IAEA BULLETIN

INTERNATIONAL ATOMIC ENERGY AGENCY

The flagship publication of the IAEA | June 2017

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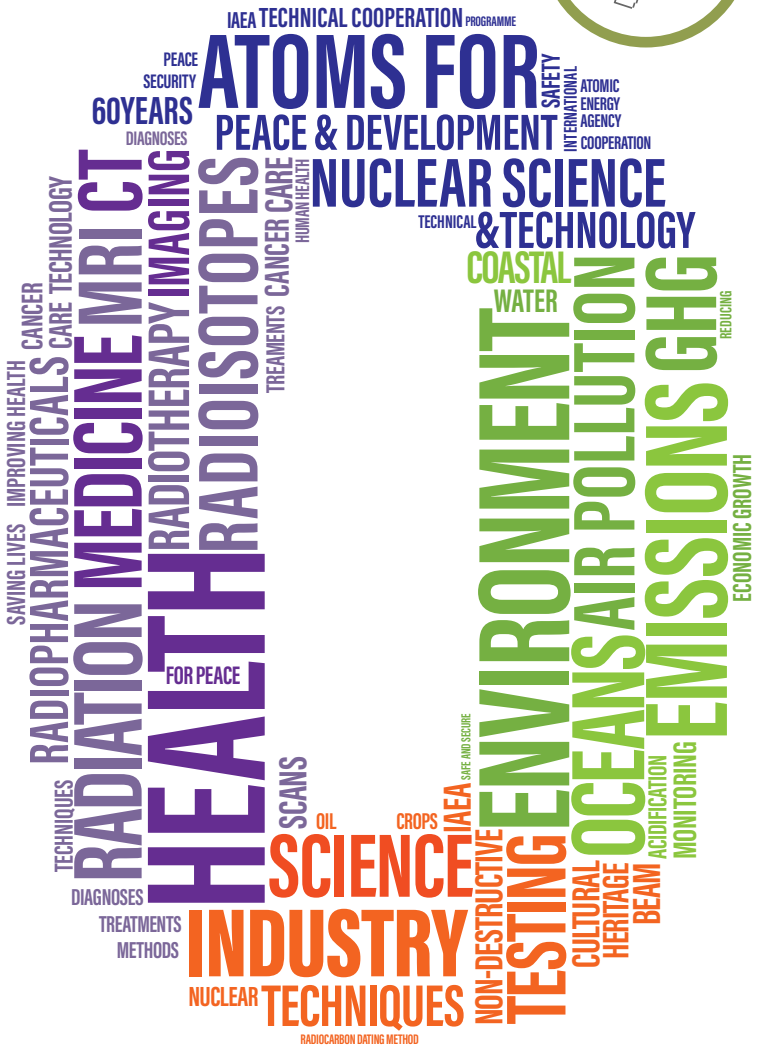

years contributing to development

International Conference on the IAEA Technical Cooperation Programme

IAEA *60 Years* *Atoms for Peace and Development*

Also inside: **IAEA News**

IAEA BULLETIN
is produced by the
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Cover: R. Kenn/IAEA

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IAEA

The International Atomic Energy Agency's mission is to prevent the spread of nuclear weapons and to help all countries — especially in the developing world — benefit from the peaceful, safe and secure use of nuclear science and technology.

Established as an autonomous organization under the United Nations in 1957, the IAEA is the only organization within the UN system with expertise in nuclear technologies. The IAEA's unique specialist laboratories help transfer knowledge and expertise to IAEA Member States in areas such as human health, food, water, industry and the environment.

The IAEA also serves as the global platform for strengthening nuclear security. The IAEA has established the Nuclear Security Series of international consensus guidance publications on nuclear security. The IAEA's work also focuses on helping to minimize the risk of nuclear and other radioactive material falling into the hands of terrorists and criminals, or of nuclear facilities being subjected to malicious acts.

The IAEA safety standards provide a system of fundamental safety principles and reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from the harmful effects of ionizing radiation. The IAEA safety standards have been developed for all types of nuclear facilities and activities that serve peaceful purposes, including decommissioning.

The IAEA also verifies through its inspection system that Member States comply with their commitments under the Nuclear Non-Proliferation Treaty and other non-proliferation agreements to use nuclear material and facilities only for peaceful purposes.

The IAEA's work is multi-faceted and engages a wide variety of partners at the national, regional and international levels. IAEA programmes and budgets are set through decisions of its policymaking bodies — the 35-member Board of Governors and the General Conference of all Member States.

The IAEA is headquartered at the Vienna International Centre. Field and liaison offices are located in Geneva, New York, Tokyo and Toronto. The IAEA operates scientific laboratories in Monaco, Seibersdorf and Vienna. In addition, the IAEA supports and provides funding to the Abdus Salam International Centre for Theoretical Physics, in Trieste, Italy.

Sixty years and beyond — contributing to development

By Yukiya Amano, Director General, IAEA

2017 marks the 60th anniversary of the establishment of the IAEA. The technical cooperation programme has been an integral part of the Agency's work from the start. It is the main mechanism through which we have been transferring technology to Member States since 1957.

The objective of the programme is to make a real difference to the lives of millions of people in areas where the peaceful application of nuclear technology holds a comparative advantage. We support projects in areas such as health, food and agriculture, water and the environment, industrial applications, and energy. I believe that nuclear technology has a great deal to contribute to sustainable development. I welcome the fact that the United Nations Sustainable Development Goals (SDGs) explicitly recognize the importance of science and technology for development.

The IAEA provides support to developing countries by implementing technical cooperation projects. In many cases, we do this in partnership with other United Nations organizations and development agencies.

In this edition of the *IAEA Bulletin* you will find nine impact stories, each related to one of the nine SDGs for which the IAEA's work is directly relevant. You will learn about our work in helping the Dominican Republic control the spread of the Mediterranean fruit fly, which threatened fruit and vegetable production in the entire Caribbean region (page 4). You will gain an insight into how doctors and medical physicists provide radiotherapy treatment to thousands of patients in Myanmar with the help of the IAEA (page 6). And you can read how farmers in southeast Asia are harvesting more rice from new varieties of crops developed using nuclear techniques (page 14).

You will also have an opportunity to hear from researchers who, after holding IAEA fellowships, are applying nuclear technology in their countries to monitor and fight marine pollution (page 16), and you will discover how scientists in Croatia used nuclear techniques to study an ancient statue found under the sea (page 12).

This edition of the *IAEA Bulletin* was produced for the International Conference on the IAEA Technical Cooperation Programme: Sixty Years and Beyond — Contributing to Development, taking place in Vienna from 30 May to 1 June 2017. The conference is an opportunity for Member States, United Nations agencies and other partners to explore ways of working together even more effectively for the benefit of the people we serve.

I hope you will find this overview of the IAEA technical cooperation programme interesting and informative.

"It [the technical cooperation programme] is the main mechanism through which we have been transferring technology to Member States since 1957."

— Yukiya Amano, Director General, IAEA

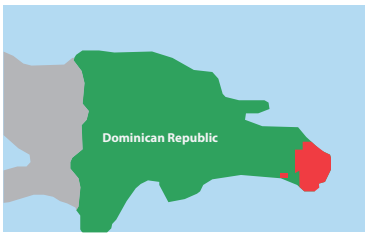
(Photo: C.Brady/IAEA)

(Photo: C. Brady/IAEA)

(Photo: Department of Atomic Energy, India)

Foreword

60 Years: Contributing to Development



From inside the IAEA

IAEA Updates

How the IAEA contributes to the SDGs

Dominican Republic uses nuclear technology to win the war against fruit flies

By Laura Gil

A group of men in sun hats gather around a cardboard trap for flies. They inspect it with their pencil-shaped UV lamp, nod, and smile from time to time. These insect specialists have left their lab coats behind to help the Dominican Republic verify its success in controlling the Mediterranean fruit fly, a pest that cost the country US $40 million in lost exports last year. The men nod again, satisfied that the trap contains no wild flies.

