2019

IAEA Technical Cooperation Programme

The IAEA Technical Cooperation Programme

Selected Highlights

2019

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SUSTAINABLE DEVELOPMENT GOALS

2019

FOREWORD BY THE DEPUTY DIRECTOR GENERAL

For more than 60 years, the IAEA has supported Member States through its technical cooperation (TC) programme by building sustainable human and institutional capacities for the safe and peaceful application of nuclear technologies. By leveraging this experience in capacity building and coordination, the IAEA has been able to contribute reliably and consistently to the national and regional development ambitions of its Member States, and to the attainment of the Sustainable Development Goals.

The Agency's TC programme is active in 147 countries and territories, including 35 least developed countries. The programme's effectiveness rests on an iterative process, through which the IAEA and its Member State counterparts work closely together to develop new skills and infrastructure, and to build atop those achievements to reach increasingly ambitious targets.

Today, the programme provides support in a wide range of fields that address crucial development issues, namely human health, non-communicable disease and infant nutrition; improved agriculture, better crops, healthier livestock and environmentally friendly pest management; environmental monitoring and water resource management; among others. Work in these fields, however, is not limited to training. Technical cooperation extends to include knowledge-sharing modalities and the development and reinforcement of cooperative networks, facilitating collaboration across borders and across regions.

2019 produced considerable achievements of note for the IAEA's technical cooperation programme. The thousands of counterparts trained and the hundreds of capacity building events held all contribute to human well-being and a better world for everyone. I look forward to continuing cooperation with our Member States in the peaceful application of nuclear science and technology, and I eagerly await the successes to come.

This brochure showcases a selection of success stories drawn from the past year of technical cooperation activities. These highlights and achievements demonstrate how the programme is supporting the sustainable development of Member States. I hope they help readers better understand the technical cooperation programme and its impact.

DAZHU YANG,

IAEA Deputy Director General and Head of the Department of Technical Cooperation

The contents of this brochure were originally prepared for and published on the official IAEA website.

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Paraguay Launches Environmental Radiation Monitoring System, with IAEA Support

With new equipment provided by the IAEA, scientists in Paraguay can now measure radiation in the environment. (Photo: ARRN)

"We want to evaluate the radiation exposure to the public and make sure that control measures are appropriate. Having our own capacity will contribute to reducing any potential radiological risk to the population and the environment."

— Mario Gutiérrez, ARRN Executive Secretary

Three unmanned environmental monitoring stations to detect and measure radiation from soil and air were inaugurated in Paraguay in September 2019, with support from the IAEA. The facilities, which are the first of their kind, represent a leap for Paraguay in the protection of people and the environment from the harmful effects of ionizing radiation.

"We want to evaluate the radiation expsure to the public and make sure that control measures are appropriate," said Mario Gutierrez, Executive Secretary of AARN. "Having our own capacity will contribute to reducing any potential radiological risk to the population and the environment."

Key achievements of the project

- Paraguayan counterparts received comprehensive training in the measurement of radiation levels and the identification of the source
- Three new monitoring stations will now enable Paraguay to identify and resolve any incidents of environmental radiation resulting from human activities

This would also give the Paraguayan population peace of mind, he added, particularly because the country shares borders with Argentina and Brazil, both of which operate nuclear power plants.

By monitoring radiation levels in the environment, scientists will be able to develop national baseline data on naturally-occurring radiation — radiation originating from naturally-occurring radioactive materials found in soil, water and air. Based on this data, they will be able to identify any type of alteration in these values that may occur.

One station was installed in the capital, Asunción, and the other two in Pilar and Alberdi, close to the border with Argentina.

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Training provided by the IAEA has prepared experts to not only measure radiation levels, but also identify the sources responsible for the radiation.

The new stations can significantly increase the ability to differentiate natural radiation from others generated by radiation sources, such as radiation from an accidental release or a lost source, Gutiérrez said.

Growing use of radioactive sources

Many radioactive sources are used widely in industry and in medicine. To see inside a patient's body, medical staff use diagnostic imaging with radioactive substances. To treat cancer, oncologists use radiation technologies. Recently, Paraguay has witnessed an increase in the application of radiation sources in medicine.

"Millions of dollars are being invested in health, nuclear medicine and radiotherapy as the country's economy grows," Gutiérrez said. "While in 2018 our regulators provided 300 authorizations in the field of ARRN competencies, [in 2019] we will reach 1000. The biggest increase in the use of radioactive sources comes from the medical field."

The IAEA supports countries like Paraguay in the safe and secure use of radioactive sources. "More applications of nuclear technology should come hand-in-hand with a more systematic control of these, to reduce any related risk to people and the environment and increase their benefits," said Diego Telleria, radiation protection specialist at the IAEA.

Environmental monitoring

Each of the three environmental radiation monitoring stations consists of a device, housed in a 20-foot container, that monitors the air, measures gamma radiation and transmits that information to the base station.

Each site can measure in a radius of 150 km. The wind forces air into an air sampler and through a filter, which retains 85 % of all particles that pass through it. The filters are replaced automatically every day and used filters are measured in the high-resolution detection device at the station. Resulting from this is a gamma ray spectrum, which is sent to the ARRN for analysis, and the data is made available online.

The IAEA has also provided a laboratory in Paraguay with a liquid scintillation analyser to allow scientists to analyse radiation levels in water, sediments and food samples. This will complement the environmental monitoring stations. Scientists from the Multidisciplinary Centre of Technological Research (CEMIT) at the National University of Asunción have been trained to use the new equipment and interpret the results, which will help widen the scope of their research.

The upgrade will also enable the team to undertake more sophisticated scientific studies by, for example, measuring baseline radiation throughout 2019 and observing how it changes according to weather, time, or soil composition.

IAEA technical cooperation with Paraguay in 2019

75 Trained (including 34 women)

6 International experts provided

29 Attended specialist meetings

South-South/Triangular Cooperation in 2019

Training courses hosted **3**

Expert and lecturer assignments provided by Paraguay **2**

Based on data available as of March 2020

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Radiation-Processed Seaweed Increases Typhoon Resistance of Rice

The weather resistance of rice increases when treated with irradiated seaweed. (Photo: IAEA)

Key achievements of the project

- Using mutation-induced breeding, counterparts in the Philippines were able to develop new, improved varieties of foodstuffs (such as rice) which are more resilient to insects and arthropods, and to the strong winds and gusts of typhoons

Researchers in the Philippines have found that an extract of seaweed, when processed with radiation, can make plants more resistant to typhoons and boost rice production by 20–30%. The extract, called carrageenan, comes from algae that is abundant in the sea.

While carrageenan is already used widely as a gelling agent and thickener in the preparation of processed foods, this is the first time researchers — with the support of the IAEA — have applied it on a large scale as a plant growth promoter.

