support provided in 2018 for mutation breeding and for the early detection of animal disease enabled countries to strengthen crop production resilience, and to improve the detection capacity of veterinary services to respond to outbreaks of animal disease.

In Latin America and the Caribbean, supporting food safety and agricultural development remains a top priority. The TC programme is assisting Member States by addressing problems such as pest control, livestock health and water and nutrient management of key crops in the face of climate change. At both national and regional levels, capacities to face these challenges are being supported and strengthened. With Caribbean Member States identified as SIDS, additional climate change measures are necessary to support national economies that rely heavily on the export of crops, and to support the food needs of their own populations.

CROP PRODUCTION

The IAEA continued to collaborate with the Institute of Agronomic Sciences of Burundi (ISABU) in 2018, through the TC project BDI5001, 'Improving Cassava Productivity through Mutation Breeding and Better Water and Nutrient Management Practices Using Nuclear Techniques'. The Institute, headquartered in Bujumbura with several sub-centres around the country, has laboratories for soil analysis and plant breeding, which work on plant material irradiated in Seibersdorf to get improved varieties. ISABU's Soil and Water Management Unit studies cassava nutrient requirements, while the Plant Pathology and Cassava Units oversee breeding to achieve cassava disease resistance and the Tissue Culture Laboratory contributes to cassava multiplication for line mutants. The results are disseminated to end-users which include farmers and private farm owners involved in cassava production.



“Food and agriculture accounts for the highest disbursement of TC funds in Africa. The strengthening of laboratory capacities for the diagnosis and control of transboundary and zoonotic diseases remains a major focus area in the region.”



Tissue Culture Laboratory at ISABU, Gisozi, Burundi. Photo: Felix Barrio/IAEA

A TC project in Malaysia is supporting the application of an integrated agricultural approach that brings together a new rice variety, biofertilizer and plant growth promoter. The new approach has made a considerable difference to rice farmers, whose harvest yields – and with it their income – increased by 40% in the last two growing seasons thanks to the ‘nuclear package’. The package, a set of products and services developed by the government’s nuclear agency, Nuklear Malaysia in collaboration with the IAEA, is designed to help the country’s rice farmers cope with low soil fertility and changing weather patterns, including more erratic rainfall and longer dry spells.

More than 150 mutant lines of bioenergy crops, suitable for growth on marginal land, have been produced under RAS5070, ‘Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques (RCA)’ from 2016 to 2018. Guidelines on soil and water use efficiency for the optimal use of this kind of marginal land for bioenergy crops were developed, and more than 70 lines were under field trial on marginal land. Some varieties show promising results. Also in 2018, Nitrogen-15 and Carbon-13 isotopic techniques were introduced and applied successfully in participating countries to study the efficiency of soil, water and nutrient use for bioenergy crop cultivation on marginal land. In addition, protocols for screening target ‘green’ traits in selected crops have been formulated under RAS5077, ‘Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties (RCA)’, which have contributed to an increase in environmentally friendly crop productivity through the application of mutation techniques and related biotechnology.

In Oman, national recommendations on the development of strategies, plans and protocols for the quantification of evaporation and transpiration have been developed under the project OMA5006, ‘Using Isotopes and Nuclear Techniques in Integrated Water, Soil and Nutrients Management to Optimize Crop Productivity’. In addition, training provided through the project has built the capacity of counterparts in the basic application of nuclear and isotope techniques in soil-water-nutrient and plant management.

Project BUL5015, ‘Increasing Productivity and Quality of Basic Food Crops’ is addressing the problem of drought stress in Bulgaria, which is a major factor limiting the yield and yield stability of crops. The project is focused on the development of drought tolerant mutant lines of targeted crops (potato and pepper). During 2018, the first year of implementation,

an expert mission took place to provide counterparts with technical information about using nuclear techniques for crop improvement. Individual training on mutation breeding, biotechnologies and the use of proteomics techniques in crop breeding was also provided under the project.

Several advanced mutant lines are already in the process for official release in the Latin America and the Caribbean region, as a result of the regional project RLA5068, 'Improving Yield and Commercial Potential of Crops of Economic Importance (ARCAL CL)'. These new crop varieties possess tolerance to drought, extreme temperatures and salinity, as well as resistance to diseases and herbicides. New crop varieties will also have enhanced potential to face the effects of climate change. The results of the project, now in its third year of implementation, were presented in Panama City in June. The project has been carried out in cooperation with the FAO.

AGRICULTURAL WATER AND SOIL MANAGEMENT

National training on land degradation and the competitive advantages of using nuclear techniques to assess it took place at the Agricultural Research, Education and Extension Organization, Tehran, Islamic Republic of Iran, in November 2018 under IRA5013, 'Investigating the Effects of Deforestation and Afforestation on Soil Redistribution'. Twenty-two participants from various institutions attended, mainly from the fields of forestry, agriculture and soil management. The participants were given hands-on computer training, using different models to assess land degradation using data collected within the project framework. The network established under this project is a good example of interaction and has paved the way for continuous cooperation between different institutions that deal with the problem of soil erosion at a national scale.

Climate change is threatening the Latin America and the Caribbean region. Higher temperatures, changing rainfall patterns and the increased incidence of extreme weather events are endangering agricultural production, resulting in a tremendous challenge for the region to produce sufficient food to meet the demands of a growing population. On-farm water use efficiency must be improved through best farm practices, including efficient irrigation management, improved soil fertility and reduction of nutrient losses through leaching. The project RLA5077, 'Enhancing Livelihood through Improving Water Use Efficiency Associated with Adaptation Strategies and Climate Change Mitigation in Agriculture' (ARCAL CLVIII), focuses on evaluating mitigation-adaptation strategies for climate change that could lead not only to improved water use efficiency, but also to a reduction in fertilizer losses. Recently 13 countries from the region participated in a regional training course on the use of stable isotopes (Oxygen-18 and Deuterium) to assess water use efficiency. The training course on the partition of evapotranspiration into soil evaporation and crop transpiration helped to improve water use efficiency at different field levels and provided critical information to farmers, helping them to understand the impact of their farming techniques on water loss through transpiration and evaporation. Training was also conducted on the use of nitrogen-15 to trace nutrient losses through deep drainage, with the goal of minimizing nitrate pollution.

LIVESTOCK PRODUCTION

The capacities of veterinary labs of Member States participating in RAF5068, 'Improving Livestock Productivity through Strengthened Transboundary Animal Disease Control using Nuclear Technologies to Promote Food Security (AFRA)', which conducted its final coordination meeting in the first half of 2018, has increased significantly. For example, the project has notably strengthened the Accra Veterinary Laboratory of the Veterinary Services Directorate of Ghana, which is now assuming the status of a regional support laboratory



Realtime PCR Machine (Pikoreal -24) enabled the establishment and routine application of molecular techniques. Photo: Joseph Awuni

in the West Africa sub-region and contributing immensely to the control of transboundary animal diseases in Ghana and the entire sub-region.

In the Central African Republic, the IAEA is building capacity through TC project CAF5010, 'Building National Capacities for the Diagnosis and Control of Animal Diseases and for Increasing Animal Production'. The project is also contributing to furnishing the laboratories of the Ministry of Livestock to enable the diagnosis and control of animal diseases. Essential infrastructure was destroyed in the Central African Republic after years of civil confrontation, so achievements enabled by projects like this have a great impact on the local economy.

In Europe, project RER5023, 'Enhancing National Capabilities for Early and Rapid Detection of Priority Vector Borne Diseases of Animals (Including Zoonoses) by Means of Molecular Diagnostic Tools', is enhancing the capabilities of veterinary laboratories officially designated as responsible

for the diagnosis of animal and zoonotic diseases and VBDs. The project supports the dissemination of diagnostic tools for early and rapid detection and differentiation of VBDs, thus assisting the development of strategies for control and eventual eradication of priority VBDs. Support has also included training to improve capacities for detection and differentiation of priority VBDs pathogens in animals and animal vectors through three regional events.

INSECT PEST CONTROL

The insectarium in Bobo-Dioulasso, established with support from the IAEA and the African Development Bank under project BKF5020, 'Strengthening the Insectarium to Create Agropastoral Areas Permanently Liberated from Tsetse Flies and Trypanosomiasis', is capable of producing 300 000 sterile male flies per week, and is supplying sterile male flies for the programme in Burkina Faso and neighbouring countries that are infested with the same tsetse fly species. The size of the colony is above 900 000 productive females and is growing exponentially.

An expert mission in 2018 assisted with the assessment and entomological study of the lesser date moth (LDM) in Oman, supported through TC project OMA5007, 'Strengthening Sterile Insect Technique Based Area-Wide Integrated Management of Date Palm Pests'. A range of actions to be taken by national authorities were identified to improve the prospects for success in mass rearing to support SIT and enhance the production of date crops. Another expert mission assisted the counterparts with the development of a rearing system for LDM including the development of a suitable artificial rearing medium. Oman's capacity for plant management was increased with the provision of data loggers and a plant growth chamber.

In rural Thailand, TC project THA5052, 'Developing Sustainable Management of Fruit Flies Integrating Sterile Insect Technique with other Suppression Methods', which closed in 2018, assisted national authorities in protecting premium export fruits such as durian and mangosteen. Beforehand, many farmers were forced to use vast amounts of pesticides in order to maintain fruit at an acceptable standard for export. Despite the pesticide application, hundreds of millions of dollars' worth of fruit were damaged by the oriental fruit fly each year. Farmers are now applying the SIT, and receive 5 000 000 sterile pupae each week from a facility in Pathumthani, which allows them to export 4000 tons of high quality eco-friendly fruit each year.

Under project MEX5031, 'Using the Sterile Insect Technique to Control Dengue Vectors', the IAEA has been providing support to Mexico's mosquito mass-rearing facility in Rio

Florida (Tapachula, Mexico) in mosquito mass-rearing, quality control, irradiation, marking and chilling. The pilot trial for mosquito release includes a control area (Rio Florida, 20 ha), and a treated area (Ejido Hidalgo, 24 ha). Before the SIT pilot trial, no vector control strategy was conducted in either area. When baseline data collection and community engagement activities began, the communities received basic information about breeding sites and control methods including SIT, although mosquito releases were initiated in October 2018 only in the treated site (Ejido Hidalgo). In both areas the presence of *Aedes aegypti* and *Aedes albopictus* is constant, but in Rio Florida the mosquito density (based on ovitrap) is clearly higher than in Ejido Hidalgo. The project released around 1.1 million male mosquitoes in 2018. Of those, around 427 000 were released by air (using a drone) and around 644 000 on the ground. The plan is that in the near future the releases will be made only by drones.