"For us, it became a trauma. I would go to sleep thinking of the fly, I would dream of the fly, and in the morning, I would wake up with the fly in my mind."

— Ángel Estévez, Minister of Agriculture, Dominican Republic

The Mediterranean fruit fly was reported for the first time in March 2015 in Punta Cana, the eastern region of the island. As soon as the Government announced the presence of this pest, the United States of America banned the import of 18 fruits and vegetables from the Dominican Republic, severely affecting the country's main source of income after tourism: agricultural exports.

But, thanks to a quick response by the Dominican Republic Ministry of Agriculture and with the support of the IAEA, the Food and Agriculture Organization of the United Nations (FAO) and the United States Department of Agriculture (USDA), the outbreak was contained in just ten months. The result? In January 2016, the USA lifted the agro-ban for most of the country.

"It [the ban] was disastrous," said Pablo Rodríguez, financial manager of Ocoa Avocados, the country's top exporter of green king avocado. "Almost all we do is export, so you can imagine our loss. Just because of a few flies, we all had to pay." Ocoa Avocados' losses amounted to US $8 million.

Others could adapt more easily. Cory St Clair is a small producer in Cabeza de Toro. He had just planted chillies and red peppers when the ban was introduced, and he started looking for other markets straight away. Now he sells mainly to Canada and Europe. "We were lucky," he said. "But bigger exporters were not."

Fear of the flies

While most of the flies were spotted in non-commercial almond trees along the coast, there was a fear that they might also invade commercial fruit and vegetable farms.

"We could have easily lost approximately US $220 million if the fly had reached the areas where the horticultural industry is concentrated," said Minister of Agriculture Ángel Estévez, "which means losing around 30 600 jobs directly and indirectly. We are a small country, and the livelihoods of thousands of people working in the horticultural sector depend on exports."

In 2014 and 2015, fruits and vegetables accounted for approximately 30% of food exports, earning the country around US $610 million per year, according to the Central Bank of the Dominican Republic. The agriculture sector is also the third largest source of employment.

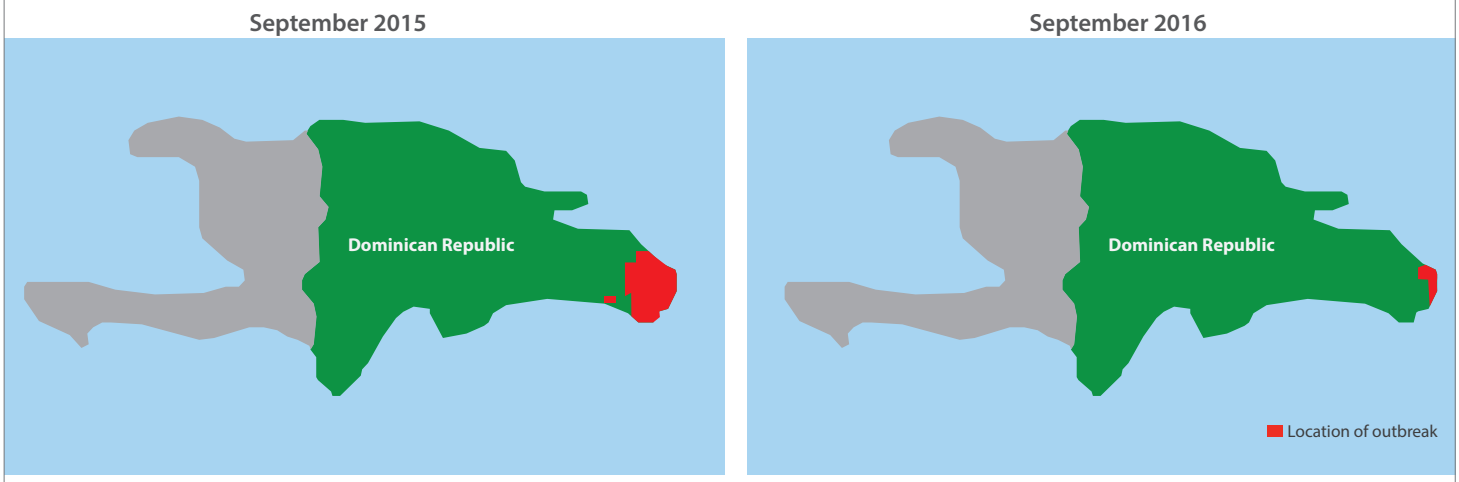
When the Government detected the outbreak, it did not have the adequate institutional capacity to respond, Minister Estévez said. "For us, it became a trauma. I would go to sleep thinking of the fly, I would dream of the fly, and in the morning, I would wake up with the fly in my mind."

Radiation to the rescue

When the Ministry of Agriculture asked for assistance in March 2015, the IAEA and the FAO helped the Ministry and its partners launch an integrated pest eradication campaign with the support of the Animal and Plant Health Inspection Service of USDA (USDA-APHIS), the International Regional Organization for Plant and Animal Health (OIRSA) and the Inter-American Institute for Cooperation on Agriculture (IICA).

The authorities established an extensive network of traps in strategic spots to determine the spread of the pest, destroyed infested almonds, guavas and caya fruits, sprayed insecticide mixed with a food

Location of the Mediterranean Fruit Fly Outbreak



attractant in hot spots, and imposed strict controls in the rest of the country, including ports and airports. But the key to containing the fly population was a nuclear-based method of 'birth control' for insects, called the sterile insect technique (SIT).

SIT involves rearing large numbers of male flies and sterilizing them with ionizing radiation. These sterile flies are then released from the ground and by air over pest-infested areas, where they mate with wild populations, which then do not produce offspring.

"It's amazing to me," St Clair said. "When I first heard about it, it sounded like science fiction." Thanks to the intensive weekly release of millions of sterile Mediterranean fruit flies, the outbreak was controlled and the USA lifted its ban in 23 of the 30 affected provinces within ten months.

SIT is among the most environmentally friendly control tactics available, and is usually applied as part of an integrated campaign to control insect populations. The IAEA and the FAO jointly support about 40 SIT field projects, delivered through the IAEA technical cooperation programme in different parts of Africa, Asia, Europe, and Latin America and the Caribbean.

"We're hitting the fly right where it hurts," said Rafael Antonio Cedarro, a trap reviewer in La Romana, one of the areas under surveillance. "In this area, we have 195 traps, and in the past months we have trapped no wild flies." These 195 are just some of the 14 525 traps placed around the country to verify that the outbreak is under control.

"We're impressed by the fast progress achieved in only a few months," said Walther Enkerlin, an entomologist at the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

No future for pests

The technical cooperation assistance provided by the IAEA, the coordinated emergency response and the Ministry's containment of the outbreak have led to a number of knock-on benefits, not only for the Dominican Republic but for the entire region.

"The project has prevented the spread of the fly to other Caribbean and mainland countries, including Mexico and the USA, avoiding large economic losses," Enkerlin said.

The Ministry of Agriculture now has the necessary technical and human capacity to tackle this and other outbreaks and to share lessons learned and know-how, said Frank Lam, IICA representative in the Dominican Republic. "It has been a costly experience that we want to share so that it doesn't happen to other countries. We don't want others to face this without being prepared," Lam said.

Minister Estévez is working together with his counterpart in Haiti to develop a strategy to protect the entire island of Hispaniola, which they share, and avoid future infestations. "It's not worth controlling the outbreak on one side of the island if it will appear on the other," he said. "Insects have neither ID nor passport. But now we have the right capacity in place to face this invisible threat."

As a spinoff from the technical cooperation project, about 300 people worked under the Ministry of Agriculture's programme in charge of controlling and eradicating the outbreak at the peak of the eradication phase.

The IAEA has trained specialists from the Dominican Republic on SIT through 3 technical cooperation interregional projects. The country is currently participating in 2 regional projects related to SIT.