"It worked from the very first day I used it," said Isagani Concepción, a supervising engineer and part-time farmer at San Manuel in the central province of Tarlac. Concepción's four-hectare rice field was used for testing. After he applied the modified carrageenan, he noticed a 30% increase in production. "I used to get 291 cavans, now I get 378. Even spraying only a small dose is as effective as using organic fertilizer." One cavan is a sack of approximately 50 kg.

Plants also started growing more extensive roots, sturdier stems and more tillers. This, Concepción said, has made them resilient to typhoons. In Bulacan, Typhoon Lando in 2015 devastated all the control plants, which were not given irradiated carrageenan. Those treated with the new growth promoter remained standing.

For farmers in East Asia, the irradiated product is pertinent at a time when rising temperatures will heat the oceans. The implication for farmers is that warming oceans can lead to more intense and frequent typhoons.

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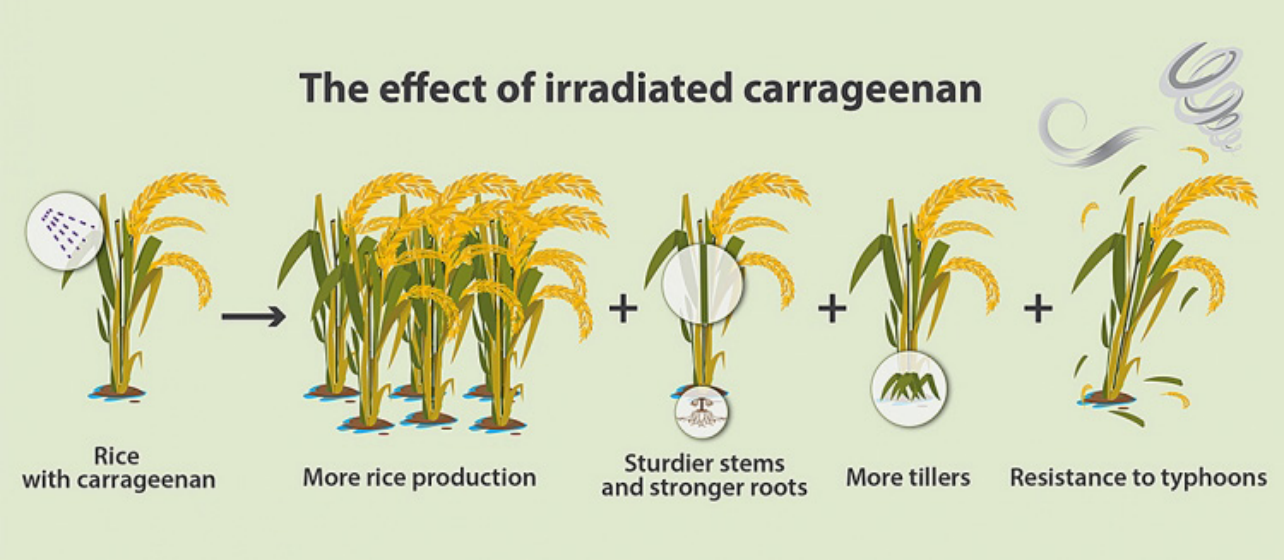
Agricultural researchers at the National Crop Protection Center of the University of the Philippines in Los Baños tested the benefits of carrageenan as a plant growth promoter on more than 5000 hectares. The IAEA provided the irradiators and the training of local experts on their use. In a study in Pulilan, a central province of Bulacan, researchers found that sprayed areas produced crops with yields 65% above that of the control group, while using only half of the recommended fertilizer dose.

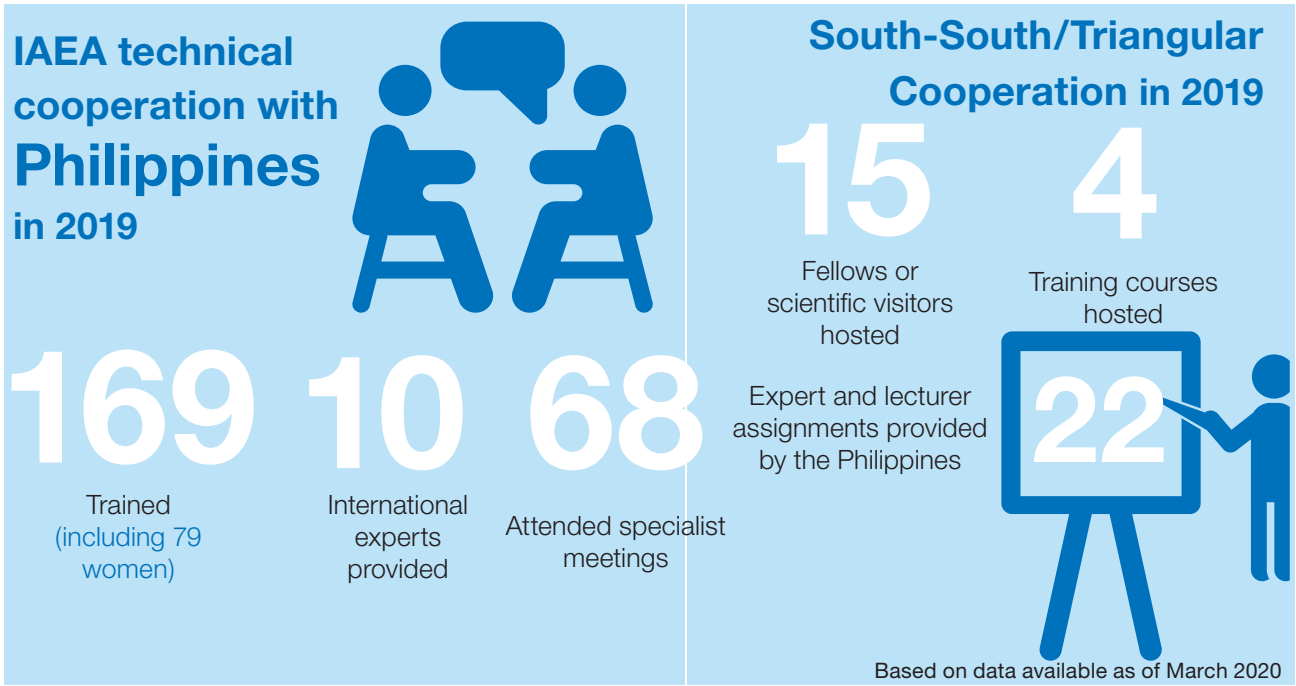
The technology consists of subjecting the material to radiation to reduce the molecular weight of carrageenan and thereby increase its effectiveness. Carrageenan is a mixture of natural polymers derived from weeds, with high molecular weight, explained Sunil Sabharwal, radiation processing specialist at the IAEA. Irradiation with gamma rays degrades the natural carrageenan into smaller oligomers with comparatively low molecular weight, which are known to stimulate plant growth.