A three-year project involving 18 countries, 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 CCLI)', ended in 2018. Within the framework of the project, 90% of the participating countries either established or strengthened surveillance networks for the early detection of non-native invasive fruit fly species. Preventing pest outbreaks is the most effective approach to avoid severe economic losses – the outbreak of the Mediterranean fruit fly (or medfly) in the Dominican Republic in 2015 caused an economic loss of over US \$40 million in only ten months due to quarantine restrictions imposed by trading partners. The outbreak was finally eradicated from the Dominican Republic in July 2017, which not only benefitted the horticultural industry of that country but protected the plant resources of the whole Caribbean region and of the neighbouring countries in mainland (Mexico and the USA).

An outbreak of *Bactrocera scutellata* (Hendel) was recorded on 2 February 2018 in Manzanillo, Colima, Mexico, and declared eradicated eight months later in September 2018. Within the framework of RLA5070, an expert reviewed the eradication actions implemented by the National Service for Agrifood Health, Safety and Quality (SENASICA) authorities in Mexico and provided valuable recommendations. With the eradication of this pest outbreak and the strengthening of the trapping network, a total area of 473 000 hectares of cultivated hosts is being protected, with an estimated production of 11.3 million tonnes valued at US \$3.3 billion. Finally, a total of five areas were declared pest free and 14 official agreements for exports of commodities have been signed or will be signed shortly. This includes pitahayas (dragon fruit), blackberries and tree tomato from Ecuador to the USA, and melons from Honduras to Taiwan and Mexico. Exports of melons from Brazil to China and mango for South Africa and Republic of Korea are under negotiation.

Substantial progress was achieved during the first year of implementation of the three-year TC project RLA5075, 'Strengthening the Regional Capacities in the Prevention and Progressive Control of Screwworm'. Three major outputs were produced, including a working document on the Current Situation of the New World Screw Worm (NWS) in the Americas that includes the geographical location of the pest problem and its economic impact, a road map for NWS suppression and progressive eradication in the American continent, and a strategic plan for the progressive eradication of NWS from South America. The publication is the first of its type to address the NWS problem at a continental level. The road map raises the possibility of NWS eradication in South America using area-wide SIT in a progressive manner to benefit the countries in the region where the disease is still present. The road map is a decision support document for international organizations such as the FAO, World Organisation for Animal Health (OIE), WHO and the World Trade Organization, as well as for funding organizations interested in addressing this key pest problem in the Latin America and Caribbean regions. The strategic plan delineates an operational strategy for eradication of NWS from South America using SIT, in a south to north direction starting in Uruguay and gradually advancing towards Argentina and Brazil. The plan also presents the financial resources required for phased NWS eradication.

The three documents will be fundamental to Member States considering an eventual intervention programme against NWS in South America. The NWS is considered by FAO and OIE as one of the main transboundary pest problems affecting food security and safety in Latin America.

Throughout 2018, the TC programme continued its support to Member States across the region for the field evaluation of the SIT for mosquito control under 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'. The project provided guidance and advice to participating Member States on entomological field analysis, pilot site selection, SIT component training and stakeholder and community engagement for countries launching pilot testing in 2018. Advances in capacity building related to SIT included expert missions to support preparation for mark-release-recapture in advance of field testing in Bahamas, Ecuador, Honduras, Jamaica and Peru; delivery of a gamma-cell irradiator to Brazil to enhance the country's irradiation capabilities, and initiation of the refurbishing of the facility to ensure safe and productive operation; and equipment purchase and delivery for Cuba that included field and mosquito colony equipment, mosquito mass-rearing racks and mosquito mass-rearing trays. Fellowships at the IAEA, Seibersdorf were provided for participants from Argentina and Jamaica.

FOOD SAFETY

Under project RAF5078, 'Establishing a Food Safety Network through the Application of Nuclear and Related Technologies, Phase II', 88 participants from 33 African Member States participated in the African Food Safety Workshop in June, in partnership with the National Metrology Institute of South Africa. The Workshop supported the improvement of regional measurement and standards infrastructure for food safety, and further expanded the regional food safety network beyond laboratories, by attracting non-profit organizations, technical institutions, government regulators, commercial testing and research institutions and professional associations, as well the private sector.

In the Philippines, the TC programme assisted the Philippine Nuclear Research Institute (PNRI) to upgrade its facility for the microbiological decontamination of spices and herbal products, which could no longer cope with ever increasing demands from local producers. Support was delivered through two national TC projects PHI1019, 'Enhancing the Safety and Throughput of the Gamma Irradiation Facility Through Full Automation', and PHI1020, 'Enhancing the Utilization of the Fully Automated Philippine Nuclear Research Institute Gamma Irradiation Facility', and included the purchase of a new, more powerful gamma irradiator as well as assistance in research and development regarding the irradiator.



*PNRI staff operate the newly purchased, more powerful gamma irradiator.
Photo: Miklos Gaspar/IAEA*

Water and the Environment

REGIONAL HIGHLIGHTS

In Africa, groundwater resources are being characterized to enhance evidence-based decision-making for their judicious use. In the Sahel region, thirteen countries are embarking on their first sampling campaigns. The use of the IAEA Water Availability Enhancement (IWAVE) methodology is being mainstreamed into this regional project.

In the Asia and the Pacific region in 2018, the TC programme focused on capacity building for the investigation of atmospheric particulate matter and pollution sources in urban environments, using nuclear analytical techniques. Emphasis was also placed on the management of marine and air pollution and groundwater resource management, and on assessing the impacts of climate change on land-water-ecosystem interactions. The information generated will help authorities to plan remedial measures for environment protection and enhancement of quality of life.



Training on the determination of uranium isotopes in environmental samples by alpha-particle spectrometry. Photo: Martina Rozmaric/IAEA

Member States in the Europe region pay significant attention to the control of environmental and water pollution. Through national and regional projects, the Agency has provided assistance in radiation monitoring, particularly relevant to uranium legacy sites which remain a concern in Central Asia. Agency support has allowed Member States to enhance their capacity to monitor radioactivity levels in all environmental media including soil, sediment, freshwater and vegetation. In order to support regional capacity to implement marine monitoring programmes, international best practices in conducting marine pollution studies of radionuclides, heavy metals and organics have been shared with Member States with coastal regions in order to improve the environment.

Member States in the Latin America and the Caribbean region prioritize the generation of data on the environment that can be used in evidence-based policy- and decision-making for marine and coastal areas. The Agency has been

supporting several multi-year projects over the past decade in support of this priority. This cooperation has led to the emergence of a surveillance and response network of marine and coastal laboratories and research centres, mainly located in the Greater Caribbean, that are working on topics related to environmental protection, seafood safety and human health using nuclear and isotopic techniques. Agency capacity-building and support to these centres and laboratories has enhanced monitoring capacities in the region, leading to the production of scientific data, enhanced knowledge and better coordinated collaboration and research.

WATER RESOURCE MANAGEMENT

The IAEA developed the IWAVE methodology to strengthen knowledge management about national water resources by implementing a step-wise analytical framework to understand the circumstances affecting national water resource management. The IWAVE



“Cooperation has led to the emergence of a surveillance and response network of marine and coastal laboratories and research centres, mainly located in the Greater Caribbean, that are working on topics related to environmental protection, seafood safety and human health using nuclear and isotopic techniques.”

approach enables the identification of gaps that stand in the way of national water resource goals and organizes the necessary inputs and activities to achieve national water resource objectives, with a particular focus on isotope hydrology.

The First Coordination and IWAVE Consultative Meeting for project RAF7019, 'Adding the Groundwater Dimension to the Understanding and Management of Shared Water Resources in the Sahel Region', was held in February 2018. The project builds on project RAF7011, 'Integrated and Sustainable Management of Shared Aquifer Systems and Basins of the Sahel Region.' The final reports of RAF7011 were released in French in 2018. The new project, the first in Africa to mainstream the IWAVE approach, has already attracted donor funding from Japan, Sweden and the USA. Five countries have been selected to undergo the IWAVE process following a rigorous technical assessment of their readiness, and the first IWAVE mission to Niger has been completed.

The IWAVE approach is supported in Latin America and the Caribbean under regional project RLA7024, 'Integrating Isotope Hydrology in National Comprehensive Water Resources Assessments', which runs from 2018 to 2021. The project focuses on expanding technical capacity to conduct comprehensive assessments of water resources in Latin America and the Caribbean using isotope hydrology in support of SDG6, with the ultimate aim of increasing water availability. Most Member States in the Latin America and the Caribbean region require easier and faster access to good-quality isotope data, active water isotope monitoring programmes, skills and experience in isotope project planning, and experience in isotope data interpretation. A comprehensive action plan to strengthen capabilities for stable water isotope and tritium analysis and interpretation began implementation in 2018 to meet these needs. Activities included support to the expanding national isotope monitoring networks in the region, provision of laboratory equipment, isotope proficiency tests, and training courses. National institutions with analytical capabilities are now increasingly capable of providing timely, complete and accurate data and interpretation to better enable informed decision making and water management policy.

Pollution and changes in land use and climate change have affected Colombia's hydroelectric plants and dams, reducing generation capacity and water storage, and affecting the quality of water intended for consumption or fishing in local communities. With the support of the TC project COL7003, 'Estimating Sedimentation Rates and Reconstructing Sedimentary Processes in Hydroelectric Power Plants, Water Dams and Reservoirs', Colombia has received expert advice on measuring the sedimentation rates in the Magdalena river basin, which has contributed to the sustainable management of water resources and hydroelectric energy efficiency. The generation of data on sedimentary processes occurring in the water basin will provide decision-makers with the evidence needed to establish comprehensive strategies to improve the management of water resources and reduce the negative impact of the sedimentation process on the environment.

In Argentina, support has been provided under TC project ARG7008, 'Improving Management and Evaluation of Quality and Availability of Water Resources in Certain Regions through the Use of Isotopic Techniques', to introduce isotopic techniques for water resource management that enable the evaluation of water quality and availability for all possible uses. Fellowships and scientific visits to isotope hydrology laboratories in Austria, Canada, Germany and the United States of America helped to build national capacity, and workshops supported the implementation of hydrodynamic, hydro-chemical and isotopic sampling campaigns. The project has had concrete impact in three specific areas: remediation of mining sites with environmental liabilities, spatial planning, and the implementation of new tools for water resource management. As part of the project, two study sites were selected at Los Gigantes, Córdoba (a former uranium mine presently under remediation), and Uspallata-Yalguaraz, Mendoza (two basins with possibilities to locate new productive projects that depend on the availability of water). These sites were used for training activities in applying isotopic techniques that contributed to the development of improved hydrogeological conceptual models of them. In 2019, the project will focus on the transfer of the technology to San Rafael for the preparation of remediation of a uranium mining site.