Yangon radiologists, medical physicists juggle to provide cancer patients with quality care

By Miklos Gaspar

Mya Mya Kyi is in a hurry, trying to cut through a throng of patients waiting for their turn in the hallways of the Radiotherapy Department at Yangon General Hospital in Myanmar. As the department's chief medical physicist, she is in charge of therapy planning for the almost 300 patients per day who receive cancer treatment on the hospital's four radiotherapy machines.

"Treatment plans, dosimetry calculations, daily audit of the machines and quality control — the day is never long enough for all of this."

— Mya Mya Kyi, Medical Physicist, Radiotherapy Department, Yangon General Hospital, Myanmar

While the country's Ministry of Health has bought radiotherapy equipment for the Yangon hospital and three similar facilities around the country, training for medical physicists, including training in quality assurance of the radiotherapy equipment, is not available locally. Mya Kyi and her colleagues rely on the IAEA for these services.

"Treatment plans, dosimetry calculations, daily audit of the machines and quality control — the day is never long enough for all of this," she says while making her way from a room with a cobalt-60 machine to her workstation, where she prepares treatment plans.

Medical physicists work with the sophisticated technology used in radiation medicine to diagnose and treat patients with diseases such as cancer. They need to have knowledge of both the human body and the principles of physics, and know how to apply these principles to support the diagnosis and treatment of patients.

Radiotherapy: from the margins to the mainstream

The demand for radiotherapy has increased threefold over the past ten years, said Professor Khin Cho Win, head of the radiotherapy department at Yangon General Hospital. Last year, the Department received 6200 new patients, the majority of whom needed radiotherapy. This compares with just 2000 cases in 2005. "We expect this trend to continue," Cho Win said.

What will hopefully gradually change is the characteristics of the patients. Many people with cancer do not go to see their doctor until it is too late, and at that point are referred to radiotherapy only for palliative care. Half of the radiotherapy patients at Yangon General are in the final stages of cancer, when the only care available is pain relief during the final phase of the disease. By contrast, in developed countries, only 14% of new cancer patients need palliative radiotherapy — the majority undergo treatment intended to cure their cancer. An IAEA mission conducted in 2015 to assess Myanmar's cancer control services recommended the establishment of dedicated palliative care services and an expansion of primary care facilities and home-based care.

Opening up more radiotherapy centres and increasing access to these facilities is high on the country's health agenda. There are just 18 radiotherapy machines for Myanmar's population of 52 million. This is significantly below the level of one machine per one million people recommended by the World Health Organization (WHO).

Myanmar is not alone: according to the IAEA Directory of Radiotherapy Centres (DIRAC) database, most radiotherapy facilities in the world are located in high-income countries, and at least 36 nations do not have any of this equipment to treat cancer.

IAEA assistance

The IAEA is doing its part to help and will continue to support staff at Myanmar's cancer centres, said Ho-Seung Lee, who is in charge of the IAEA technical cooperation programme with Myanmar.

The five medical physicists and the dozen radiologists at Yangon General participate in IAEA-organized training courses, go on scientific visits to institutions in neighbouring countries with more experience in using state-of-the-art radiotherapy equipment, and send dosimetry measurements to the

Staff of the Nuclear Medicine Department at Yangon General Hospital have received training from IAEA experts and partners on the safe and effective use of their new equipment.
(Photo: M. Gaspar/IAEA)

IAEA laboratory near Vienna to check the calibration of their radiotherapy machines. This ensures that patients get the right dose: high enough to be effective, but not a centigray more, so as not to deliver more radiation than absolutely necessary for the treatment. Lately, the health professionals have also begun using the IAEA's online learning tools, offered via the Human Health Campus. "We only wish internet connectivity were better," Mya Kyi says.

Radiation physics and dosimetry are the cornerstone of safe and effective radiotherapy for the treatment of cancer, and are also essential to quality assurance in other radiation medicine disciplines, said May Abdel-Wahab, Director of Human Health at the IAEA. "IAEA support helps countries like Myanmar ensure that accurate doses are delivered and appropriate training is given to medical physicists, radiation oncologists and others involved in radiation medicine to achieve an optimal outcome for patients."

Nuclear medicine: using isotopes to diagnose disease

Staff at the Yangon Hospital Department of Nuclear Medicine, which performs crucial services in the diagnosis of various diseases and in treating thyroid cancer, has also received new equipment from the Government, including the first cyclotron facility and the first positron emission tomography/ computed tomography (PET/ CT) facility in the country.

The cyclotron is used for the production of radioisotopes essential for 'acquisition PET/ CT' studies, which are crucial to the early diagnosis of several diseases, including cancer and cardiovascular disease. The health professionals have also been given two single-photon emission computed tomography (SPECT) cameras; SPECT is another nuclear medicine imaging technique that uses gamma rays to carry out functional scans of the brain, thyroid, lungs, liver, gallbladder, kidneys and skeleton.

Since they were the first in Myanmar to use such equipment, the department's staff did not have anybody to turn to locally for expertise and training, explained the department head, Professor War War Wan Maung. So she sent her colleagues on IAEA-sponsored fellowships to hospitals in neighbouring countries.

Following an earlier request to the IAEA, the department underwent an IAEA Quality Management Audit in Nuclear Medicine Practices (QUANUM) in September 2016, which pointed out a few areas for improvement to ensure higher-quality care.

"We have already corrected all of the six problems found," Wan Maung said. These included replacing the floor in the treatment room, for which the IAEA report helped the hospital secure extra funding from the Government. "This is an excellent outcome for us and our patients."

Myanmar has benefitted from over 30 fellowships and scientific visits and 6 national technical cooperation projects in the field of radiation medicine and health over the past 10 years. Myanmar has also participated in over 30 regional technical cooperation projects dedicated to health.

Scientists explore groundwater in the Sahel with nuclear technology

By Laura Gil

In the deserts of the Sahel, one of the poorest regions of the world, rich bodies of water underground provide a source of life. Using nuclear-derived techniques, scientists from 13 African countries have carried out the first ever regionwide assessment of groundwater in this area of 5 million square kilometres, with the help of the IAEA. They have so far gathered valuable clues — including the widespread presence of good quality and recently recharged groundwater, contamination levels, and flow patterns that connect the different aquifers and basins.

"People need water to live — and to manage water, you need to understand it."

— Beatrice Ketchemen Tandia, Hydrogeologist and Head, Cooperation Division, Department of National Sciences, University of Douala, Cameroon

"This information is like gold," said Eric Foto, head of the isotope hydrology laboratory at the University of Bangui in the Central African Republic. "With it we can tell the Government where we have shallow, renewable water to drill wells, where pollution comes from, or how long quality water will last."

To policy-makers who struggle to ensure that safe potable water is available in this region, such findings are critical.

The Sahel stretches from western Africa to central and northern Africa and is home to 135 million people. One of the biggest challenges is access to clean water, which is essential not only for drinking, but also for food production and sanitation.

"People need water to live — and to manage water, you need to understand it," said Beatrice Ketchemen Tandia, Head of the Cooperation Division at the Department of National Sciences of the University of Douala in Cameroon, who has participated in IAEA research projects as a hydrogeologist since the early 1990s.

Through its technical cooperation programme, the IAEA has provided equipment and trained local scientists from 13 countries — Algeria, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Ghana, Mali, Mauritania, Niger, Nigeria, Senegal and Togo — to study five main aquifer systems that cross their borders: the Iullemeden aquifer system, the Liptako-Gourma-Upper Volta system, and the Senegalo-Mauritanian, Lake Chad and Taoudeni basins.

Throughout the project, information on progress made was regularly shared with partner organizations including the United Nations Educational, Scientific and Cultural Organization (UNESCO) and basin authorities — the Niger Basin Authority, the Lake Chad Basin Commission, the Volta Basin Authority, the Integrated Development Authority of the Liptako-Gourma region, and the Organization for the Development of the Senegal River — as well as the German Federal Institute for Geosciences and Natural Resources.