Farmers realized that plants also grew resilient to insects and arthropods such as centipedes when treated with radiation-processed carrageenan. At the same time, the population of spiders, which kill virus-carrying green leafhopper, increased. “We didn’t need to use pesticides because we realized more friendly insects chased away the pests. These insects have helped to decrease the number of the pests, and we have stopped using insecticides,” said Colduron.

“Carrageenan plant growth promoter is the answer to harvest shortage,” Abad said. “This technology increases harvest yield and, with it, farmers’ livelihoods.”



(Infographic: R. Kenn/IAEA)



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Future of Low Carbon Energy Systems: IAEA Workshop Reviews Potential Uses of Small Modular Reactors

46 participants from 14 Member States met in Pitesti, Romania, from 24 to 27 June for the Regional Workshop on SMR Deployment Scenarios in Global Energy Portfolio. (Photo: IAEA)

"The relatively low cost of SMRs, together with their wide range of potential applications, makes them an attractive option for future decarbonized energy mixes."

— Marco Cometto, Energy Economist, IAEA

Developing cost effective, decarbonized power systems is central to meeting Sustainable Development Goals 7 (Affordable and Clean Energy) and 13 (Climate Action) and small modular reactors (SMRs) may play an important role in reducing carbon emissions, experts agreed at a recently-organized IAEA workshop.

The 46 participants coming from 14 Member States as well as representatives from two reactor vendors met in Pitesti, Romania, from 24 to 27 June for the Regional Workshop on SMR Deployment Scenarios in Global Energy Portfolio. Their focus was to review potential applications for SMRs beyond electricity production and consider how these reactors might fit into energy systems which may include other low carbon energy sources. They discussed factors leading Member States to pursue SMRs and heard presentations from reactor vendors on the current state of the technology. Participants also exchanged information on financing challenges and licensing issues associated with the nascent SMR designs. About 50 SMR designs are currently under various stages of development and deployment.

SMRs can offer several advantages over existing reactors in terms of cost and flexibility. Modular components are prefabricated before being brought to the plant site, which significantly reduces construction costs, and their small size makes them ideal for deployment in countries with small grids and less developed infrastructure.

Key achievements of the project

- Participants agreed that small modular reactors (SMRs) have a vital role to play in the attainment of Sustainable Development Goals 7 and 13
- Future technical cooperation activities will be organized to explore the design safety, regulatory and licensing issues related to SMRs

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They may also be used for a variety of non-electric applications, including desalination and district heating.

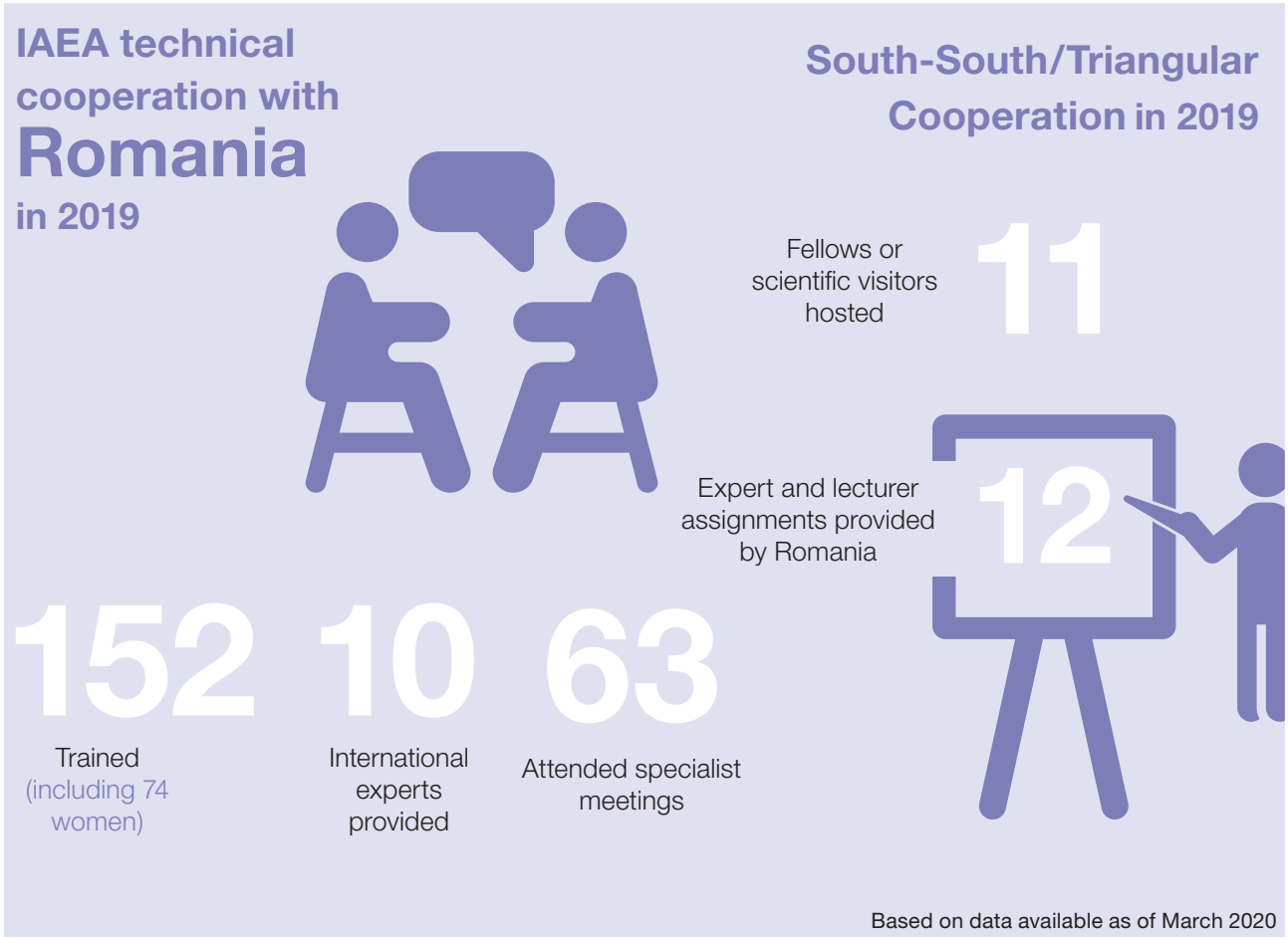
“In order to meet the carbon emission targets established in the 2030 Agenda for Sustainable Development as well as the Paris Agreement, it will be necessary to decarbonize not only the energy sector, but the industrial sector as well,” said Marco Cometto, an energy economist at the IAEA. “The relatively low cost of SMRs, together with their wide range of potential applications, makes them an attractive option for future decarbonized energy mixes.”