Vital information to support the identification of favourable zones for the exploitation of aquifers in Honduras has been generated with the support of HON7001, 'Using Isotopic Techniques to Improve the Management of Groundwater Resources in the Central District'. This data will allow Honduran authorities to develop sustainable drilling plans for Tegucigalpa to improve the drinking water distribution service in the city. Key achievements included the delimitation of aquifer recharge zones, improved knowledge of the hydrogeological functioning of aquifers in the city, and identification of areas vulnerable to anthropogenic pollution, using geochemical and isotopic techniques. The project results will support the efforts of the municipal water service to better manage local water resources and ensure sustainability, thanks to the identification and delimitation of sustainable exploitation zones. The results will also contribute to the protection of aquifer recharge zones and areas that are sensitive to contamination.

The Panama Canal is the vital waterway that joins the Pacific and the Atlantic Oceans. It is essential to global trade, and accounts for a major part of Panama's gross domestic product. Natural disasters in 2010 affected the Canal, with water from the Canal leaching into the water table and severely affecting the drinking water supply of Panama City. The Hydrological and Hydraulics Research Centre at the Technological University of Panama (UTP) received specific equipment and training in the use of radiotracers and chemical tracers to characterize the dynamics of the sediment transport phenomenon in the Canal under the national project PAN1001, 'Investigating Sediment Transport in the Panama Canal Basin Using Tracers'. The data acquired will help to establish a national programme to measure the transport and behaviour of pollutants, and will contribute to ensuring the drinking water supply of the capital. In 2018, funded by PAN1001, staff of the UTP joined colleagues in a training course organized under RAF7018, 'Applying Radiation technologies to Assess Sediment Transport for the Management of Coastal Infrastructures'. Held in Morocco, the course focused on the use of nucleonic control systems for the measurement of fine sediment deposits in harbour basins and navigation channels, and strengthened interregional cooperation and the exchange of experiences in the field.

Also in Africa, regional training courses to improve the capacities of radioanalytical laboratories were carried out in 2018 under RAF7017, 'Promoting Technical Cooperation among Radio-Analytical Laboratories for the Measurement of Environmental Radioactivity'. The new capacities include the ability to determine uranium isotopes in environmental samples using alpha-particle spectrometry, measure naturally occurring radionuclides in environmental and naturally occurring radioactive material (NORM) samples using gamma-ray spectrometry, and estimate uncertainty in radio-analytical techniques. The project also supported interlaboratory comparison exercises as a means to improve quality, and sponsored African experts in the global Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) network activities.

Afghanistan's drinking water supply infrastructure has been damaged or destroyed over the past four decades. Annual precipitation is low, and drought conditions are continuous. Kabul is experiencing huge population growth and, consequently, increased demand for water. Under TC project AFG7001, 'Improving Drinking Water Quality Using Hydrochemical and Isotope Techniques', the Agency continued to support enhancements to Afghanistan's national capacity to effectively apply isotope hydrology techniques in water resource assessment and management. These assessments provided important information on the groundwater regime in Kabul basin to the national authority.



Participants preparing the nucleonic gauge for sedimentation measurement. Photo: Reinhardt Pinzon/UTP



Participants attending an RTC on determination of uranium isotopes in environmental samples by alpha-particle spectrometry. Photo: M. Rozmaric/IAEA

MARINE, TERRESTRIAL AND COASTAL ENVIRONMENTS

In Angola, the Agency is assisting the Atomic Energy Regulatory Authority to develop Angola's capability in the field of environmental radioactivity measurements and to establish a fully functional monitoring programme, supported by TC project ANG7003 'Establishing a National Laboratory for the Analysis of Radioactive Environmental Activities'. The laboratory is highly important for Angola, as it will help to effectively control NORM generated by the oil industry.

The 'IAEA/RCA Elemental Database in the Asia-Pacific Region', a world class database on airborne particulate matter in the Asia and the Pacific region, has been established under RAS7029, 'Assessing the Impact of Urban Air Particulate Matter on Air Quality (RCA)', and previous RCA-related projects. The database provides scientific evidence and findings for environmental management authorities to make well-informed decisions and issue relevant regulations and standards. In 2018, a regional workshop on Long Range Transport of Atmospheric Aerosols in the Asia-Pacific Region was carried out under the project, and the database was updated.

Fifty-four trainees from the Asia and the Pacific region have enhanced their capacities in the radiochemical analysis of marine environmental samples. Three regional hands-on training courses on the topic were conducted in 2018 under RAS7028, 'Enhancing Regional Capabilities for Marine Radioactivity Monitoring and Assessment of the Potential Impact of Radioactive Releases from Nuclear Facilities in Asia-Pacific Marine Ecosystems (RCA)'.

In Uzbekistan, the mining industry and uranium production legacy sites have the potential to significantly affect surrounding areas with radionuclides and potentially toxic elements associated with uranium production residues. The Centre of Hydrometeorological Service at Ministry of Emergency Situations of the Republic of Uzbekistan (Uzhydromet) is tasked to conduct the environmental radioactivity monitoring activities in the country. The project UZB1004, 'Enhancing the Capabilities of the Environmental Radiation Monitoring Network and Improving the Laboratories of the National Hydrometeorological Service' supported Uzhydromet laboratory staff with training in sampling and analysis to measure radionuclides in soil, freshwater and bottom sediments. The project also provided Uzhydromet with new analytical equipment that allows for the determination of activity concentrations of low-level alpha-emitting radionuclides. With the new sampling equipment, it is now possible to monitor existing radioactivity levels in all environmental media including soil, sediment, freshwater and vegetation. Furthermore, a new portable air

sampler enables Uzhydromet to conduct ad-hoc air monitoring at country borders and in emergency situations. The improved technical capabilities of the environmental monitoring network in Uzbekistan can now be used to support environmental impact assessments, verify environmental safety and prepare for the implementation of environmental remediation programmes. With human and technical capacity established, the laboratory can play a future role as a regional centre for the control of environmental contaminants.

The regional TC project RER7009, 'Enhancing Coastal Management in the Adriatic and the Black Sea by Using Nuclear Analytical Techniques', is unusual in that it brings together countries bordering two separate semi-closed seas to jointly evaluate and demonstrate processes that influence marine environment, using sediments as environmental archives. The project has already enabled the formation of a strong collaborative network of analytical laboratories and experts in the participating countries of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Italy, Montenegro, Romania, Russian Federation, Slovenia, Turkey and Ukraine, who share resources and knowledge. In September, scientists from the participating Member States met for the first regional workshop to review existing national data on marine pollution studies of radionuclides, heavy metals and organics, to identify knowledge gaps, constraints and bottle-necks in their respective marine monitoring programmes, and to propose a harmonized suitable field sampling strategy for regional monitoring programmes. As part of the workshop, a sampling mission on board the R/V Academic (the research vessel of the Institute of Oceanology 'Fridtjof Nansen' in Varna, Bulgaria) was conducted to collect samples. The sampling mission not only collected data, but also enabled the sharing of knowledge and expertise on sampling and sample handling. The project aims to establish a data inventory for sediments in the Adriatic and the Black Sea, enabling comparison and assessment of how marine processes respond to pollution and climate changes in closed and semi-closed seas. The data are expected to assist decision makers in determining where mitigating efforts are needed.

The regional project RLA7022, 'Strengthening Regional Monitoring and Response for Sustainable Marine and Coastal Environments (ARCAL CXLV)', is supporting a regional monitoring and response network in the Caribbean, contributing to the generation of information and data that will assist competent national authorities to sustainably manage the marine and coastal environments of the Greater Caribbean. In 2018, a regional training course on 'Scientific Communication' was supported through the project. The course brought together scientists and communicators with the goal of designing a communication strategy and action plan to raise awareness about the state of marine and coastal environments in Latin America and the Caribbean.

Over 60 scientists and coastal managers and health managers from more than 30 countries attended a workshop held during Monaco's Ocean Week, April 2018, at the Oceanographic Museum of Monaco. The workshop was organized by the IAEA in partnership with the RAMOGE Agreement, the Global Harmful Algal Bloom Programme (GlobalHAB) of the Scientific Committee on Oceanic Research and the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, and the National Oceanographic and Atmospheric Administration, with the goal of identifying the main constraints to the monitoring of benthic harmful algal bloom species and their toxins, and defining the best approaches to prevent and manage their impacts. The workshop was attended by counterparts from TC projects in Africa, supported through RAF7014, 'Applying Nuclear Analytical Techniques to Support Harmful Algal Bloom Management in the Context of Climate and Environmental Change, Phase II', Asia and the Pacific, supported through RAS7026, 'Supporting the Use of Receptor Binding Assay (RBA) to Reduce the Adverse Impacts of Harmful Algal Toxins on Seafood Safety', and Latin America and the Caribbean, through RLA7022.

RLA7022 also supported the participation of nine scientists from Colombia, Costa Rica, Cuba, El Salvador, Guatemala and Mexico (including five young female scientists) who presented scientific papers on harmful algal blooms at the 18th International Conference on Harmful Algae Blooms in Nantes, France, in October. Participation in this conference helped to improve the visibility of monitoring capabilities in the region.

Microplastics have emerged as a significant source of marine pollution. Twenty scientists from the Latin America and the Caribbean region were trained under RLA7022 in August in Brazil on the use of the mid-infraRed spectroscopy technique for the development of precision microplastic analysis, advanced data modelling, mapping and data interpretation. Participating countries are committed to establishing microplastic monitoring programmes in their countries and data will be collected on a joint platform.



Participants
for sediment
Reinhardt Pi

Microplastics training. Photo: Luka Melero, Melero Photos and Filming

Industrial Applications

REGIONAL HIGHLIGHTS

Nuclear science and technology can be used in industry to support economic development in Africa, particularly non-destructive testing and the use of radiotracers in industrial processes. Several countries in the region received support to develop feasibility studies on the acquisition of multipurpose irradiators for commercial uses in 2018.

In the Asia and the Pacific region, the TC programme continues to enhance national capabilities in the industrial application of radioisotope and radiation technology. This includes helping Member States to build capacities in advanced non-destructive testing techniques and supporting the upgrading of gamma and electron beam facilities. National and interregional projects implemented by the Agency support the planning and implementation of research reactor projects.

Radiation technology continues to play an important role in Europe, and is applied in industry to conserve the environment and to promote efficient use of resources. For example, the benefits of electron beam irradiation in improving waste water treatment have been shared with interested Member States. Radiation techniques for the synthesis and modification of polymeric materials have also been disseminated through regional projects, and Member States in the region have also gained knowledge in applying radiotracer techniques to detect and localize leaks in industrial systems. Cultural heritage preservation continues to be a priority area for certain Member States, with nuclear technology being applied to improve understanding of materials for conservation and historical purposes.