The goal: help save water

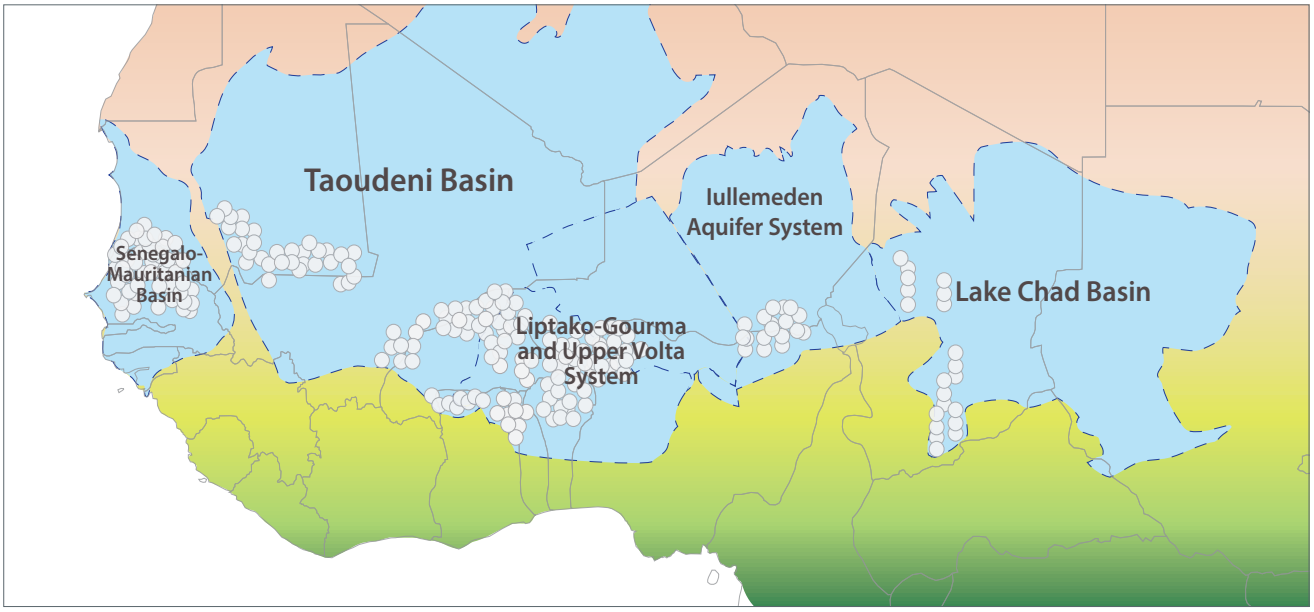
During the past few decades, the Sahel has suffered from extreme drought, adversely affecting agriculture and causing widespread hunger. Without many rivers to draw water from, the five transboundary water systems studied here represent the main water supply for the population.

So far, scientists from each country have published major findings, which include recommendations for governments to draw up plans to save water and protect it from pollution. The next step will be to integrate these findings at the regional level and publish a comprehensive report — expected later this year — that will identify common priorities and threats and recommendations to enhance the sustainable management and rational use of the shared aquifer systems.

"Running out of water can lead to hunger, and hunger can lead to conflict," Foto said. "The earlier we know about our water, the earlier we can manage it."

How they do it

Scientists study the different isotopes present in water to determine various factors and



Location of the five aquifer basins and systems studied in the Sahel. The dots on the map show where scientists collected water samples.
Image: IAEA

processes, including its source, age, recharge flow and quality (see The Science box).

"Whilst African institutions have relied on external consultants, now they are able to do the work alone," said Neil Jarvis, a member of the project team at the IAEA. "Our assistance has permitted each country to take charge of its activities."

Over the past five years, local scientists have collected almost 2000 samples from wells, rivers and rain in the Sahel's most populated, often cross-border areas. IAEA experts have helped them analyse these samples, using isotopic and other chemical parameters. They also have helped in the interpretation of the data, training experts from across the Sahel. Local scientists now have a broad understanding of isotope hydrology, and access to a network of specialists from 12 other countries they can compare results with.

However, challenges remain. Many parts of the Sahel suffer from conflict and strife, including areas where water samples needed to be collected. In the area of the Lake Chad basin, for example, the security situation was sometimes an impediment.

"Scientists in neighbouring countries could almost never go to the area to take samples because of armed rebel groups," Foto said. "But what we do is travel with colleagues from non-governmental organizations and take advantage of their protection. Work goes on."

THE SCIENCE
Isotope hydrology

Water molecules carry unique 'fingerprints' based on their different proportions of isotopes, which are chemical elements with atoms that have the same number of protons, but a different number of neutrons. They may be natural or artificial. Radioisotopes are unstable and are constantly releasing energy called radioactivity as they decay to regain stability. Scientists can measure the period of time it takes for half of the radioisotopes to decay, which is known as the half-life. By knowing the half-life of a radioisotope and the isotope content in water or in other substances, scientists can determine the age of water containing those radioisotopes.

Stable isotopes do not disintegrate and remain constant throughout the entire period they are present in water. Scientists use the different isotope contents in surface water and groundwater to determine various factors and processes, including sources and history of water, past and present rainfall conditions, recharge of aquifers, mixing and interactions of water bodies, evaporation processes, geothermal resources and pollution processes.

Isotope hydrologist takes water samples from a well in Bangui, Central African Republic
(Photo: L. Gil/IAEA)

Morocco considers nuclear power in future energy mix

By Jennet Orayeva

With its electricity consumption expected to increase considerably in the coming years and with a high dependence on imported energy sources, Morocco is evaluating whether nuclear power could be an option for its 2030 energy mix. Affordable and clean energy is vital to meeting Morocco's growing electricity demand to sustain its socioeconomic development.

"Morocco's national energy strategy is considering nuclear power as a long-term alternative to meet the country's future needs, but no decision has been made so far," said Khalid El Mediouri, Director General of the National Centre for Nuclear Energy, Sciences and Technology (CNESTEN) and Chair of the Nuclear Power and Seawater Desalination Committee (CRED), set up in 2009 by the Ministry of Energy, Mines, Water and Environment. "For this purpose, we undertook a global evaluation of these conditions alongside the infrastructure required for a nuclear power project compliant with international standards."

Today, nearly 30 countries around the world are considering or actively embarking upon such a programme. The IAEA helps these countries build their knowledge in energy planning, analysis and nuclear expertise. In the past two years in Africa, the IAEA has conducted four Integrated Nuclear Infrastructure Review (INIR) missions to Ghana, Kenya, Morocco and Nigeria.

In October 2015, Morocco hosted an INIR mission and developed an action plan to address the mission's recommendations and suggestions.

"Morocco recognizes the importance and the usefulness of the IAEA's Milestones approach and its associated technical assistance programmes," El Mediouri said, referring to an IAEA methodology that guides countries and organizations to work in a systematic way towards the introduction of nuclear power. "Through the integrated work plan, the IAEA continues its valuable assistance for the implementation of the INIR mission recommendations. This supports further progress in Morocco's nuclear infrastructure development."

Nuclear technology for socio-economic development

Morocco has participated actively in the IAEA technical cooperation programme to strengthen its capacities for the peaceful use of nuclear technology. Multiple projects have helped the country build local capabilities in conducting an energy planning study and nuclear power assessment. The country is also benefiting from an IAEA coordinated research project that helps decision makers consider all energy supply technology options.

The country's experience with nuclear technology dates back to the 1950s: it has used nuclear techniques in medicine,

IAEA energy planning tools help evaluate options

At the request of a Member State, the IAEA provides guidance and technical support for evaluating energy options, including nuclear energy. While providing assistance in this area, the IAEA does not influence Member States' choice of energy options. Its energy planning approach provides an opportunity to evaluate all energy options equally.

Nuclear Research Centre of Maamora, Morocco.
(Photo: CNESTEN)

agriculture and industrial applications. Under the supervision of CNESTEN, Morocco operates the MA-RA1 research reactor at the Maâmora Nuclear Research Centre. It is used for research in nuclear energy, neutron activation analysis, geochronology research, education and training.