The workshop, hosted by Romania’s National Commission for Nuclear Activities Control, is the latest activity of an IAEA regional technical cooperation project, Facilitating Capacity Building for Small Modular Reactors: Technology Developments, Safety Assessment, Licensing and Utilization, aimed at assisting Member States in Europe to build capacity in the area of SMRs so that the increasing demand for carbon free energy can be met. Through an ongoing series of workshops, the project is providing a forum for exchanging technical information on several challenges associated with SMR deployment including issues around the design and technology of SMRs as well as licensing, safety assessment and modes of implementation.

“The continued rise of renewable energy sources, particularly wind generation, has changed the economics of grid management such that load following capabilities are becoming increasingly desirable for historically baseload plants,” said Zeljko Tomsic, a professor in the Faculty of Electrical Engineering and Computing at the University of Zagreb. Load following power plants can adjust their output throughout the day according to demand fluctuations, whereas baseload power plants are usually operated at their maximum capacity.

Participants agreed that while nuclear power, and SMRs in particular, can play a major role in future decarbonized energy systems, regulatory and licensing uncertainties remain major challenges for the deployment of SMRs. They also concurred that financing issues must be addressed in order to optimize the deployment of SMRs in combination with other renewable energy sources.

Under the technical cooperation project, several more workshops will be organized, focusing on design safety, safety assessment, regulatory and licensing issues as well as emergency preparedness and response for SMRs.



Tajikistan Inaugurates its First Radiotherapy Centre in its Northern Province with IAEA Support

Young doctors at the Republic Oncology Research Centre. (Photo: O. Pellet/IAEA)

Each year, approximately 3000 cancer patients in Tajikistan require radiotherapy as part of their treatment.

Until recently, patients living in the Sughd region, Tajikistan's northernmost province, would have to travel across 300 kilometres of mountainous roads to reach the country's only operational radiotherapy clinic, located in the national capital, Dushanbe.

On 18 August 2019, this gap separating cancer patients from the care they require was finally closed when a new radiotherapy facility was officially inaugurated in Khujand, the Sughd province capital.

Rajabboy Ahmadzoda, Governor of the Sughd Region, inaugurated the new facility, established with IAEA support. The new radiotherapy department, the first of its kind in Khujand, will increase access to cancer care while simultaneously reducing waiting times and improving equipment usage elsewhere in the country.

Key achievements of the project

- Since 2014, a series of IAEA projects have strengthened the quality of cancer services in Tajikistan
- With IAEA support, a new radiotherapy facility was officially established in Khujand, the capital of Sughd province, to provide greater access to cancer care in the mountainous region

The provision of the new radiotherapy equipment for the Sughd Centre is the latest in a series of advances made by the Government of Tajikistan with the support of the IAEA, through the technical cooperation programme. Since 2014, a succession of projects have supported the strengthening of cancer services in Dushanbe, and the expansion of radiotherapy treatment to Khujand, by delivering specialized training and equipment.

The Republic Oncological Scientific Centre in Dushanbe has previously been the only provider of radiotherapy services for this nation of nine million, until August 2019. This meant that cancer patients in Tajikistan's northern Sughd region would have

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to travel long distances to access the cancer treatment prescribed to them. For many, this journey can be unaffordable. By introducing such services into the northern province, which is home to close to a third of the country's population, officials aimed to expand access to radiotherapy, which at least half of all cancer patients will require.

In his speech, delivered at the new facility's inauguration, Governor Ahmadzoda described the challenges borne by cancer patients in the Sughd region in accessing cancer care. He also noted that the demand for services in Dushanbe had placed a heavy load on the country's only Cobalt-60 machine, which the new regional centre will now help alleviate, thereby improving cancer services for the country's entire population.

"Cancer is a growing problem worldwide. Dealing with this issue requires vision and strong partnerships between the public sector, professionals and development partners," said Ana Raffo-Caiado, Director of the IAEA's Technical Cooperation Division for Europe. "Tajikistan has made the fight against cancer a priority and has spent the last decade addressing and improving the healthcare system."

The IAEA has worked with Tajikistan to support the establishment of the new radiotherapy department since the earliest planning phases. In addition to the Cobalt-60 unit, which forms the centrepiece of the new radiotherapy department, the IAEA procured a conventional simulator and a treatment planning system for the Centre, as well as quality assurance and quality control equipment.

Rajabboy Ahmadzoda, Governor of the Sughd Region, participates in the ribbon-cutting ceremony for the new radiotherapy department of the Sughd Regional Oncological Centre, alongside Ana Raffo-Caiado (Photo: Office of the Governor of Khujand Province)

IAEA technical coperation with Tajikistan in 2019

49	8	11
Trained (including 16 women)	International experts provided	Attended specialist meetings

1 Training course hosted by Tajikistan

Based on data available as of March 2020

TC fellowships were organized with the support of Armenia's National Centre of Oncology to ensure that the staff of the new radiotherapy department received effective training in the latest technologies and treatment modalities.

"This new department will soon be accepting patients. As it grows in the coming years, it will offer the people of this region readily available access to improved cancer treatment. The centre will also offer new opportunities to medical professionals to further their skills in the field of radiotherapy," said Raffo-Caiado.

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Brain Gain: IAEA Organizes Second Regional Meeting of Vice Chancellors of African Universities to Address Human Resource Development in Africa

More academic programmes in nuclear science and technology must be established, and coherent strategies to curb 'brain drain' of African experts must be developed, if the full potential of nuclear technology for development is to be maximised in Africa.

These were the conclusions of 23 Vice Chancellors of universities across 16 countries in Africa and representatives of regional and international academic bodies who met from 17 to 19 June 2019 in Marrakech, Morocco, to develop practical measures and explore potential collaboration to address regional human resource capacity gaps in this field.

Meeting participants discussed and agreed on collaboration modalities in order to implement new nuclear science and technology graduate and post-graduate academic programmes in accredited universities in Africa.

They also adopted a practical recommendation on future collaboration with United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Academy of Sciences, the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) and the Harbin Engineering University, to increase the number of trained graduates and post-graduates.

The attending Vice Chancellors agreed to establish a prize to promote the involvement of women in science and technology and to develop a mentorship programme to encourage greater cooperation among the participating universities.

The meeting was hosted by the Government of Morocco through its National Centre for Energy, Sciences and Nuclear Techniques, and aimed to build upon the achievements of an earlier event held in June 2018.

For many Member States in the Africa region, their application of nuclear science and technologies (NST) is limited by a shortage of qualified professionals, particularly female professionals.