In Latin America and the Caribbean, industrial applications are being utilized in Member States in areas ranging from industrial irradiation to non-destructive testing. With the support of national and regional projects, Member States are better prepared to improve efficiency in industrial sites and processes, as well as to test and certify the structural integrity of civil structures. In addition, the TC programme is supporting Latin American Member States to successfully apply irradiation technologies to cultural heritage artefacts.

RADIOISOTOPES AND RADIATION TECHNOLOGY FOR INDUSTRIAL APPLICATIONS

A new regional project in Africa, RAF1008, 'Supporting Radiation Technologies in Industrial Applications and Preventive Maintenance of Nuclear and Medical Equipment', was launched in 2018 to resume capacity building support for non-destructive testing, radiotracer applications, and the maintenance of nuclear instrumentation. Two five-week regional training courses were implemented at AFRA RDCs in France and Egypt in 2018 under the framework of the project.

Seven African countries have developed feasibility studies for acquiring multi-purpose industrial irradiators, with the support of RAF1006, 'Facilitating the Commercial Application of Irradiation Technologies'.

The IAEA's technical cooperation programme is providing support to Malaysia's automotive industry. Various TC projects have helped build Nuklear Malaysia's capacities in radiation processing to meet the automotive industry's demands for heat and flame-resistant cables for use in the engine compartments of vehicles. In 2018, the TC programme supported Malaysia with two scientific visits, on accelerator technology and radiation technology, and two fellowships, on computed tomography and non-destructive testing.

In 2018, the first regional TC project in Asia and the Pacific to apply nuclear technologies for the characterization, preservation and conservation of cultural heritage, RAS1021, 'Harnessing Nuclear Science and Technology for the Preservation and Conservation



“Radiation technology continues to play an important role in Europe, and is applied in industry to conserve the environment and to promote efficient use of resources.”



RAF1008: First Coordination Meeting. Photo: S. Haile/IAEA

of Cultural Heritage’, was initiated. The region is rich in unique cultural artefacts and tops the United Nations Educational, Scientific and Cultural Organization world cultural heritage lists in many categories. The first project coordination meeting, held in September in Thailand, was attended by 31 participants from 21 Member States. It took stock of the situation at regional and national level, analysed resources, constraints and needs, and reviewed relevant nuclear technologies. Priorities and specific activities were set for the next three years.

The Maltese Government has stressed the importance of safeguarding Malta’s heritage, as this constitutes the cultural identity of the Maltese Islands, and occupies a significant niche in the tourism industry. The Agency is providing support to the preservation of Malta’s national cultural heritage using nuclear technology through a national project MAT1001, ‘Training and Upgrading of Technical Capabilities for Scientific Application in the Field of Cultural Heritage’. Within the scope of this project, representatives from Heritage Malta’s Diagnostic Science Laboratory and the regulatory body of Malta undertook a group scientific visit to the University of Ferrara, Italy, to improve their knowledge of practices in curatorial and conservation work, including research and material identification. In addition, the project supported the procurement of standard reference materials for the Heritage Malta’s Diagnostic Science Laboratory. Procurement of these reference materials aided the setting up of the scanning electron microscopy/energy dispersive X-ray spectrometry and X-ray fluorescence (XRF) for the quantitative analysis of stone, mortars, ceramics, metals and glass.

Also in Europe, project RER1019, ‘Enhancing Standardized Radiation Technologies and Quality Control Procedures for Human Health, Safety, Cleaner Environment and Advanced Materials’, has been assisting participating Member States in the use of standardized QA/QC procedures in the radiation processing of health care related products, advanced materials and waste water. In 2018, the project enhanced Member State knowledge of recent research and development achievements in the use of electron beam irradiation for industrial waste water treatment, and in the application of radiation technologies for the synthesis and

modification of advanced polymer materials. The project also provided regional workshops to support the upgrade of QA/QC systems to improve radiation processing procedures. In addition, the project supported standardization of QA/QC procedures in the region through an inter-laboratory comparison exercise in technological dosimetry, conducted by the Institute of Nuclear Chemistry and Technology in Poland (an IAEA collaborating centre for 2016-2020). This follows a first inter-comparison exercise conducted in early 2017 under a previous project RER1017, 'Using Advanced Radiation Technologies for Materials Processing'.

Member States in Europe have enhanced their capacities to apply radiotracer and sealed source techniques in industries to optimize industrial process while saving materials and energy and protecting the environment, supported by IAEA technical cooperation project RER1020, 'Developing Radiotracer Techniques and Nuclear Control Systems for the Protection and Sustainable Management of Natural Resources and Ecosystems'. Eight specialists from six Member States were certified in radiotracer and gamma scanning applications in industry at Level 1+2, recognized by the International Society for Tracer and Radiation Applications, following a two-week training course on radiotracer and sealed source methodology and technology as applied to industry and environment, hosted by the National Institute of Nuclear Science and Technology in Saclay, France. The certified radiotracer practitioners will support the introduction and promotion of radiotracer technology in industries in their countries. The project continues to support the certification programme, as well as national seminars through which the technology can be promoted among national stakeholders.

The TC programme is supporting the strengthening of nuclear science and technology in the industrial sector in Latin American and the Caribbean via regional and national projects. Under RLA1015, 'Harmonizing Integrated Management Systems and Good Irradiation Practice Procedures in Irradiation Facilities', Member State capacity building is focused on enhancing the safety and quality of irradiated products, as well as on reinforcing safety, security and environmental systems at irradiation facilities. The expected outcome of this project is harmonization of integrated management systems and validation in irradiation facilities that have been enhanced to meet ISO standards. During 2018, training was



NDT training in Ecuador. Photo: Eduardo Robles Piedras/ININ, Mexico

provided on establishing guidelines for integrated management systems; the fundamentals of management systems in irradiation facilities; development, validation and routine control of industrial radiation processes; safe and efficient management of radiation processing facilities; and on dosimetry systems for low absorbed doses.

The first regional training course in Latin America and the Caribbean on non-destructive testing for the evaluation of civil structures was held in Quito, Ecuador, in May, at the Army's Polytechnic School of the University of the Armed Forces, supported by RLA1014, 'Advancing Non-Destructive Testing Technologies for the Inspection of Civil and Industrial Structures (ARCAL CLIX)'. The training course, which brought together 30 participants from 11 countries in the region, initiated the development of a cohort of personnel trained and qualified in non-destructive testing in accordance with ISO9712 and ISO17024, and competent to carry out inspections of civil and industrial structures. This is particularly important for the evaluation and verification of the safety of damaged buildings following emergencies such as earthquakes, floods and cyclones. Under the same project, eight experts from the region were certified according to ISO 9712 Level 2 on Digital Industrial Radiology.

RESEARCH REACTORS

Following a request by the Democratic Republic of the Congo, the Agency conducted an Integrated Safety Assessment of Research Reactors peer review mission of the CREN-K research reactor at the University of Kinshasa in May. The mission was followed by a Operation and Maintenance Assessment for Research Reactors mission, supported through ZAI1010, 'Strengthening National Capabilities for the Operational Safety of the TRICO II Research Reactor Including Emergency Preparedness and Response, and Regulatory Infrastructure'. An Integrated Nuclear Infrastructure Review for Research Reactors mission was carried out in Nigeria in April under NIR2008, 'Developing Nuclear Power Infrastructure for Education and Training and National Capacity for Radioactive Waste Management'.

The Agency is supporting the Regional Advisory Safety Committee for Research Reactors in Africa (RASCA) through TC project RAF1007, 'Strengthening the Capacities of Research Reactors for Safety and Utilization (AFRA)'. The main purpose of RASCA is to ensure a high level of safety of research reactors in the African region. RASCA acts mainly as an advisory group with the goal of helping to solve significant safety issues and improve the functioning of the operating organizations' national safety committees. In 2018 the Committee met in Cairo to exchange information and share knowledge and experience on research reactor safety issues of common interest, focusing on operating experience feedback programmes, and periodic safety reviews.

In Jordan, the 5MW Jordan Research and Training Reactor has started the production of iodine radiopharmaceuticals, supported by TC project JOR1008, 'Enhancing Capacity Building Towards Safe and Effective Operations and Utilization of the Research and Training Reactor', and has obtained Jordan Food and Drug Administration and Ministry of Public Health licenses. The product will be distributed to local hospitals. The Jordan Research and Training Reactor, housed on the campus of the Jordan University for Science and Technology, is a multipurpose research reactor that will provide training to IAEA Member States in many areas, including the production of medical radioisotopes for therapy and diagnostics.

Energy Planning and Nuclear Power

REGIONAL HIGHLIGHTS

Energy planning is a priority for many countries in Africa. The Agency assists Member States in assessing their current energy needs and making accurate projections for the future. The programme has also focused on producing sub-regional energy plans, using a regional approach to foster collaboration between various sub-regional groupings.

The Asia and the Pacific region has the highest number of countries embarking on nuclear power programmes. The Agency is supporting the development of national infrastructure for several Member States in the region that are embarking on building their first nuclear power plant, or expanding their nuclear programme.

Within the Europe region, several Member States are embarking or considering embarking on a nuclear power programme. To this effect, the Agency has supported countries in all stages of their decision-making process as well as in subsequent steps to design, construct and commission a nuclear power plant, in accordance with the Agency's established guidelines and standards, and facilitated the sharing of international best practices. For Member States with nuclear power plants in operation or expanding their nuclear power capacity, the Agency supported effective long term safety operation as well as security of uranium production and supply in 2018, in addition to other activities. Experiences shared amongst Member States globally have contributed to maintain and enhance the safe performance of nuclear power plants.

In response to a regional priority in the Latin America and the Caribbean region for integrated long term energy development studies, the TC programme has been supporting Member States in strengthening their capacities to analyse energy systems and produce detailed studies using IAEA's energy planning models since 2016. In support of sustainable energy development, energy system scenarios are analysed on national, sub-regional and regional levels, given a set of assumptions regarding demographic and economic characteristics, technologies, fuel prices, and environmental/climate change impacts. The continued safe use of nuclear power in the region is also a priority. Aging nuclear power infrastructure requires support to keep human resource capacity at suitable levels, and new and innovative techniques are required to maintain nuclear power infrastructure operating correctly and in a safe manner.

ENERGY PLANNING

In 2018, in the frame of the current TC regional project RLA2016, 'Supporting Formulation of Plans for Sustainable Energy Development at a Sub-regional Level - Stage II (ARCAL CLIII)', 15 countries participated in three workshops to study energy demand in the region using the Model for Analysis of Energy Demand. As a result, capacities were enhanced, information was exchanged and sub-regional scenarios for energy demand were developed. At the end of the year, a training course involving 21 participants from 11 countries was held with the aim of analysing energy supply options using the Model for Energy Supply Strategy Alternatives and their General Environmental Impacts.