Morocco is playing an important role in strengthening South–South cooperation by providing IAEA-supported education and training for African countries, mainly through regional designated centres in the fields of radiation safety, radiotherapy, nutrition, non-destructive testing and water resources.

Integrated Nuclear Infrastructure Review (INIR)

The Integrated Nuclear Infrastructure Review (INIR) is a holistic peer review to assist Member States in assessing the status of their national infrastructure in respect of the introduction of nuclear power. The review covers the comprehensive infrastructure required for developing a safe, secure and sustainable nuclear power programme.

Upon request from a Member State, the IAEA conducts an INIR mission, sending a team of international experts who have direct experience in specialized nuclear infrastructure areas, and also IAEA staff. Before receiving an INIR mission, the country must complete a self-evaluation of the 19 nuclear power infrastructure issues included in the IAEA's 'Milestones' approach, a comprehensive methodology that guides countries and organizations to work in a systematic way towards the introduction of nuclear power.

INIR missions enable IAEA Member State representatives to conduct in-depth discussions with international experts about experiences and best practices in nuclear power infrastructure development. Recommendations and suggestions are provided in a report to the Member State. By providing a comprehensive assessment of all facets of a nuclear power programme, spanning the regulatory body, utilities and all relevant government stakeholders involved, INIR helps ensure that the infrastructure required for the safe, secure and sustainable use of nuclear power is developed and implemented in a responsible and orderly manner.

Nuclear techniques help European countries understand and preserve cultural heritage

By Jeremy Li

Before a piece of ancient artefact is displayed at exhibitions, experts need to determine its origins and carry out the necessary restoration work. Error or mistake in any of the many steps involved could cause irreparable damage to the artefact. Thanks to various nuclear techniques and IAEA support, several countries in Europe have acquired the skills they need to process and restore their cultural artefacts efficiently and safely.

The technical cooperation programme has supported 3 scientific visits and fellowships in this field in Bulgaria, and 5 scientific visits and fellowships in Croatia.

Such techniques were used on an Apoxyomenos — an ancient bronze statue of a young athlete — in Croatia. After resting 45 metres underwater for some 20 centuries, it was retrieved by archaeologists in 1999 from the seabed near a small island in the Adriatic Sea. When first discovered, the statue was tarnished beyond recognition. Thanks to several techniques involving ionizing radiation, experts were able to analyse the statue's age and the type of metals used, and restore it.

"Restorers need to first characterize the artefact — gather enough information — in order to know precisely what method to use for the restoration to be successful," said Stjepko Fazinić, Research Advisor at the Ruđer Bošković Institute in Croatia. "Insufficient characterization of artefacts can lead to significant damage, because you might apply the wrong technique to restore these objects. Ionizing radiation can help us minimize this risk."

To promote the use of nuclear techniques for the conservation of cultural heritage, the IAEA has been assisting Croatia with training and equipment since 1993 through a series of technical cooperation projects.

Under one such project, the IAEA provided Croatia with mobile X-ray fluorescence spectroscopy equipment (see The Science box), which helped scientists analyse more than 1000 samples of ancient artefacts within the project's first year. "We are able to determine the age of more than 170 archaeological samples every year using nuclear techniques," Fazinić said.

Beating the bugs

But even when all the steps of the restoration process are strictly followed, artefacts of organic origin are still susceptible to severe deterioration due to insects and bacteria, for example.

"Textiles, wood, paper, leather objects and mummies are extremely vulnerable," Fazinić said.

Gamma-ray panoramic irradiation is a frequently used technique for sterilization to destroy biological contaminants. It uses a radioactive source, primarily cobalt-60, to induce chemical changes in the DNA of these harmful organisms and eliminate them. In 2015, the IAEA provided cobalt-60 sources to Croatia to aid this effort.

"Every year, our colleagues from the radiation chemistry and dosimetry laboratory irradiate about 20 m^3 of materials with this technique," Fazinić said. "Over the past 20 or so years, they have sterilized more than 5000 artefacts."

The Ruđer Bošković Institute and the Croatian Conservation Institute are two of the IAEA's main counterparts in the conservation of cultural heritage. Early comers to the game, the Croatians have been using nuclear analytical techniques for decades and are now sharing their knowledge by training scientists from other countries, such as Bulgaria.

Bulgaria: increasing the use of the radiocarbon dating technique

"In Bulgaria, our first sign of human activity dates back to 40 000–50 000 years ago," said Vladimir Dimitrov, professor at the Institute of Organic Chemistry's Centre of Phytochemistry at the Bulgarian Academy of

Sciences. "We have a very rich history, full of cultural heritage, and there is much more waiting to be discovered."

Besides the sheer volume of unexcavated artefacts, lack of funding and equipment are major obstacles in uncovering Bulgaria's past, Dimitrov said.

"We don't have our own laboratory to carry out the dating analysis, so to determine the age of an artefact we must send the samples to other countries, which is not cheap and takes a long time," he said. Transporting the samples can also increase the risk of damage.

One of the most commonly used methods for age determination of organic archaeological finds is the analytical technique called radiocarbon dating (see The Science box). "Our institute has individuals with skills and knowledge in applying the technique, but we don't yet have the capacity to build a full laboratory," Dimitrov said.

An ongoing IAEA technical cooperation project will provide Bulgaria with the necessary support, including equipment to establish a radiocarbon dating laboratory. The laboratory is expected to be fully functional later this year.

The head of the Apoxyomenos statue that was found in the Adriatic sea, after treatment.
(Photo: Ruđer Bošković Institute)

"Once the laboratory is up and running, we expect to spend 20% to 30% less money on determining the age of ancient artefacts," Dimitrov said. "So we can do more with less."

THE SCIENCE

X-ray fluorescence (XRF) spectroscopy

XRF is a method that detects and measures the concentration of elements in virtually all types of material. Scientists normally use a small and mobile X-ray fluorescence spectrometer to bombard a sample of the test material with high-energy X-ray beams. The beam interacts with the atoms in the sample, displacing the electrons in the inner shell of these atoms. When an electron is displaced, it leaves behind a vacancy that will be filled by an electron from the higher orbit. When an electron moves from a higher orbit to a lower one, a certain amount of energy is lost. This energy loss is detected by the spectrometer and is used to identify the element it originates from. The method is accurate because the amount of energy loss is unique to each element.

Radiocarbon dating method

The radiocarbon dating method measures the amount of radiocarbon (carbon-14) in organic material — such as leather and wood — to determine the age of that material. Carbon-14 is an isotope of carbon that is constantly formed in the natural atmosphere. It is quickly absorbed by all living organisms. When organisms die, they stop absorbing carbon-14 and immediately start decaying. Because carbon-14 has a very long half-life (5730 years), the age of the sample can be determined by measuring its radioactivity level.

However, this method can only give an approximate age for the sample, usually a range of a few years.

Bangladesh triples rice production with help of nuclear science

By Nicole Jawerth

New varieties of rice developed using nuclear techniques have helped Bangladesh increase its rice production threefold in the last few decades, despite increasingly harsh climatic conditions. This has enabled the country to establish a secure and steady supply of rice, while staying one step ahead of its rapid population growth.

"I have more rice for my family, and I now earn almost double with the rice and mustard seed I grow, compared to before," said Suruj Ali, a farmer from Gerapacha village near the border of Bangladesh and India, who grows a new type of rice plant called Binadhan-7. "I also save money because I don't have to spray as much for insects."

Binadhan-7 is one of several rice varieties developed by scientists at the Bangladesh Institute of Nuclear Agriculture (BINA), with the support of the IAEA and the Food and Agriculture Organization of the United Nations (FAO). It was developed through a process which uses radiation, called plant mutation breeding (see The Science box), and has become a popular rice variety in the northern part of the country, helping farmers and workers stabilize their income and find year-round employment.

Globally, more than 3000 plant varieties have been developed and released using plant mutation breeding techniques. These varieties will continue to play a key role in meeting global food demand, as the world's population rapidly grows and environmental conditions become more challenging.