Shaukat Abdulrazak, Director of the Division for Africa, joins Azzeddine El Midaoui, President of Ibn Tofail University and President of the Association of Moroccan Universities, in delivering opening remarks for the meeting. (Photo: IAEA)

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This shortage is caused in part by the comparative dearth of nuclear education and training opportunities on the continent—in lieu of continuing their studies at a domestic university, trainees are often forced to rely on foreign academic institutions and on training provided in other regions.Responding to this need, the IAEA launched a regional technical cooperation project, within the framework of the AFRA Agreement.

A preliminary meeting in 2018 concluded with the launching of a PhD Sandwich Fellowship Programme, whose enrolees are expected to lead NST programmes in tertiary institutions, to promote further research and development, and to contribute to the effective management of the IAEA's technical cooperation programme in Africa.

Vice Chancellors of African Universities and Representatives of Regional and International Bodies involved in education and training meet in Marrakech, Morocco, to discuss human resource development needs in Africa. (Photo: IAEA)

Opening the meeting on behalf of the Minister of Higher Education of Morocco, Azzedine El Midaoui, President of Ibn Tofail University and President of the Association of Moroccan Universities, highlighted the importance of education and training in nuclear science, and called for the establishment of NST-focused academic programmes in African Member States to enable Africa to train a critical mass of young graduates and to maximize the full potential of nuclear technology for development in the region.

Shaukat Abdulrazak, Director of the IAEA's Technical Cooperation Division for Africa, emphasized the importance of developing human resource capacities in Africa as a driving force for the contribution of the peaceful use of nuclear technology for development. He furthermore encouraged the attending Vice Chancellors to support the development of their respective National Human Resources Development Plans, in order to match the growing demand for nuclear-related capacities and to improve the employability of graduates. In addition to these measures, coherent strategies will be required in order to curb the 'brain drain' of African experts, explained Director Abdulrazak.

During the meeting, the Vice Chancellors made country presentations, during which they described the structure and content of their ongoing academic programmes in nuclear science and technology, both at the graduate and post-graduate levels. They also identified the sectors of their national economies which typically recruit these candidates, facilitating the process of developing more market-oriented academic content with which to respond more effectively to emerging demands.

Vice Chancellors of accredited Universities from the following Member States participated in the meeting: Algeria, Benin, Burkina Faso, Cameroon, Central African Republic, Djibouti, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Morocco, Namibia, Niger, Nigeria and Sudan.

Bangladesh's Crop Scientists Find an Ally to Better Cope with Climate Change

"We are in a constant fight. We fight salinity in our soil, extreme temperatures, drought and floods. But, for all these problems, we have a solution—at least as far as crops are concerned."

— Mirza Mofazzal Islam, Chief Scientific Officer of BINA

Key achievements of the project

- With IAEA support, Bangladeshi experts have developed new, more resilient varieties of rice, capable of withstanding flood conditions for up to three days
- In recent decades, new rice varieties have increased Bangladeshi rice production three-fold

New varieties of rice made using nuclear techniques have helped Bangladesh increase its rice production three-fold in the last few decades. (Photo: IAEA)

Bangladesh, whose populous and low-level delta region is expected to be severely affected by rising sea levels, is using nuclear technology to adapt to this threat. Scientists are looking for ways to protect the country's agriculture against flood and salinity, as well as drought and changing temperatures. With support from the IAEA and the Food and Agriculture Organization of the United Nations (FAO), they are developing climate change resilient crop varieties that will help feed the country's growing population.

Scientists at the Bangladesh Institute of Nuclear Agriculture (BINA) have been developing radiation-induced plant varieties that can resist diverse climatic conditions. In the last decades, these plant varieties have helped farmers increase rice production three-fold, ensuring food security and giving this predominantly agricultural country an important economic push.

The more than 60 plant varieties the scientists can offer to farmers today have been developed through a process called plant mutation breeding.

These varieties of rice, lentils, chickpeas, peanuts, mustard, sesame, soybean, jute, tomato and wheat have now become popular across Bangladesh, accounting for about 8% of its crops, helping farmers produce a steady supply of these crops and improving livelihoods.

"Irradiation can be used to induce mutations in plants to produce varieties that display improved product quality, have higher yields and yield stability, greater resilience to climate change and tolerance to environmental stresses," said Ljupcho Jankuloski, plant breeder and geneticist at the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. "The rice mutant varieties developed at BINA have helped Bangladesh increase its rice production in the last few decades."

Through the Joint Division and the technical cooperation programme, the IAEA has been training scientists at BINA since the 1970s. With the threat of putting 27 million people at risk by 2050, climate change is expected to take a strong toll in this part of the world. Sitting on low land and relying heavily on agriculture, the country is especially vulnerable to climate change.

"It is especially now in the face of increasingly extreme weather conditions and the need for more yields that nuclear science and technology

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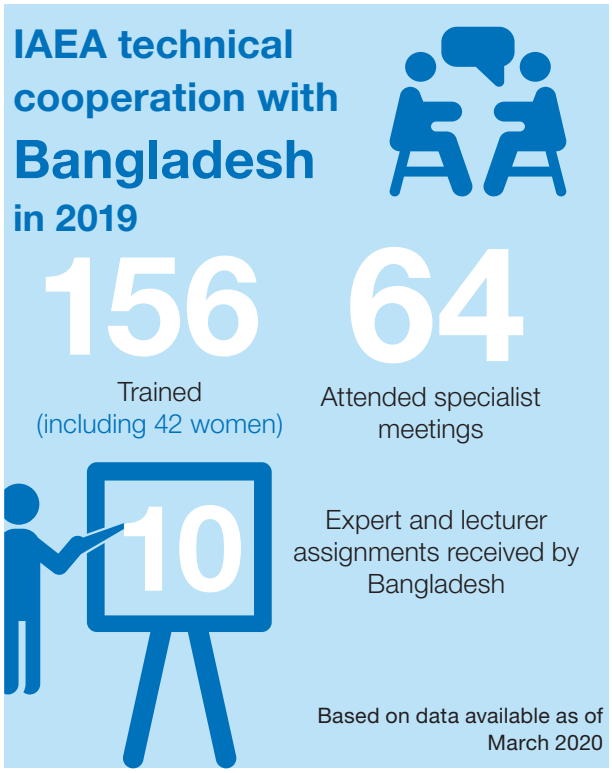
in agriculture has become indispensable," said Syahril Syahril, project manager at the IAEA responsible for technical cooperation with Bangladesh.

One new mutant rice variety, for example, needs less time to grow while producing more rice, in comparison to local conventional varieties. Another, resistant to salinity, is being deployed near the Bengal Bay, a one-million hectare spread of saline soil. "Before, this area could grow no crops," Mofazzal Islam said. "Seeing that crops can thrive here gives us hope, especially because we are expecting rising sea levels and higher salinity in soil to be one of the biggest threats to our agriculture."