INTRODUCTION OF NUCLEAR POWER

Integrated Nuclear Infrastructure Review (INIR) missions were carried out in Niger in April under NER0007, 'Enhancing Human Resources Development in Nuclear Science and Technology', in Saudi Arabia in July, under SAU2009, 'Developing the Infrastructure for the Nuclear Power Programme', in Sudan in August, under SUD2005, 'Developing National



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Nuclear Infrastructure for a First Nuclear Power Plant’ and in the Philippines in December, under PHI2012, ‘Developing Nuclear Power Infrastructure in the Philippines – Phase II’. An Integrated Work Plan Development meeting took place in Sudan in November 2018. Sixteen Member States received integrated Agency support through the Integrated Work Plans process.

In Bangladesh, the construction of the country’s first nuclear power plant at Rooppur began in November 2017 when the first concrete for the nuclear island was poured. The plant will comprise two VVER-1200 reactors. Throughout 2018 the TC programme continued to support the country’s efforts to develop nuclear power infrastructure and a regulatory framework through two national TC projects: BGD2016, ‘Developing Infrastructure and Support Systems for a Nuclear Power Plant During the Various Stages of Construction’, and BGD2015, ‘Developing a Structured Licensing Programme for the Effective Regulatory Oversight of a Nuclear Power Plant During the Construction Phase’.

In Belarus, IAEA support is being delivered through BYE2007, ‘Improving Capacity of Operating Organization for Ensuring Safe and Reliable Nuclear Power Plant Operation’. The IAEA has developed a country-specific Integrated Work Plan which outlines IAEA support in developing the infrastructure for the implementation of a nuclear power programme and addressing related challenges. Within the education and training part of this programme, the country has created a national training system to supply qualified specialists for the nuclear power sector. Key organizations involved in the implementation of the national nuclear power programme (nuclear energy programme implementing organization, operating organization, regulatory body and technical support organization) have been defined. In 2018, a range of support was provided, including a national workshop on strategies for spokespersons and media relations, a group fellowship to maintain the qualifications of staff in the chemistry and electricity departments, and expert missions focused on waste management strategies and operator training.

Four senior managers from Poland participated in group training at the proposed site for the Hanhikivi 1 nuclear power plant in Finland from 28 November to 1 December 2018, supported by national TC project POL2019, ‘Supporting the Development of Nuclear Power Infrastructure’. The participants learned about site preparation, preparation of supporting infrastructure such as roads, maritime infrastructure, electric power grids, emergency communications, water supply and wastewater treatment infrastructure, infrastructure for waste management, as well as about scheduling those activities. Furthermore, the participants gained practical knowledge about the process of safety culture.

NUCLEAR POWER REACTORS

In the Asia and the Pacific region, a national training course on ‘Advanced Water Cooled Reactors (WCRs): Physics, Technology, Passive Safety, and Basic Principle Simulators, a Competence Based Approach with PC Based Basic Principle Simulators’ was held in January in Pakistan’s Institute of Engineering and Applied Sciences, Islamabad. The 60 participants, from research institutes, governmental organizations and universities, received a comprehensive overview of operational conditions in advanced nuclear power plants with passive safety systems. In Sharjah, United Arab Emirates, a regional training course on ‘Pressurized Water Reactor (PWR) Technology Using PC Based Basic Principle and GlassTop Nuclear Power Plant Simulators’, was held in February at the University of Sharjah, supported by RAS2018, ‘Supporting Decision Making for Nuclear Power Planning and Development - Phase III’. The course provided participants from seven Member States with a comprehensive training on the physics and technology fundamentals of PWRs using PC-based basic principle simulators and glass top simulators provided by the host. A regional training workshop on ‘Phenomenology and Numerical Simulations of Severe Accidents in Advanced WCRs’, was held in December in New Delhi, India under the same

project, which provided 35 participants from five Member States with a comprehensive overview of the phenomenology of severe accidents, including an overview of the associated technologies designed to cope with such events.

In Jordan, a national training workshop on ‘Small Modular Reactors Technologies and the IAEA Integral Pressurized Water Reactor (iPWR) Basic Principle Simulator’ was held in June in Irbid, within the framework of JOR2013, ‘Supporting Licensing and Construction Activities for the Nuclear Power Plant’. Over 60 participants were provided with a comprehensive overview of water cooled small modular reactor (SMR) technologies and training on an iPWR simulator.

Over sixty national participants attended a national workshop on ‘Nuclear Power Technology and Nuclear Power Education and Training’ in Colombo, Sri Lanka, in December, under SRL2010, ‘Establishing a Roadmap for the Nuclear Power Programme’. The workshop provided a comprehensive overview of advanced water cooled reactor technologies for near term deployment, and the corresponding fuel cycles.

In April, under SAU2008, ‘Developing and Deploying Small Modular Reactors and High Temperature Gas-Cooled Reactors for Cogeneration’, a national workshop on Reactor Technology Assessment Training for Large Water Cooled Reactors in Saudi Arabia was held in Riyadh for 50 participants. The workshop was intended to train national technical staff involved in the decision process, and to enable practice in the IAEA Reactor Technology Assessment methodology.

More than sixty participants from the 16 Member States in Europe and Central Asia participated in three workshops supported by RER2014, ‘Facilitating Capacity Building for Small Modular Reactors: Technology Developments, Safety Assessment, Licensing and Utilization’. The different advanced reactor technologies of SMRs, and their economic and financial aspects, were presented and discussed during these workshops.

A regional workshop on ‘Technical Challenges in the Application and Licensing of Digital I&C Systems for Nuclear Power Plants’ took place in November in Yerevan, Armenia, within the framework of TC project RER2015, ‘Strengthening Nuclear Power Plant Lifetime Management for Long Term Operation’. The workshop provided an international forum to discuss and share experiences concerning technical challenges with the design, implementation and licensing of modern instrumentation and control (I&C) systems for nuclear power plants. Thirty-two participants from 12 Member States attended the workshop. Lectures covered, among others, overall I&C architectures including computer security considerations, the application of defense-in-depth and diversity principles, the functional design of I&C systems, verification of software designs and the current status and difficulties with I&C modernization at operating nuclear power plants.

NUCLEAR FUEL CYCLE

In 2018, TC project RAF2012 ‘Enhancing Regional Capabilities for a Sustainable Uranium Mining Industry’, supported a specialized training course for African Member States on achieving and maintaining good operational and environmental performance in uranium projects.

Four interregional events were conducted in 2018 under INT2019, ‘Deploying Technology and Management of Sustainable Uranium Extraction Projects’, addressing policy, regulatory frameworks and technology for uranium production, the management of licensing activities involving NORMs and inspection of uranium production activities, a case study of life cycle management of uranium production by in-situ recovery, and conventional safety of uranium production. One hundred and sixty-one participants from 35 Member States attended these four events.

An innovative case study meeting in Beijing and Tongliao, China, comprising presentations and a detailed site visit, demonstrated a good approach for focused and in-depth communication and knowledge transfer. The theme, in-situ leach uranium mining, allowed participants to share information about this important mining technique, which has provided approximately half of the world's mined uranium in recent years and is of interest to many Member States. The meeting was supported under CPR2013, 'Studying Identification Technology and Technical Economic Evaluation of Typical Sandstone-hosted Concealed Uranium Deposits', and INT2019, 'Deploying Technology and Management of Sustainable Uranium Extraction Projects'.

Radiation Protection and Nuclear Safety

REGIONAL HIGHLIGHTS

Nuclear and radiation safety is fundamental to the safe and secure use of nuclear science and technology. A robust and sustainable radiation safety infrastructure is a mandatory condition to ensure the appropriate control of the use of radiation sources, and for the protection for workers, patients, the public and the environment, particularly in medical and industrial facilities.

In Africa, the IAEA assists Member States to improve their compliance with the International Safety Standards in all the Thematic Safety Areas, and in the implementation of the Code of Conduct on the Safety and Security of Radioactive Sources.

The use of radiation technology continues to grow in the Asia and the Pacific region. Regional TC projects in radiation safety support Member States in these endeavours, providing focused support based on the status and the extent of radiation usage. In 2018, the Agency provided various tools to support Member State efforts to manage regulatory activities, protect personnel occupationally exposed to radiation, implement the Code of Conduct on the Safety and Security of Radioactive Sources, and conduct dose assessments for medical purposes.

In 2018, Agency support to strengthen radiation and nuclear safety in the Europe region was provided in numerous areas. Safety is the main priority in the region and is in line with the newly endorsed *Europe Regional Profile*. Various activities conducted under national and regional projects in 2018 addressed safety in regulatory infrastructure, radiation protection of patients and workers, radioactive waste management including in the Chornobyl site, environmental remediation and decommissioning of facilities, as well as emergency preparedness and response.

In the Latin America and the Caribbean region, a national project for each of the 19 Spanish speaking countries focuses on strengthening national infrastructure for radiation safety and security, covering all the Thematic Safety Areas. Specific needs were identified



“A robust and sustainable radiation safety infrastructure is a mandatory condition to ensure the appropriate control of the use of radiation sources, and for the protection for workers, patients, the public and the environment, particularly in medical and industrial facilities.”



RAF9061: Training course for senior managers on the Integrated Management System.
Photo: C. Karle/IAEA

based on the Regional Strategic Profile for 2016–2021, RASIMS, EPRIMS and mission reports. In addition, a regional project, RLA9084, ‘Strengthening the Regulatory and Radiation Safety Infrastructure’, supported strengthening of the regulatory infrastructure, and another regional project, RLA9085, ‘Strengthening Regional Capabilities for End Users/ Technical Support Organizations on Radiation Protection and Emergency Preparedness and Response in Line with IAEA Requirements’, was dedicated to the radiation protection of workers and patients. The regional projects were focused on the dissemination of new international safety standards and guides, and on the promotion of networking and coordination among peers.

GOVERNMENTAL REGULATORY INFRASTRUCTURE FOR RADIATION SAFETY

Senior-level managers from 24 African Member States met at IAEA Headquarters in Vienna in August to participate in an intensive training course which demonstrated how nuclear regulatory bodies should establish, implement and improve their integrated management system, supported by RAF9061, ‘Enhancing the Capacities of National Regulatory Bodies for Safety in AFRA Member States’. The course provided professionals involved in their country’s regulatory bodies with the opportunity to explore integrated management systems, including IAEA requirements and standards, and self-assessment. By the conclusion of the training course, participants had developed a draft plan to establish or revise the integrated management systems of their organization and had presented it for peer review.