"Plant mutation breeding saves time and money for researchers, and results in the kinds of plants farmers need to cost-effectively keep food on the table and money in their pockets," said Ljupcho Jankuloski, Acting Head of the Plant Breeding and Genetics Section of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. "For many farmers, these plant varieties are a game-changer."

Helping farmers in northern Bangladesh

What sets Binadhan-7 apart from local rice varieties is its shorter growing time and ability to produce more rice. Local varieties produce around 2 tonnes of husked rice per hectare and take about 150 days to mature for harvest. Binadhan-7 produces around 3.5 to 4.5 tonnes per hectare and takes around 115 days.

The extra weeks that local rice varieties take to grow are a problem, as the rice is exposed to increasingly harsh weather

The IAEA's technical cooperation programme has supported 40 fellows and scientific visitors from Bangladesh in the field of food and agriculture over the past 10 years. Three national projects related to agriculture are currently active.

The Binadahn-7 rice variety, developed by scientists at the Bangladesh Institute for Nuclear Agriculture, Mymensingh, Bangladesh.
(Photo: N. Jawerth/IAEA)

events and insects as temperatures shift with the changing seasons — a situation that is worsening as climate change causes more variable and extreme weather. It also leaves too little time to grow another crop before the seasons change, resulting in several months between seasons where fields lie unused.

"I used to only be able to grow two crops and would have several months each year without anything, but with Binadhan-7 I can now grow three crops and earn money all year long," Ali said. He, along with his family of five, lives off 3 acres of land where he grows rice and mustard seed. "I've used that extra money to build two new extensions for my house. I hope I can earn enough to send my kids abroad someday."

Since its release in 2007, Binadhan-7 has helped to improve the livelihoods of more than 20% of the people living in the northern region, according to BINA.

No meal is complete without rice

New rice varieties like Binadhan-7 help to address the demand for this staple food in Bangladesh.

"For most Bangladeshi people, a meal is not a meal if it does not include rice," said Mohammad Moinuddin Abdullah, Secretary at the country's Ministry of Agriculture. "With a projected population of 195 million by 2030, this puts immense pressure on rice production."

A cornucopia of new crops

Thirteen new rice varieties have been developed by BINA since the 1970s using plant mutation breeding, in part through assistance from the IAEA and its technical cooperation programme. More than 40 new crop plant varieties have been developed in the country using this technique, including chickpeas, jute, lentils, mustard seed, peanuts, sesame seed, soybean, tomato and wheat.

These new varieties help Bangladeshi farmers deal with enduring problems such as water shortages, drought, salty soil and soil degradation, which make it difficult for crops to survive and make land unusable for farming.

Like Bangladesh, many countries throughout the region work with plant mutation breeding to ensure people have food despite increasingly harsh climatic conditions. In October 2016, Bangladesh hosted an IAEA-organized training course on plant mutation breeding for new rice varieties for scientists from 12 countries in the region. Participants exchanged experiences and shared materials to refine and advance their research. Part of this training focused on helping young scientists to develop their skills and knowledge in advanced plant breeding techniques to ensure this work continues in their countries.

This course is one of several IAEA technical cooperation and coordinated research projects related to plant mutation breeding hosted worldwide each year.

"I have more rice for my family, and I now earn almost double with the rice and mustard seed I grow, compared to before."

— Suruj Ali, farmer from Gerapacha village, Bangladesh

THE SCIENCE

Plant mutation breeding

Plant mutation breeding is the process of exposing plant seeds, cuttings or a shredded plant leaf to radiation, such as gamma rays, and then planting the seed or cultivating the irradiated material in a sterile rooting medium, which generates a plantlet. The individual plants are then multiplied and examined for their traits. Molecular-marker-assisted breeding, often referred to as marker-assisted selection, is used to accelerate the selection of plants with desired traits, carried by genes of interest.

Plant mutation breeding does not involve gene modification, but rather uses a plant's own genetic resources and mimics the natural process of spontaneous mutation, the motor of evolution. By using radiation, scientists can significantly shorten the time it takes to breed new and improved plant varieties.

IAEA fellows protect the marine environment

By Oleksandra Gudkova

Researchers trained at the IAEA Environment Laboratories in Monaco are applying various nuclear techniques back in their home countries to preserve the marine environment. The techniques are helping the former IAEA fellows better protect their oceans and seas — from fighting toxic algal blooms to tracing pollutants in water.

"To foster sustainable development, it is not only important that researchers establish the techniques back in their countries, but that they also transfer the knowledge and expertise they have gained to their colleagues," said Marie-Yasmine Dechraoui Bottein, a research scientist at the IAEA Environment Laboratories. A few months after training the fellows, IAEA experts visit the countries to provide further advice and support them in ensuring the full operation of the laboratories, she added.

Through fellowships, the IAEA's technical cooperation programme strengthens capacities and expands opportunities for professionals working with nuclear science and technology.

Last year, for example, experts from Cuba, Morocco, the Philippines, Singapore, Sri Lanka and Tunisia had the opportunity to participate in specialized fellowships. This article provides an overview of what some of them learned.

Researchers at the IAEA Environment Laboratories study pollutants in the oceans and in marine organisms. (Photo: J. Weilguny/IAEA)

Helping fight toxic algal blooms

Biotoxins — toxic substances of biological origin — are a global problem. They come in many forms and can be produced by nearly any type of living organism, from animals to fungi. When toxin-producing algae grow in large quantities, they can affect marine organisms. These phenomena are called harmful algal blooms, or HABs.

If people eat seafood contaminated by biotoxins, they can be poisoned and their lives threatened. It is therefore important to detect biotoxins before the seafood reaches people's plates.

Last year, fellows from affected countries, including Morocco, the Philippines and Tunisia, spent between one and six months at the IAEA laboratories, learning how to detect biotoxins in seafood to better manage HABs.

"Our laboratory will be the first in Morocco to use the technique I learned during my training in Monaco," said Jaouad Naouli, who works at the Water and Climate Division of Morocco's National Centre for Nuclear Energy, Sciences and Technology (CNESTEN).

Naouli's training included learning to apply the receptor binding assay (RBA) technique for biotoxin analysis. RBA focuses on the properties of biotoxins and on the interactions between biotoxins and the receptors they bind with. By using radiolabelled biotoxins, this method allows scientists to determine the quantity of toxins that are present in seafood or in seawater.

"With this highly specific, sensitive and rapid technique, we will have a stronger biotoxin monitoring programme in Morocco," Naouli added.

Singapore's environmental monitoring programme

In 2016, the IAEA Environment Laboratories hosted, as part of an IAEA technical cooperation project, four fellows from Singapore's National Environment Agency

Scientist at the IAEA Environment Laboratories in Monaco.
(Photo: J. Weilguny/IAEA)

and the Public Utilities Board, Singapore's national water agency. During their three-month stay, the fellows were trained in applying various radioanalytical techniques to measure the activity concentrations of various radionuclides in rainwater, seawater, air, animal and plant samples.

"The hands-on laboratory work allowed me to pick up new skills and good laboratory practices, and all the lectures and exercises trained me to deal with radioanalytical work independently," said Wei Ning Yap, a senior chemist at the Public Utilities Board's Water Quality Office.

They learned in particular how to extract specific radionuclides from large volumes of seawater by applying a sequential separation method.

After collecting 200 litres of seawater and separating out the targeted radionuclides, they performed tests to detect caesium, strontium and plutonium isotopes. The knowledge obtained will help them measure radioactivity levels in Singaporean seawater, seabed and fresh water sediments, and surface water from reservoirs.

"The techniques I learned give me the basis to develop various methods for local application in Singapore," Yap said. "This is very important to safeguard Singapore's water cycle from a radiological perspective."

Tracing marine pollution in Sri Lanka

Scientists at the IAEA Environment Laboratories in Monaco also train fellows in the analysis of carbon and nitrogen stable isotopes in marine samples to investigate pollution and nutrient enrichment. Nuclear and isotopic techniques can be used to trace the source of pollutants in the mixing zones of estuaries and in coastal and shallow waters. These techniques provide a unique source of information on the origins of contaminants and are used to trace their pathways in the environment. They also help scientists reconstruct past environmental conditions, allowing them to track changes in climatic conditions.