Scientists have also developed rice varieties that can do better in flood-prone areas. "In general, crops can survive even when completely submerged, but only for three to four days," Mirza Mofazzal Islam added. "But with modern breeding, the new rice varieties can live underwater for more than three weeks."

Climate change is expected to take a strong toll in Bangladesh. Above, climate-resilient varieties are planted for testing at the Bangladesh Institute of Nuclear Agriculture in Mymensingh. (Photo: L. Gil/IAEA)



At the same time, a new rice variety developed by New Rice for Africa (NERICA) in Uganda can thrive under drought conditions.

"We have gone from worrying about hunger to focusing on nutrition," Mirza Mofazzal Islam said. "From food security to nutritional security. This means we are not only interested in ensuring access to food, but to healthy, nutritious food. Our aim is to be self-sufficient by 2021 with the help of these new varieties."

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Tripling Cassava Yields with the Help of Nuclear Science

Farmers in the Gitega Province in central Burundi harvest cassava, a starchy root vegetable and major cash crop, after using nuclear-enhanced methods to boost crop yields. (Photo: E. Vyizigiro/Institute of Agricultural Science of Burundi).

Seeing is believing, and when neighbouring farmers visit Theogene Ntakarutimana's cassava farm in central Burundi, on what is increasingly arid terrain, they are often speechless.

"Everyone who visits my farm and sees the way I am farming and producing cassava, they get excited," said Ntakarutimana, who started growing cassava using methods enhanced with nuclear science and related techniques in 2016. "I used to have a low yield, about 11 tonnes per hectare, but thanks to the enhanced practices, production has increased to 30, sometimes 33 tonnes. Other farmers are asking about the methods I have applied, and everyone is willing to learn."

Cassava, a starchy root vegetable, is the third largest source of carbohydrates worldwide, after rice and maize and a major cash crop for many farmers in Africa. The continent produces approximately 55% of the world's output, followed by Asia, with around 34%.

Key achievements of the project

- Hands-on and in-the-field training was organized for more than 350 Burundian farmers, including 146 female farmers
- The use of nuclear-derived soil and water management techniques has tripled cassava yields for the participating farmers

However, in many parts of Asia and Africa, harsh conditions, including drought and water scarcity, and declining soil fertility, are affecting traditional cassava farms and threatening food security.

In 2016, the IAEA, in cooperation with the Food and Agriculture Organization of the United Nations (FAO), partnered with research institutes and farmer associations to boost cassava production by developing improved soil nutrient and water management practices using nuclear-derived techniques. The new practices developed through the project have led to an up to three-fold increase in cassava yields.

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In the first phase of the project, researchers in Burundi, Central African Republic and Laos were trained to use nitrogen-15 (15N), a stable isotope of nitrogen, to measure plant uptake of added nitrogen fertilizer and to track the amount of nitrogen absorbed.

Nitrogen is one of the primary nutrients that plants need for optimal growth, and the amount of nitrogen found in soil will depend on soil fertility and quality. Nitrogen, in combination with potassium and phosphorous, is used as a fertilizer to enhance cassava growth.

“Nitrogen is part of all life — the air we breathe, the water we drink, the food we eat,” said Mohammad Zaman, a soil scientist in the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. “Using nitrogen-15 does not solve the problem, but it gives you the ability to know how to better manage nitrogen.”

In the second phase of the project, training courses were organized for local researchers and organizers to develop region-specific practices using nuclear science. Subsequent training courses with classroom activities and hands-on field work were also organized for more than 350 farmers, including 146 women farmers.

In a field demonstration in 2016, Vyizigiro and his team exhibited for farmers three different cassava plots farmed using traditional methods and the nuclear science-enhanced techniques. The traditional approach produced under 12 tonnes and the ISABU’s about 25 tonnes, while the nuclear-derived techniques yielded 33 tonnes.

Cassava production demonstration field in Cibitoke Province in northwest Burundi. (Photo: E. Vyizigiro/ISABU)

IAEA technical cooperation with Burundi in 2019

26 Trained (including 1 woman)

2 International experts provided

8 Attended specialist meetings

South-South/Triangular Cooperation in 2019

4 Fellows or scientific visitors hosted

1 Expert and lecturer assignments provided by Burundi

Based on data available as of March 2020

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IAEA Project Strengthens Control of Water Quality in the Zamora River

The Bombuscaro River, an important tributary of the Zamora River, located in Ecuador's Zamora-Chinchipe Province. (Photo: A. Neild)

Southeast Ecuador is home to a constellation of copper and gold mines, which have sustained economic activity in the region for decades. The Zamora River—which passes through the area before emptying into the Santiago River—has felt the effects of the nearby mining activities and the quality of its water has suffered dramatically.

Following the implementation of a national technical cooperation project, Ecuador's Water Secretariat (SENAGUA) has used the training and specialized equipment it received through IAEA support to implement strategies which are improving the conservation of the entire Zamora River Basin.

Launched in 2016, the TC project was designed to deliver support to the Water Secretariat across a variety of categories. A liquid water isotope spectrometer was provided by the Agency to support the analysis of stable water isotopes in the river and in nearby groundwater sources. This type of isotopic data provides hydrological information which is critical for the characterization of water quality, quantity and its historical movement. Hydrological data also reveals details related to the basin's water cycle, such as its recharge rate and the interaction between surface and groundwater sources – essential data for sustainable water- and land-use policies.

The IAEA also reinforced Ecuador's human resource capacity to apply isotope hydrology and related nuclear techniques, by training more than 25 technical staff from SENAGUA as well as over 100 students and professors from the Amazon Regional University (IKIAM) in their use for the monitoring of mining activities and their effects on water resources.

Key achievements of the project

- More than 25 technical staff from SENAGUA and over 100 students and professors from the Amazon Regional University benefitted from capacity building
- The IAEA also facilitated close cooperation between SENAGUA and the Pan-American Health Organization (PAHO)

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From 13 to 16 March 2019, Dazhu Yang, Deputy Director General and Head of the Department of Technical Cooperation, conducted an official visit to Quito, Ecuador to review the status and progress of Agency efforts in the country. As part of his visit, Mr Yang met with Technical Undersecretary of Water Resources Diana Ulloa and Evelyn Adriana Mina, a Water Quality Management Analysist at SENAGUA, to discuss the skills or capacity gaps still remaining to be addressed in the area of water resource management.

Committed to promoting South-South cooperation, the IAEA also facilitated close cooperation between SENAGUA with the PAHO in Ecuador. PAHO provided support by validating information gathered from 57 field monitoring points—installed by the IAEA and maintained by SENAGUA—while SENAGUA, in turn, provided PAHO with primary data on the Zamora River Basin, which will subsequently be used for the implementation of PAHO's 'Safe Water Plan.'