In 2018, TC project RAS9089, ‘Strengthening Radiation Safety Infrastructure’, contributed to enhancing governmental regulatory infrastructure in the Asia and the Pacific region, with an advisory mission to Kuwait in March, the provision of the Regulatory Authority Information System (RAIS) to Kuwait, Lebanon, Mongolia, the Philippines and Sri Lanka, and the development of a software application by the IAEA to assist Member States in managing their regulatory control programmes in accordance with IAEA Safety Standards and guides. In addition, a workshop on staffing and training of regulators took place in Doha in August, which provided regulators with a strategy for staffing. In Mongolia, regulators were trained on how to develop the programme for inspection and enforcement,



National Awareness Workshop on Radiation Safety and Nuclear Technology Applications hosted by the Ministry of Science and Technology, Vientiane, Lao People’s Democratic Republic on 13 August 2018. Photo: Mr Kongsaysy Phommamaxay, NLO, Lao People’s Democratic Republic

and in Manila in October new regulators were trained on how to establish a registry for radiation sources and on methodology to fully utilize RAIS.

In Oman, regulations and corresponding guidelines were drafted with the help of three expert missions, taking into consideration IAEA Safety Standards for radiation generators, safe management of radioactive waste and safe transport of radioactive material, supported by project OMA9005, 'Strengthening the Radiation Safety Infrastructure and its Supportive Technical Capabilities'. The counterparts were trained and assisted to develop the regulations. Two national workshops on licensing and inspection of medical practices and industrial practices were organized, which enhanced the radiation safety culture of the Omani participants and improved their knowledge in the field and their capabilities to conduct authorization and inspection processes and procedures in the medical and industrial applications.

The Agency provided a Technical Safety Review service to Saudi Arabia, to address national needs under SAU9011, 'Supporting the Implementation of the Regulatory Body and the Development of Nuclear Regulations'. Also in Saudi Arabia, project SAU6007 'Strengthening National Radiation Dose Measurements', facilitated the commissioning of an X-ray system and organized national training to provide an overview of the essential technical and practical skills needed for X-ray calibration. The training was designed for staff responsible for SSDL activities.

The Agency continues to support countries in the region in the adoption and promulgation of relevant legislation and the establishment of adequate regulatory infrastructure for the control of radiation sources. In Lao People's Democratic Republic, a National Awareness Workshop on Radiation Safety and Nuclear Technology Applications and a legislative assistance meeting were held in August to support the finalization of the draft radiation safety law before its submission to the Parliament. The Parliament of Lao People's Democratic Republic considered and adopted the law on 14 December, and it is expected to be promulgated in 2019.

In Nepal, in collaboration with the Ministry of Education, Science and Technology, the Agency organized an outreach workshop on Safe, Secure and Peaceful Applications of Nuclear Science and Technology to Help Reach National Development Goals in December in Kathmandu. The workshop was very positively received by the attendees.



Members of Parliament of Nepal on the podium. Speaking: Chairperson of the House of the Representatives' Education and Health Committee, Ms Jayapuri Gharti. Photo: Christian de Francia/IAEA

The first two days of the programme were designed for experts from various Ministries, institutions and participants from the medical, mining, health, agriculture and research sectors. Each Agency presentation was followed by a Nepal presentation on the same topic and discussion. A special session for the members of Nepal's parliament was held on the last day of the workshop, attended by some 30 Members of Parliament, including Chairpersons and Members of the relevant committees of both Houses, the Chief Whip and Whips from across different political parties.

Project KIG9006, 'Improving the Regulatory Infrastructure for Ensuring the Radiation Protection and Safety of the Population', is increasing the efficiency of the regulatory system in Kyrgyzstan by providing support to the State Regulation Centre on Environment Protection and Ecological Safety. The support provided so far has included sensitization of high-level authorities and stakeholders about the role and importance of the regulatory authority. The project has also enhanced the capabilities of the Department for Radiation and Nuclear Safety of the State Inspectorate for Environmental and Technical Safety by providing measurement devices for use during inspections. In addition, 11 inspectors were successfully trained at the Training and Research Center for Radiation Safety of the Taras Shevchenko National University in Kyiv, Ukraine. The training included radiation protection and radiation sources management and safety inspections and practical exercises with visits to radiation facilities. The project also provided expert advice to the Department for State Sanitary Epidemiological Control of the Ministry of Health on strengthening the legal and regulatory framework for training in radiation protection and safety in the country. This project also benefits from synergies with regional TC projects that support Kyrgyzstan in inspection and regulations drafting activities.

Eleven English-speaking countries were supported by a designated regional project that provided regulatory assistance and support for harmonization using Caribbean regional organizations and the infrastructure of CARICOM. This regional approach focused on the creation of initial regulatory infrastructure, implementation of international safety standards, regulation of basic and new radiation technologies and the facilitation of cooperation at the Caribbean regional level. The exchange of experiences with other SIDS was promoted through an interregional project.

Costa Rica continues to take important steps towards strengthening its safety regulatory infrastructure. In 2018, supported by project COS9010, 'Strengthening National Radiation Safety and Protection Infrastructure', the regulatory authority organized training courses that reached out to several end users in the field of radiotherapy and dental radiology. The regulatory authority also received support to complete the national inventory of DSRSs and to train the national counterpart on DSRS management. Costa Rica now has a fully operational RAIS, a software application developed by the IAEA to assist Member States in managing their regulatory control programmes in accordance with IAEA Safety Standards and guides.

SUPPORTING SAFETY IN NUCLEAR POWER PLANTS AND RESEARCH REACTORS

Two national workshops and on-the-job fellowship training took place in Poland in 2018, yielding fruitful results under the national project POL9024, 'Strengthening Safety Capabilities for New Build Licensing'. An Advanced Licensing Exercise Project (ALEP) workshop was held in Warsaw, in August. ALEP is a tailored, advanced capacity development activity that applies concepts of continuous improvement, learning and questioning to support the achievement of regulatory readiness for the licensing of Poland's first nuclear power plant. The workshop focused on mapping the competences and organizational capabilities of the National Atomic Energy Agency (PAA) of Poland that are needed to perform a regulatory review of the application for the construction license of

the nuclear power plant. Over the next two years, a simulated licensing exercise will test and verify national safety requirements framework for NPP construction.

Under the same project, PAA staff benefitted from on-the-job training (OJT) fellowships to various foreign nuclear regulatory authorities, where they can observe and learn how regulators verify compliance of safety requirements by nuclear power plants, focusing on siting, construction and operational aspects. The OJT assignment periods range from two to six months. OJT fellowships present unique opportunity to gain hands-on experience by Polish regulators, allowing to achieve regulatory readiness for first nuclear power plant in the country. In 2018 two OJTs were completed and another four will start soon.

Three international expert missions were supported in Turkey under the national TC project TUR9021, 'Enhancing the Atomic Energy Authority's Capabilities for Regulatory Oversight of Construction, Commissioning and Operation of New Nuclear Power Plants'. Two were related to probabilistic safety assessment (PSA) issues, and were aimed at enhancing the capabilities of the Turkish Atomic Energy Authority (TAEK) in the modelling of PSA based allowed outage times and on-line maintenance.

RADIATION PROTECTION OF WORKERS, PATIENTS AND THE PUBLIC

An IAEA technical cooperation project has helped the United Arab Emirates enhance radiation protection standards in the field of radiology and nuclear medicine, including a comprehensive, upgraded patient radiation protection procedure. Over 225 medical professionals, 50% of whom were women, participated in workshops and other training exercises to address areas of image quality optimization, patient radiation dose and guidelines for patient referrals for radiological examinations. This project enabled a reduction of radiation doses from computed tomography practices by more than 50%; a reduction of radiation doses from dental imaging by over 70%; as well as the establishment of a professional development programme on patient radiation protection in radiology and nuclear medicine.

The objective of project BOH9010, 'Strengthening Infrastructure for Radiation Protection of Patients in Medical Exposure', is to upgrade the radiation protection of patients by implementing regulations on radiation protection in medical exposure. The project aims to strengthen infrastructure in the field of medical physics in major hospitals in Bosnia and Herzegovina, and to upgrade the knowledge and skills of radiological medical practitioners and medical radiation technologists. Each clinical institution participating in the project has put forward a multi-disciplinary team consisting of medical physicists, radiologist and imaging technologist. In 2018, a meeting was organized for the representatives of each hospital (the Head of Radiology Department or senior radiologist, and the Head of Medical Physicists and Radiation Protection Department) as well as representatives of the Institute of Public Health to discuss the importance of optimizing radiological examinations, and to provide an overview of the regulatory framework for optimization of medical exposures. A national training course was organized for 15 medical practitioners from the five main centres in Bosnia and Herzegovina. The workshop focused on optimization of procedures in diagnostic radiology for medical physicists, radiologists and medical radiation technologists.

Establishing an optimized radiation protection programme to increase the coverage of dose control for workers occupationally exposed to radiation was identified as one of the major priority areas for further development in the Europe region. Through the TC regional project RER9140, 'Strengthening Protection of Radiation Workers and Occupational Exposure Monitoring,' the Agency supports Member States in strengthening their national capacities for occupational radiation protection (ORP) in compliance with International Basic Safety Standards. Forty-four participants from 23 Member States in the Europe region were trained at a regional workshop on ORP, co-organized with the International Labour Organization and the TAEK.

The same project supported the implementation of an Occupational Radiation Protection Appraisal Service (ORPAS) in Bosnia and Herzegovina – the second to be hosted by a European country. The ORPAS team, which comprised ten occupational radiation protection experts from Belgium, Greece, Ireland, the Netherlands, Poland, Portugal, Serbia, Sweden, Ukraine and the IAEA, found that the State Regulatory Agency for Radiation and Nuclear Safety and the technical support organizations working in medicine and in industry, agriculture and other fields are committed to ensuring the safety of workers in line with the IAEA safety standards.

Also under RER9140, support was provided for 26 Individual Monitoring Service laboratories from 14 Member States in the Europe region to participate in a regional intercomparison exercise for whole-body photon dosimeters organized by the European Radiation Dosimetry Group. The intercomparison exercise helps the participating Member States to improve the QMSs of their laboratories by providing the Individual Monitoring Service with a method to show compliance with the ISO/IEC 17025 requirements. Accreditation in conformity to this standard is becoming more and more important in the Europe region.

The regional project RER9147, 'Enhancing Member States' Capabilities for Ensuring Radiation Protection of Individuals Undergoing Medical Exposure', assists Member States in strengthening their radiation protection infrastructures for the medical use of ionizing radiation. A series of workshops were organized for professionals who routinely perform medical diagnostics and intervention activities with patient exposure to radiation, including radiographers, radiologists, medical physicists and interventional specialists. The workshops raised awareness of the need for high-standard training courses for all medical professions working with ionizing radiation, including continuous professional development (CPD) courses. As an outcome, draft content for a syllabus for CPD in medical radiation protection, together with teaching materials specific to each medical profession, have been developed.