Two fellows from Sri Lanka spent two months in the laboratories in Monaco learning about these techniques and instruments. Their training in elemental analyser-isotopic ratio mass spectrometry (EA-IRMS), a technique used to measure the abundance of stable isotopes in different materials, will enable them to use a similar instrument supplied to them by the IAEA upon their return to Sri Lanka.

Scientists at the Sri Lanka Atomic Energy Board are planning to establish an EA-IRMS facility to better develop analytical procedures for stable isotope analysis and to control marine pollution in the country.

"Identifying sources of contaminants with these precise techniques is crucial, especially in the Negombo lagoon, which provides a direct livelihood for over 5000 families in around 35 villages," said Dulanjalee Rajapaksha, Scientific Officer at Sri Lanka's Atomic Energy Board. "We must continue our work to improve the water quality in our coastal waters."

Stable nitrogen isotope helps scientists optimize water, fertilizer use

By Miklos Gaspar

Experts in a growing number of countries are using a nuclear technique to help farmers increase crop yields, optimize fertilizer use and evaluate varieties of rice, cereals and vegetables for their efficiency in making the best use of fertilizers.

Research has shown that less than 40% of the fertilizer applied globally is taken up by crops, while the remaining 60% is either lost to the atmosphere or to groundwater, or is left in the soil in a form that cannot be taken up by the crop.

"We have cut fertilizer use by around a quarter on the half-acre plot where I tried the new rice variety," said farmer U Kyaw Lay, from the central village of Thar Yar Su, Myanmar. "This represents an important saving for me and my family." In the next growing season, Lay said, he will devote more of his land to this particular rice variety, which he said was also tastier than the kind traditionally used.

Lay and 20 fellow farmers, who agreed to participate in testing best practices using the varieties, received seeds from the country's Department of Agricultural Research, which experimented with 106 existing varieties of rice and identified six that use nitrogen-based fertilizers most efficiently. This means that less fertilizer is needed for their growth, said Su Su Win, Director of the Soil Science, Water Utilization and Agricultural Engineering Division. Researchers have recommended varieties for use in Myanmar's various regions, including marginal lands, typically owned by poorer farmers.

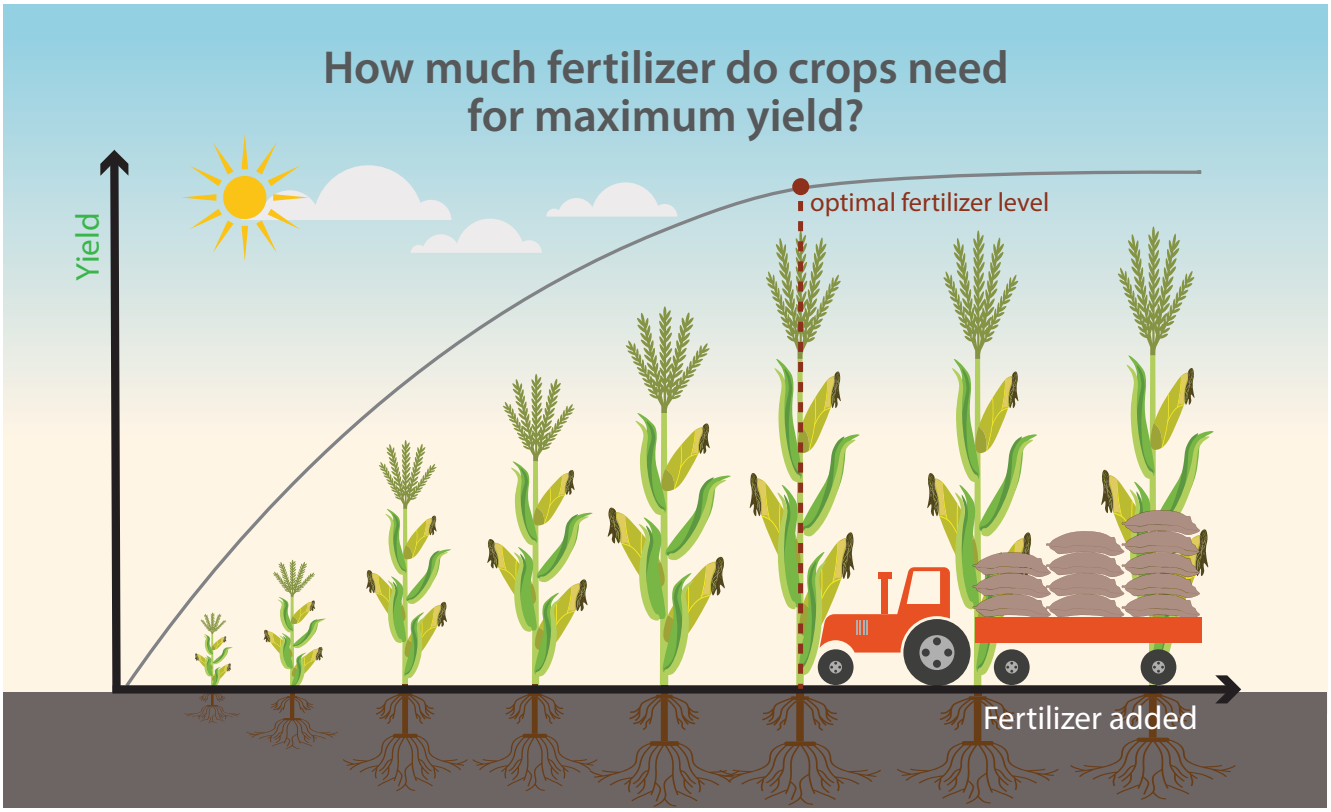
Nitrogen plays an important role in plant growth and photosynthesis, the process through which plants convert energy from sunlight into chemical energy. Nitrogen is often added to soil in the form of fertilizer. Using fertilizers labelled with nitrogen-15 (^{15}N) stable isotopes — an atom with an extra neutron compared with 'normal' nitrogen — scientists can track the isotopes and determine how effectively the crops are taking up the fertilizer. The technique also helps determine the optimal amount of fertilizer to use: after the crop has reached saturation with nitrogen, the remaining nitrogen remains in the soil and is prone to leaching (see graph).

Finding nutrient-efficient and high-yielding rice

Su Win and her team used the nitrogen-15 isotopic technique, with support from the IAEA and the Food and Agriculture Organization of the United Nations (FAO), to determine the nitrogen uptake of different kinds of rice.

"Rice is the most important crop in Myanmar and important for both food security and industrial development," Su Win said. Many of the varieties traditionally used in the country are so-called fertilizer-responsive high-yielding varieties — crops that have a high yield only when supported by fertilizers — but farmers often cannot afford fertilizers, so the yield and farmers' earnings remain poor. With the help of the nutrient-efficient new varieties now identified, farmers will have access to crops that have a higher yield without excessive fertilizer use, she said.

Nuclear techniques provide data that enhances soil fertility and crop production while minimizing environmental impact.
(Photo: M. Gaspar/IAEA)



Initial results have shown that the judicious application of nitrogen to rice crops led to fertilizer savings of around 30% and reduced the amount of fertilizer lost to the environment by 20%, while also optimizing yield, said Joseph Adu-Gyamfi, a soil fertility specialist at the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

The IAEA and the FAO support the use of this technique around the world, providing assistance through the IAEA technical cooperation programme and acting as a platform for research collaboration through numerous coordinated research projects. Currently, experts from over 100 countries are benefiting from this assistance.

Farmers in Botswana benefit from nitrogen-15 technique

In Botswana, soil scientists are in the earlier stages of using the technique to determine the amount of fertilizer required for green pepper, spinach and other horticultural crops and soils.

"Soil types are different all over the world, so we cannot just use results obtained elsewhere," said Kelebonye Bareeleng of the National Soil Laboratory. "We need to find the right amount of nitrogen needed by our particular crops."