Dazhu Yang, Deputy Director General and Head of the Department of Technical Cooperation, meets with Technical Undersecretary of Water Resources Diana Ulloa to review the recent achievements of the national project. (Photo: SENAGUA)

IAEA technical cooperation with Ecuador in 2019

76 Trained (including 28 women)

2 International experts provided

28 Attended specialist meetings

2 Expert and lecturer assignments provided by Ecuador

Based on data available as of March 2020

This complementary sequence of activities—from the IAEA's technical support to the PAHO's policy-making support—demonstrates the Agency's emphasis on identifying and leveraging regional synergies, particularly with United Nations agencies, in order to contribute to the attainment of the Sustainable Development Goals.

As a result of both the IAEA's training course and the cooperation with PAHO, SENAGUA was able to collect, integrate and validate information collected from the Zamora River, which will facilitate the characterization of the Zamora River Basin and will support decision-makers as they institute new policies to manage the precious groundwater resources.

From 1 to 5 July 2019, a final Expert Mission took place to review and substantiate the hydrological data collected by SENAGUA, validating Ecuador's capacities to effectively monitor and manage local groundwater resources.

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Supporting Ghana's Sustainability Strategy: Bridging the Gap Between Nuclear Institutions and the Private Sector

Technology Transfer and Marketing Centre (TTMC), Ghana. (Photo: T. Kudesey/GAEC-TTMC)

Ghana has embarked on successful partnership ventures with a range of local and international partners following the establishment of its Technology Transfer and Marketing Centre (TTMC).

The Centre, set up in 2014 with the support of a regional IAEA technical cooperation project on sustainability, provides advice and support to the Ghana Atomic Energy Commission (GAEC), focusing specifically on partnership building and resource mobilization. The objective of the Centre is to bridge the gap between GAEC as a research institution and the private sector, and to develop and enhance the marketing culture in GAEC.

"The Technology Transfer and Marketing Centre plays a major role in ensuring that GAEC is market-ready, and that our services are known and sought out by Ghana's business community," said Professor Benjamin Nyarko, Director General of GAEC.

Key achievements of the project

- GAEC finalized a partnership with Ghana's National Petroleum Authority (NPA) in 2016 to use GAEC's non-destructive testing (NDT) technology
- GAEC also established a partnership in 2017 with the Council for Technical and Vocational Education and Training

"The Centre's vision is GAEC's vision – we want our scientists to provide effective, demand driven and timely research, so that GAEC can promote the application of nuclear science and technology for Ghana's socioeconomic development, and at the same time ensure its own sustainability."

Prior to the establishment of the TTMC, commercialization activities at the GAEC had many challenges. GAEC's activities and services were not known to the private sector. Staff had little training to effectively market their innovations to local industries, and the Commission lacked a clear strategy to commercialize scientific innovations.

SUSTAINABLE DEVELOPMENT GOALS

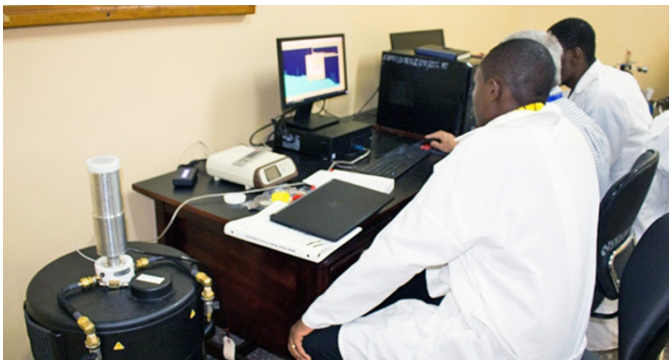
Today, the Technology Transfer and Marketing Centre is responsible for delivering training courses to GAEC stakeholders. These events have established new capacities in the Commission to build strategic, commercial partnerships across the country and throughout the region.

Using a participatory approach to identify problems and map solutions through to implementation, the TTMC has embarked on several initiatives. Directors and TTMC staff were trained in various business management programmes. All GAEC innovations and technologies were mapped, and commercialization focal persons were appointed in each GAEC institute to coordinate activities. GAEC policies and procedures, including criteria for staff promotion, were reviewed to include the commercialization of technology as well as private sector collaboration, and internal committees were set up to assist TTMC in identifying technology suitable for private sector uptake. The GAEC website was updated to highlight the activities of the Commission in research innovation of importance to the private sector.

The impact of the establishment of the TTMC has already paid off. For example, using the skills developed through TTMC training courses, GAEC submitted a proposal to Ghana's NPA in 2016 to use GAEC's non-destructive testing (NDT) technology to inspect and quality-assure the safety and environmental sustainability of oil and gas storage tanks, produced and imported into the country. This proposal was received positively by the NPA, and in 2017, GAEC was formally asked to inspect all imported and locally-produced Gas Fabrication Tanks in Ghana to ensure strict conformity to safety and environmental standards.

GAEC also established a partnership in 2017 with the Council for Technical and Vocational Education and Training, which provides training in welding using NDT technology and electronics to increase the resilience of industrial materials. These training opportunities provided the additional benefit of strengthening the employability of informal sector workers in the emerging oil and gas sector.

GAEC has also partnered with the Ghana Climate and Innovation Centre to facilitate the award of grants to scientists for transferring their technologies into commercial and industrial applications. In addition, the Centre successfully secured funding for the acquisition of equipment and for the development of new training courses for mining industry experts.



Using an accelerator to analyse archaeological samples. (Photo: T. Kudesey/GAEC-TTMC)

IAEA technical cooperation with Ghana in 2019

South-South/Triangular Cooperation in 2019

38 Fellows or scientific visitors hosted

2 Training courses hosted

147 Trained (including 35 women)

8 International experts provided

34 Attended specialist meetings

Expert and lecturer assignments provided by Ghana

Based on data available as of March 2020

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Experts Use Nuclear Technology to Study the Marine Environment

Key achievements of the project

- The IAEA delivered training to staff of the Kuwait Institute for Scientific Research (KISR)
- Following their participation in training courses and workshops, KISR staff are now ready to measure acidifaction, radioactivity and other important variables regulating life underwater

> "Kuwait is facing the effect of climate change, ocean acidification, pollution from the oil and shipping industry, power and desalination activities."
>
> — Nader Al-Awadi, the Executive Commissioner of KISR

In the face of climate change and increased industrial activity, scientists in Kuwait are using nuclear science to address challenges to the marine environment, with the assistance of the IAEA.

With the establishment of a large-scale facility to carry out research on the acidification of oceans – a result of increased amounts of CO2 entering the ocean – investigations are conducted on different marine organisms. Experts are making regular measurements of temperature and water acidity levels, and looking at how marine life is likely to respond to changes in coming decades, said Saif Uddin Iqbal Uddin, a KISR senior research scientist.