Moreover, SSDLs are the focus of support under RLA9085, 'Strengthening Regional Capabilities for End Users/Technical Support Organizations on Radiation Protection and Emergency Preparedness and Response in Line with IAEA Requirements', which aims to strengthen the calibration capabilities of laboratories in the Latin America and the Caribbean region. The International Basic Safety Standards require that instruments for the measurement of radiation dose have a calibration which is traceable to national or international standards. Under the project, the new Charter of the IAEA/WHO SSDL Network has been published in Spanish, and a thorough gap analysis was carried out



SSDL training. Photo: Nicola Schloegl/IAEA

during the first-ever coordination meeting between national dosimetry laboratories in the Latin American and Caribbean countries in April. The goal of the gap analysis was to map existing calibration capabilities in the region and to identify needs for assistance in strengthening and upgrading laboratories, as envisaged in the Regional Strategic Profile 2016–2021. The exercise identified 26 institutions in 20 countries. In addition, five countries are currently considering or planning to establish their own SSDL soon and are receiving support from the technical cooperation programme. Several training activities carried out under the project, together with a comparison exercise carried out in collaboration with a Primary Standards Dosimetry Laboratory in the United Kingdom, fostered international cooperation among laboratories.

The use of diagnostic imaging has significantly increased over the past decade, contributing to medical costs and increasing medical exposure to ionizing radiation. Under RLA9085, a Guide for the Prescription of Diagnostic Medical Imaging was published in Spanish as a working document and disseminated at a regional training course held in El Salvador in cooperation with the Ministry of Health and the national Medical School. The meeting was inaugurated in cooperation with the Pan American Health Organization, a strategic partner in the implementation of the regional project. National action plans were developed by participants during the meeting to further disseminate the guide at the national level, aiming to protect patients from unnecessary exposure to ionizing radiation through diagnostic imaging. Under the same project, 37 participants from the Latin America and the Caribbean region were sponsored to attend the XI International Radiation Protection Association Regional Congress in Havana, Cuba in April. The Agency participated in a round table session at the Congress, which was an excellent opportunity to communicate the efforts of the TC programme in the fields of nuclear, radiological and waste safety

TRANSPORT SAFETY

Under RAF9060, 'Building Competent Authority Effectiveness on Regulating the Transport of Radioactive Material', a workshop on the Transport Safety Regulatory Programme for Uranium and Other Naturally Occurring Radioactive Material Produced by Mining and Milling was conducted in Cairo in April, focusing on the needs of Democratic Republic of the Congo, Namibia, Niger and Malawi. The workshop laid the foundation for enhanced control in the transport of uranium and other NORM. Member States' capacities were also enhanced to improve and harmonize procedures for import, export and transport authorizations, and a Technical Guide for Transport Inspection was finalized. The Guide is now available in English and French.

EMERGENCY PREPAREDNESS AND RESPONSE

Within the framework of regional project RAF9055, 'Strengthening and Harmonizing National Capabilities for Response to Radiation Emergencies', thirty-eight participants from African Member States attended a three-week School of Radiation Emergency Management in November, organized in cooperation with the Government of Morocco. A tangible achievement of the school was the formation of 38 managers capable of developing and managing sustainable EPR programmes, using the IAEA Safety Standards, technical guidelines, tools and training material. The school design supported the strengthening of national, regional and international capacity to respond to nuclear and radiological incidents and emergencies, including large scale emergencies.

A National Workshop on Communication with the Public in a Nuclear or Radiological Emergency in Warsaw in June provided information and practical guidance to public information officers, spokespersons and others responsible for emergency public communication, or for public communication during a nuclear or radiological emergency.



Technical visit to Morocco's civil protection facilities. Photo: Moroccan Nuclear and Radiation Safety and Security Agency (AMSSNuR)

The workshop, organized by the PAA with IAEA support, was a useful opportunity for representatives of a great number of Polish public entities to discuss capabilities, needs and expertise together. The workshop allowed participants to acquire a deeper understanding of best practices in the public communication of nuclear and radiological emergencies. It also provided an opportunity for participants to train together, exchange ideas and strengthen cooperation within the area of public communication.

Regional project RER9137, 'Enhancing National Capabilities for Response to Nuclear and Radiological Emergencies', supports Member States in the Europe region by enhancing their capability to prepare for and respond to radiation emergencies. In October, the School of Emergency Management was organized with the support of the Government of Austria in Tulln, Austria. The three-week School trained over 20 participants from 15 countries in the effective implementation and coordination of EPR activities. For example, as part of the course, participants visited the Local Emergency Operations Centre in Tulln and learned how the Austrian Fire Brigade, Police and Red Cross is conducting first response to radiological emergencies.

RADIOACTIVE WASTE MANAGEMENT, DECOMMISSIONING AND ENVIRONMENTAL REMEDIATION

Senegal has established its first radioactive waste processing and storage facility using the ISO container design under RAF9062, 'Strengthening Radioactive Waste Management (AFRA)'. A regional training course on conditioning of spent low activity sources was conducted in Dakar in July, and twelve participants from five countries were trained: Democratic Republic of the Congo, Morocco, Senegal, Uganda and Zimbabwe.

The project ROM9037, 'Supporting Radioactive Waste and Spent Fuel Management', is assisting Romania's efforts to improve the safe management of spent nuclear fuel and radioactive waste. In 2016, the Romanian Nuclear and Radioactive Waste Agency launched a review of the national strategy for the safe management of radioactive waste and safe management of spent nuclear fuel. The revised national strategy includes the construction of a new engineered surface repository for disposal of low and intermediate level short-lived waste, to be built within the exclusion zone of the Cernavoda NPP, subject to regulatory approval. The IAEA is assisting Romania by training staff in the management of radioactive waste, improving knowledge on a geological disposal programme, providing

dedicated computer codes to perform safety case analyses, and by supporting the revision of radioactive waste management legislation in line with international recommendations.

The project MOL9008, 'Building Operational and Institutional Capacity in Decommissioning, Remediation and Radioactive Waste Management Processes', is focused on designing the infrastructure for decommissioning, planning decommissioning and remediation activities, enhancing operational capacity in safety case and safety assessment development, and strengthening capacities in characterization of radioactive waste in Moldova. The implementation started in 2018 with an expert mission to collect information and elaborate a Statement of Work for the development of a detailed decommissioning and remediation plan for near surface storage, followed by other expert missions dedicated to developing the Statements of Work on design planning and on quality management systems, respectively. In addition, a group scientific visit was organized to Bulgaria and Hungary in 2018, focusing on the collection of information necessary for the development of a detailed decommissioning and remediation plan.

In Georgia, GEO9013, 'Developing Capability of the Waste Processing Facility to Treat Radioactive Waste, including Liquid Radioactive Waste', is contributing to setting up a national system for the safe management of radioactive waste. It has enhanced the capacities at the Saakadze disposal facility and supported the purification of 50 cubic meters of liquid waste containing radionuclide ^{226}Ra and the conditioning of secondary waste. A special facility for the conditioning of solid and liquid radioactive waste has been commissioned at the Saakadze disposal site. Radiological monitoring systems have been upgraded for the Centralized Storage Facility and established for the Saakadze disposal facility. Capacities at the Centralized Storage Facility were improved, sealed and unsealed radioactive sources were collected and the preparation for starting the characterization process was initiated through the provision of characterization equipment and the training of specialists.

In the framework of UKR9038, 'Supporting Decommissioning of Nuclear Power Plant Units and Radioactive Waste Management at the Chernobyl Site and in the Exclusion Zone', a workshop on Quantitative Methods for Determining Content of Organics in Radioactive Waste Water was organized in June 2018. The workshop brought together experts from Germany, Russian Federation, Ukraine and United Kingdom to identify basic methods to characterize the content of organic matter in radioactive waste water from the Chernobyl nuclear power plant. The experts considered potential methodologies and test protocols for determining the content of organics in radioactive waste waters at Chernobyl Nuclear Power Plant, which are needed to control the efficiency of purification in the hydrothermal tank and to justify the necessity for the preliminary hydrothermal treatment of evaporator concentrate. Experts attending the workshop identified six basic methods for determining the content of organic matter and made recommendations on activities to select the most appropriate test protocol for further use in practice. The workshop results will contribute to the implementation of working programmes at water purification units and enable an authenticated approach in the action plan for the liquid radioactive waste treatment plant at the Chernobyl NPP.²⁹

Project RER9146, 'Enhancing Capacities in Member States for the Planning and Implementation of Decommissioning Projects', is supporting the development of capacities in participating Member States to plan and implement decommissioning projects for small medical, industrial or research facilities. These facilities require decommissioning at the end of their operational lifetime due to the presence of radiological hazards. The project has so far supported the establishment of a regional baseline and strategy to address existing gaps, has provided basic training to young decommissioning specialists, and has also supported the drafting of new decommissioning regulations, or the improvement of existing regulations, applying international standards, recommendations and good practices.

²⁹ This paragraph responds to section 2, operative paragraph 6 of resolution GC(62)/RES/8 to render assistance and radiological support to the most affected countries in mitigating the consequences of the Chernobyl disaster and rehabilitating the contaminated territories.

Nuclear Knowledge Development and Management



Building, collecting, transferring, sharing, preserving, maintaining and utilizing knowledge is essential for the development and maintenance of the necessary technical expertise and competencies required for nuclear power programmes and other nuclear applications. The IAEA helps Member States maintain and preserve nuclear knowledge.

In Africa, several initiatives focused on postgraduate training for enhancing human resources capacity building and nuclear knowledge management are being undertaken. These include a two-year Master's Programme in Nuclear Science and Technology, PGEC for Radiation, Transport and Waste Safety, and a PhD Sandwich Fellowship Programme which was launched in 2018.

Capacity building, human resource development and knowledge management are key for enhancing the sustainability and success of the technical cooperation programme in the Asia and the Pacific region. The IAEA TC programme assists with the development and management of nuclear knowledge in various fora, from promoting nuclear science and building interest in STEM amongst students to establishing innovative platforms for Member States to exchange knowledge.

Member States continue to receive Agency support to establish and enhance knowledge management consistent with relevant international standards. In this area, 2018 activities included the development of a curriculum for a Master's Degree in Nuclear Safety and Security and a variety of capacity building endeavours to support Member States to conduct safety assessments. Numerous modalities are used to support nuclear knowledge development and management such as activities which leverage the 'train the trainers' concept, e-learning, Webinars, in addition to traditional training courses and workshops.

In the Latin American and Caribbean region, efforts are continuing to build capacity in nuclear knowledge and create sustainable numbers of nuclear professionals for the future. Regional endeavours such as the LANENT, as well as national capacity building projects for new Caribbean Member States are necessary steps for developing the human resources needed in the future.