Potential impacts of ocean acidification and ocean warming include the degradation or complete loss of critical habitats, such as sea grass beds and coral reefs, he said. Nuclear and isotopic techniques are utilized to understand past conditions of ocean warming and acidification, and to predict future responses of marine organisms, such as mussels, oysters and corals, under changing conditions.

The Gulf waters provide a natural lab and ideal environment to study how marine life might adapt to ocean changes. "Despite huge temperature fluctuations from 8 degrees Celsius to 36, corals are surviving," he highlighted. At the same time, they are becoming more brittle due to ocean acidification. Under an IAEA project, studies focus on the effect of ocean acidification on calcification of key coral species.

Another important research area is the evaluation of the uptake of radioactivity and marine pollutants by marine sediments under ocean acidification. The seabed is a repository of contaminants and it has more pollution load than seawater, explained Uddin.

The use of early warning systems to assess radiation levels is another important area of research. In cooperation with the IAEA, Kuwait's experts have established a marine radioactive assessment network, which compares the radiation levels to baseline radioactive levels established in

Lamya Al-Musallam, a senior research associate at KISR, checks the pH level in the tanks, which is controlled by a system provided by the IAEA. (Photo: Dean Calma/IAEA)

SUSTAINABLE DEVELOPMENT GOALS

the 1990s, said Saif Uddin, adding that regular assessments are undertaken to check any impact on the marine environment. Data demonstrates that radioactivity levels are normal, and marine life is safe.

Gamma ray detectors are deployed at sea in an array of locations and studies are conducted on water entering the Gulf to detect and, in conjunction with hydrodynamic measurements and modelling, evaluate if there is any radioactivity which can impact seawater desalination, which is the source of freshwater supply in the country. The IAEA support, delivered through its technical cooperation programme, includes providing laboratory equipment as well as training of staff in gamma and alpha spectrometry, all of which are used to measure radioactivity in the marine environment.

Other IAEA supported projects relate to the monitoring of pollutants in the marine environment and how these have changed since the first Gulf war in 1990.

Investigating the impact of ocean acidification also includes the measurement of alkalinity in seawater (Photo: D. Calma/IAEA)

Nuclear technology is also used for seafood safety, for example, to monitor biotoxins produced by microscopic algae, known as harmful algal blooms. Factors such as surface water temperature, the circulation of wind and water, or the accumulation of agricultural run-off into the sea can trigger algal blooms, which can sometimes include toxic species. These toxins then enter the food chain and present a danger for people and threaten the livelihood of communities depending on fisheries.

IAEA technical cooperation with Kuwait in 2019

42 Trained (including 14 women)

11 International experts provided

24 Attended specialist meetings

Based on data available as of March 2020

South-South/Triangular Cooperation in 2019

2 Fellows or scientific visitors hosted

1 Training course hosted

Expert and lecturer assignments provided by Kuwait

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New Equipment, New Graduates to Increase Impact of Nuclear Science

New equipment worth over 600 000 euros officially handed over to the Government of Madagascar in November 2019, means the country again has a functioning gamma camera for nuclear imaging.

This new equipment will emplower local experts in many fields, from soil science to isotope hydrology and mining research, to pursue state-of-the-art research in support of the ocuntry's development objectives.

"The Government of Madagascar is fully committed to the peaceful use of nuclear technology and to reap its many benefits for our population," said Minister of Higher Education and Scientific Research Blanche Nirina Richard. "This work, and our cooperation with the IAEA, has already led to many tangible benefits in the country."

These benefits include a full study of the groundwater table in the southeastern, arid part of Madagascar, using isotopic techniques, and identification of areas where the groundwater recharges frequently and therefore can be used for both drinking water and irrigation.

This has led to the revitalization of agriculture in the area, said Joël Rajaobelison, Director General of the National Institute of Nuclear Science and Technology (INSTN Madagascar). The isotope hydrology lab of INSTN was among those receiving new equipment and consumables yesterday.

The biggest item both in size and expense is the gamma camera, to be housed in a hospital on the outskirts of the capital Antananarivo.

Using this equipment, doctors will be able to diagnose over 20 people suspected of cancer and various other noncommunicable diseases each day. The gamma camera is a tool used in nuclear medicine used to carry out scans of various parts of

Key achievements of the project

- New equipment will enable Malagasy experts and researchers to pursue further research in the field of nuclear science
- With IAEA support, Madagascar will deploy isotopic techniques to monitor and protect groundwater resources

Blanche Nirina Richard, Minister of Higher Education and Scientific Research, officially received the new equipment provided by the IAEA, on behalf of the Government of Madagascar. (Photo: M. Gaspar/IAEA)

SUSTAINABLE DEVELOPMENT GOALS

the body. It creates an image based on tiny amounts of radiation emitted by tracers introduced into a patient's body.

"Thanks to this equipment we can identify cancer metastasis in bone at least nine months earlier than using other techniques such as X-ray, with a great benefit on patient management," said Rasata Ravelo, Head of Nuclear Medicine at the Andohatapenaka hospital.

The hospital's previous gamma camera had broken down and has not been used since 2017. The IAEA, through its technical cooperation programme and with the assistance of qualified physicians, will support the hospital in launching the operations of the new equipment and has arranged for training of its physicians and technical staff to facilitate the safe and effective use of the machine.

Over 500 Malagasy experts have participated in training courses, fellowships and scientific visits over the last ten years, said Abdou Ndiath, the IAEA Project Management Officer working with Madagascar. These include Toky Mirindra Andriambarimanana, a young radiation protection specialist, who graduated in November 2019 with a Master's degree in nuclear security at INSTN, and who as part of his training participated in an IAEA nuclear security course in Morocco in October 2019. .

With the right soil conservation techniques, identified with the help of nuclear technology, farmers in Madagascar are able to protect their land from soil erosion. (Photo: M. Gaspar/IAEA)

IAEA technical cooperation with Madagascar in 2019

74 trained (including 23 women)

3 International experts provided

21 attended specialist meetings

1 Training course hosted by Madagascar

Based on data available as of March 2020

"As the amount of radioactive material in Madagascar increases, we need to make sure it is well protected," he said. Andriambarimanana, who works at the national fire service, participated in the protection of a visit by Pope Francis to the country last month, as a nuclear security expert. Nuclear security is a standard part of the precautions put in place for major public events.

Sambatra Rosa Randivoson, another graduate, is also a radiation protection specialist, who operates a radiotherapy machine in a hospital. "With my degree in nuclear security, I will be able to contribute not only to the safe but also to the secure use of radiation sources," she said.

The IAEA will continue to support experts and the government, Ndiath said. He will spend the next few days working with his counterparts from across Madagascar to design the new Country Programme Framework for Madagascar, ensuring that support from the IAEA remains aligned with the government's development objectives.

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