“In January 2018, ten candidates from ten African Member States completed their two-year master's Programme in Nuclear Science and Technology.”

CAPACITY BUILDING, HUMAN RESOURCE DEVELOPMENT AND KNOWLEDGE MANAGEMENT

In January 2018, ten candidates from ten African Member States completed their two-year master's Programme in Nuclear Science and Technology. This training was hosted respectively by the Graduate School of Nuclear and Allied Sciences, University of Ghana and the Department of Nuclear Engineering of the University of Alexandria, Egypt. Based on a recent evaluation, graduates of this programme are generally recruited by atomic energy commissions or by national regulatory bodies, and a limited number pursue PhD research programmes. Fifteen candidates from 15 African Member States were preselected in November for the next Masters programme cycle, under RAF0052, 'Supporting Human Resource Development in Nuclear Science and Technology (AFRA)'.

Also under RAF0052, ten candidates from 10 Member States—of which 8 are LDCs—were accepted for participation in a PhD Sandwich Fellowship Programme which will enable them to pursue PhD research work in a foreign university. Under the same project, the Agency organized a first meeting of Vice-Chancellors of African universities in June, to deliberate and agree on practical collaboration measures to promote and implement graduate and postgraduate academic programmes related to nuclear science and technology in accredited universities with a view to addressing human resources development needs

in Africa. The meeting was held in Mombasa, Kenya. In addition, Botswana was provided with a business plan for establishing nuclear science and technology education programmes. The plan includes the future establishment of a Botswana Institute for Nuclear Science and Technology.

Twenty-five managers from atomic energy commissions, research facilities and laboratories participated in a regional Workshop on Quality Management Systems, hosted by the Nigerian Atomic Energy Commission and supported through RAF0047, 'Promoting the Sustainability and Networking of National Nuclear Institutions for Development, Phase II'. The workshop enhanced the participants' knowledge of quality management systems and the economic aspects of QA/QC in service laboratories. The workshop also fostered awareness about the international requirements for effective quality management systems.

Also in the Africa region, the IAEA is assisting two universities in Namibia in developing human resources in nuclear science and technology. Each university nominated a candidate to participate as an IAEA TC fellow, who subsequently began 'Sandwich' PhD programmes in Ghana and South Africa. In the future, these fellows are expected to teach nuclear science and technology curricula at the postgraduate level. The curricula of the two Namibian universities were also reviewed by external experts and advice was provided through the Agency on how they might be updated and expanded.

New university teaching modules on isotope hydrology were disseminated at a regional meeting, supported by project RAF7013, 'Enhancing the Use of Isotope Hydrology in Planning, Management and Development of Water Resources (AFRA)'. The material will be incorporated into university curricula, including those of the three AFRA RDCs in Egypt, Morocco and Tunisia.

Under URT0007, 'Establishing a Graduate School of Nuclear Science and Technology at the Nelson Mandela African Institution of Science and Technology', and RWA0002, 'Strengthening National Human Capacity and Research in Nuclear Sciences and Technology', strategic plans have been developed to guide and launch postgraduate education programmes in both the United Republic of Tanzania and Rwanda.

The Agency is providing assistance to Member States in the Asia and Pacific region in their efforts to mainstream nuclear science and technology into their national development under regional project RAS0080, 'Promoting Self-Reliance and Sustainability of National Nuclear Institutions'. More than 30 participants from 11 countries in the region attended a regional meeting in Jakarta in May to enhance institutional capacities in self-reliance and sustainability. Using toolsets developed under the project, the participating Member States reviewed and updated their activities, which include strategic planning, feasibility studies and economic analyses of R&D products and services, and human resource development and management.



RAS0080: First coordination meeting, in Jakarta, Indonesia. Photo: IAEA

In the Europe region, within the framework of RER0035, ‘Supporting Enhanced Sustainability of Programme Activities’, Hungary improved the regulation of power plant maintenance, Slovenia met higher levels of safety in the transportation of neutron sources, and a new network of young regional nuclear professionals was created to exchange best practices. These are some of the concrete outcomes of the four-year-old Intercontinental Nuclear Institute (INI) that were discussed at a panel discussion at a side-event during the 62nd IAEA General Conference on 19 September 2018. A panel of INI graduates, an INI co-director and IAEA experts shared their experience of the programme, showcasing the impacts of the Institute on young nuclear professionals.

The INI promotes the long term sustainability of nuclear power programmes and infrastructure through capacity building, global dialogue and technical engagement. The programme is a joint initiative of the US/Czech Civil Nuclear Cooperation Centre in Prague and the University of Massachusetts at Lowell. The INI is supported by the IAEA, the USA and the Czech Republic and has trained over 100 fellows in the past four years.

In Latvia, project LAT0003, ‘Strengthening Knowledge and Skills in Radiotherapy Quality and Safety’, aims to improve the education and training of radiation therapy technologists (RTTs) by training the trainers, upgrading existing equipment for educational purposes and introducing new visual aids. In 2018, a ‘train the trainers’ course on radiation protection in radiotherapy for teachers involved in education and training of RTTs was organized in the University of Latvia. In addition, a new manual laser patient-positioning system, treatment-planning systems for educational purposes and computed tomography and magnetic resonance simulation software have been procured.

The regional project RER0043, ‘Enhancing Capacity Building Activities in the European Nuclear and Radiation Safety Organizations for the Safe Operation of Facilities’, is strengthening national nuclear infrastructures through a capacity building initiative, and is improving competencies in nuclear safety in participating Member States. The IAEA supported the organization of a series of workshops to develop an educational network between the universities in the region, enhance Member State understanding of the capacity building methodology, and train participants to apply human resource development and knowledge management tools to their respective national programmes.

To help its Member States understand the commitments and obligations associated with developing a safe, secure and sustainable nuclear power programme, the IAEA provides guidance, advice and training, and reviews progress according to the ‘Milestones Approach’.



RER9144: Participants at a regional training course in Obninsk & Sosnovy Bor. Photo: Y.V.Filonov/Rosatomb Technical Academy



RER9144: Regional workshop on accident analysis, International Centre for Theoretical Physics, Trieste. Photo: N.Hiranuma/IAEA

Within the framework of 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 IAEA builds capacity for nuclear infrastructure development and safety assessment in Europe by educating and training officials from interested Member States. In 2018, the IAEA trained over 50 officials from Armenia, Belarus, Bulgaria, Croatia, Czech Republic, Hungary, Kazakhstan, Lithuania, Poland, Slovakia, Slovenia, Russian Federation and Turkey in the use of water cooled, water moderated power reactor (WWER) technology with advanced safety features. The Russian Federation provided in-kind support, hosting three regional training courses at the premises of the Rosatom Technical Academy in the science city of Obninsk and in Sosnovy Bor (Leningrad region).

Representatives of Member States from the Europe region attended a regional workshop on accident analysis for severe accidents, organized at the International Centre for Theoretical Physics from 28 May to 1 June 2018 in Trieste, Italy.

The Czech Republic, taking into consideration increasing demand for nuclear personnel, as well as the ageing of experienced staff, is focusing on reinforcing its nuclear base by seeking



CZR0009: Field work on the remediation of former uranium mining sites. Photo: Barbora Dostalova/DIAMO

additional training opportunities for junior experts in the field. The TC programme, through the project CZR0009, 'Strengthening Human Resources Capacity, Nuclear Knowledge, Skills Preservation, Supplementary Enlargement of Knowledge and Expertise in Relevant Fields of the Peaceful Use of Nuclear Energy', is building capacity through the training of nuclear regulatory authority representatives and staff from technical support organizations. In August and October 2018, two staff members of DIAMO, the state enterprise responsible for remediation of former uranium mining sites, received training in Germany during a two-week scientific visit. The training covered water treatment management and waste rock dumps, as well as remediation of tailings ponds and issues associated with radon gas. The students visited remediated sites and sites undergoing remediation to compare approaches to resolving similar issues. A six-month fellowship under the same project at the University of Tennessee in Knoxville, USA, allowed two representatives from the Czech Technical University to participate in research on molten salt reactor (MSR) systems, broadening their understanding of MSR design features, safety assessment and operation. The training has allowed the fellows to proceed with the development of a methodology for safety assessment of advanced reactor concepts with respect to MSR systems, which is crucial for the licensing process in the Czech Republic.

The Agency collaborates through multiple projects and initiatives with Member States in the Latin America and the Caribbean region to improve networking, develop IT tools, strengthen and foster cooperation and coordination among education and training institutions, and to preserve and disseminate nuclear knowledge. Among these projects is RLA0057, 'Enhancing Nuclear Education, Training, Outreach and Knowledge Management'. Agency support to the LANENT under this project has made an essential contribution to preserving, promoting and sharing nuclear knowledge, as well as fostering nuclear knowledge transfer in the Latin American region in areas such as education, health, industry, agriculture, the government, the environment and mining industry. The network also seeks to communicate the benefits of nuclear technology to the public, aiming to stimulate interest in nuclear technology in younger generations.

Training courses on Nuclear Knowledge Management were delivered in Uruguay and Costa Rica with the support of RLA0057 in 2018, using teaching materials developed in previous years. The regional course in Uruguay was attended by 18 participants from seven countries, while the sub-regional course for the Central American and Caribbean region was attended by 29 participants from nine countries. The courses were developed using the 'blended-learning' modality, beginning with pre-training conducted through the Educational Portal of the LANENT Network, followed by in-person training conducted by IAEA experts. The courses promoted e-learning as a useful teaching approach in a range of scenarios related to nuclear education and training, and strengthened the pedagogical skills of the participants regarding instructional design and evaluation techniques for this teaching methodology.

The same project has also disseminated the experience of regional leading nuclear institutions – including the Argentine Atomic Energy Commission, the Autonomous University of Mexico, the Peruvian Nuclear Energy Institute – which are committed to providing support, human capital and infrastructure resources. In collaboration with other major partners, such as the Polytechnic University of Catalonia, the Polytechnic University of Madrid and the Sustainable Nuclear Energy Technology Platform, the IAEA and the institutions in Latin America are contributing to the success and sustainability of nuclear education, training, outreach and knowledge management in the region. Seven participants from the region were sponsored under the project to attend the 14th Nuclear Knowledge Management School, hosted by the International Centre of Nuclear Physics in Trieste, Italy, in August 2018. This training is intended for young professionals with current or future leading roles in the management of nuclear knowledge.

Annex 2. TC Programme Fields of Activity³⁰

Nuclear Knowledge Development and Management
Capacity building, human resource development and knowledge management (01) Building national nuclear legal infrastructures (03)
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) Nuclear Instrumentation (33)
Energy
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 and Security
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)

³⁰ Updated in 2016 for the IAEA TC programme 2018–2019. The field of activity number is shown in parentheses.



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