The experiments are still ongoing but, from the initial results, Bareeleng estimates that between one quarter and one half of the fertilizer used on cereal fields could be wasted. Not only does this represent an unnecessary additional expense for farmers, but the unused nitrates could also spoil groundwater near agricultural areas. "For a country like Botswana that relies on underground reservoirs for its drinking water, this is too risky," she said.

In the fledgling horticulture sector, where producers are trying to compete with imports from South Africa, fertilizer represents the highest input cost, so cutting its use significantly has the potential to make the industry much more competitive, Bareeleng said. "This may be the key to the development of this sector in Botswana," she said.

Cabbage in Viet Nam

In Viet Nam, results obtained using the nitrogen-15 technique showed that as much as half of the fertilizer applied to cabbage fields was lost to the environment, creating water pollution and food safety problems, Adu-Gyamfi said. "As a result of a technical cooperation project with the IAEA, local officials are now taking action and advising farmers on the most efficient use of fertilizers."

In agriculture, Myanmar has participated in 10 regional projects related to improved soil and water management and climate proofing of crops, and in 5 national projects dedicated to the improvement of rice crops. Over the past decade, 68 fellowships and scientific visits have helped build Myanmar's capacities in applying isotopes and radiation in food and agriculture.

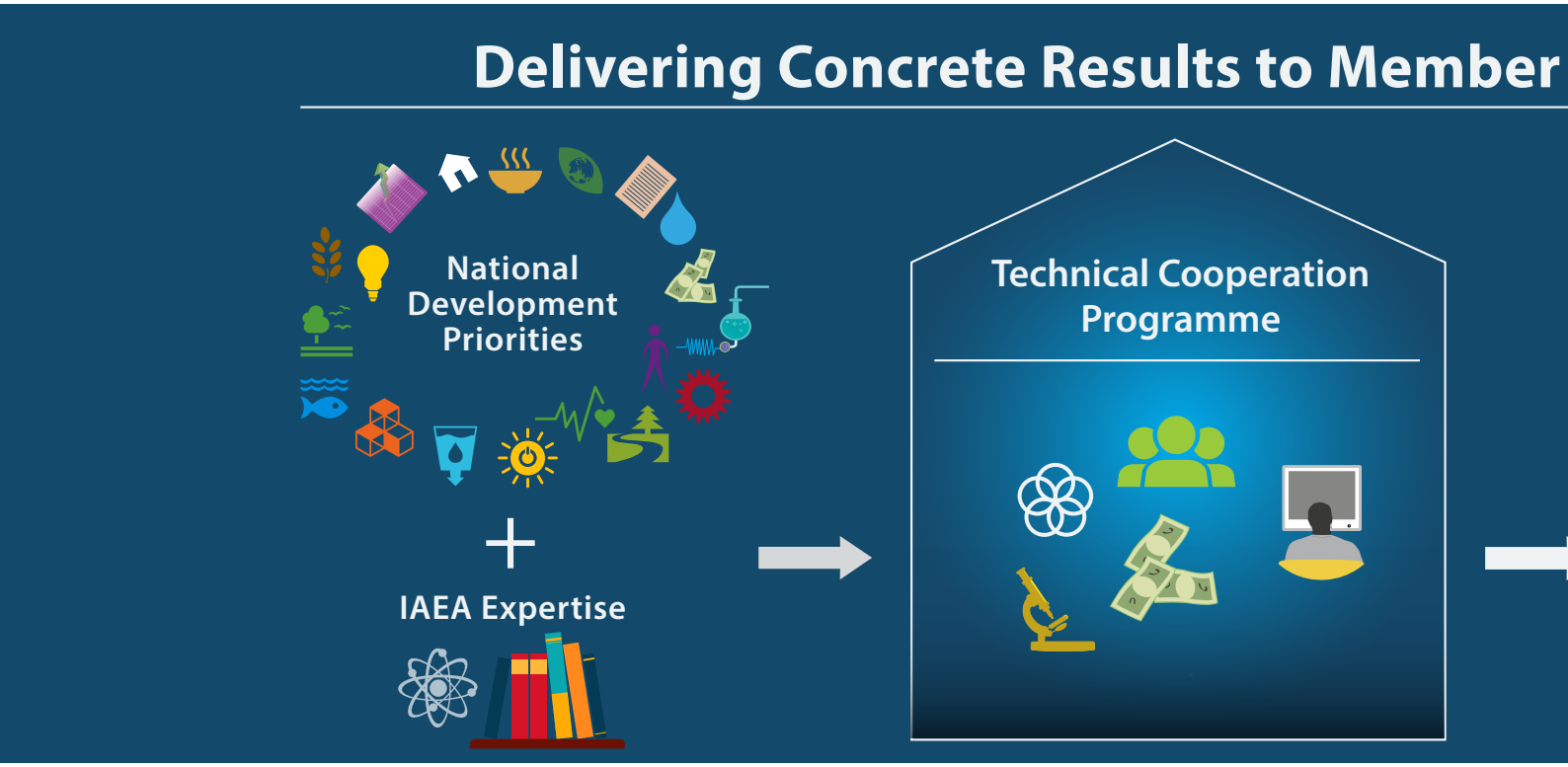
The IAEA's technical cooperation programme: Building partnerships for progress

By Dazhu Yang, Deputy Director General, Head of the Department of Technical Cooperation

Experience has taught us that partnerships are essential if we are to effectively help countries use nuclear science and technology to overcome development challenges and achieve a lasting impact. Two-thirds of our technical cooperation programme addresses issues where the IAEA does not have the lead mandate within the United Nations system, but where nuclear technology plays an essential role in delivering development results in the field. Partnerships with lead United Nations organizations and our continued participation in global discussions on the path forward enable our programme to fully maximize the benefits it offers to countries in diverse sectors, ranging from health to food security, from water management to industry.

Achieving the United Nations Sustainable Development Goals (SDGs) is not a task that any organization can undertake in isolation. Goal 17, which emphasizes the role of cooperation in achieving sustainable development, underscores just how important partnerships are. Collaboration is needed at all levels to increase access to science, technology and innovation and to enhance knowledge sharing. The IAEA, with decades of experience in building capacity in science and technology for development, has the skills and knowledge to complement, amplify and advance the crucial work of its partners.

More than 140 countries and territories now receive support through the IAEA's technical cooperation programme. Regional and interregional IAEA technical cooperation projects offer a forum where developing and developed countries can work together and with other institutions — both private and public — to expand knowledge and access to scientific expertise. As a result, increased technological innovation will drive development impact.



Our long-standing partnerships with, for example, the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) have allowed us to join skills and resources to support countries worldwide. When these partnerships are combined with the services of the IAEA's technical cooperation programme and coordinated research activities, countries gain access to a comprehensive range of scientific and development support. Partnerships with other international organizations help put science to work, taking it out of the laboratory and into the field, ensuring that new skills and competencies are applied within broader development contexts, strengthening and reinforcing the inputs and activities of each individual organization and counterpart.

May 2017 will see the first ever international conference on the IAEA's technical cooperation programme. We are aiming to highlight the achievements of the technical cooperation programme over the past six decades — and, in particular, to show how the peaceful application of nuclear science and technology can help Member States meet their development priorities. The conference also aims to raise awareness of how the technical cooperation programme can contribute to the achievement of the SDGs. Another objective of the conference is to reach out to our sister organizations in the development world, and to demonstrate to them the benefits of working in partnership with the IAEA. At the conference, we seek to strengthen partnerships with Member States, United Nations system and regional organizations, financial institutions, non-traditional donors and the private sector.


(Photo: N. Jawerth/IAEA)

Peaceful applications of nuclear science and technology have a unique role to play in meeting countries' needs and supporting development worldwide. Through partnerships between the IAEA, other organizations and Member States, we can ensure that the benefits of applied nuclear science and technology will reach the people who need them most, and that we put our best efforts forward for human well-being, global sustainability and resilience.

States

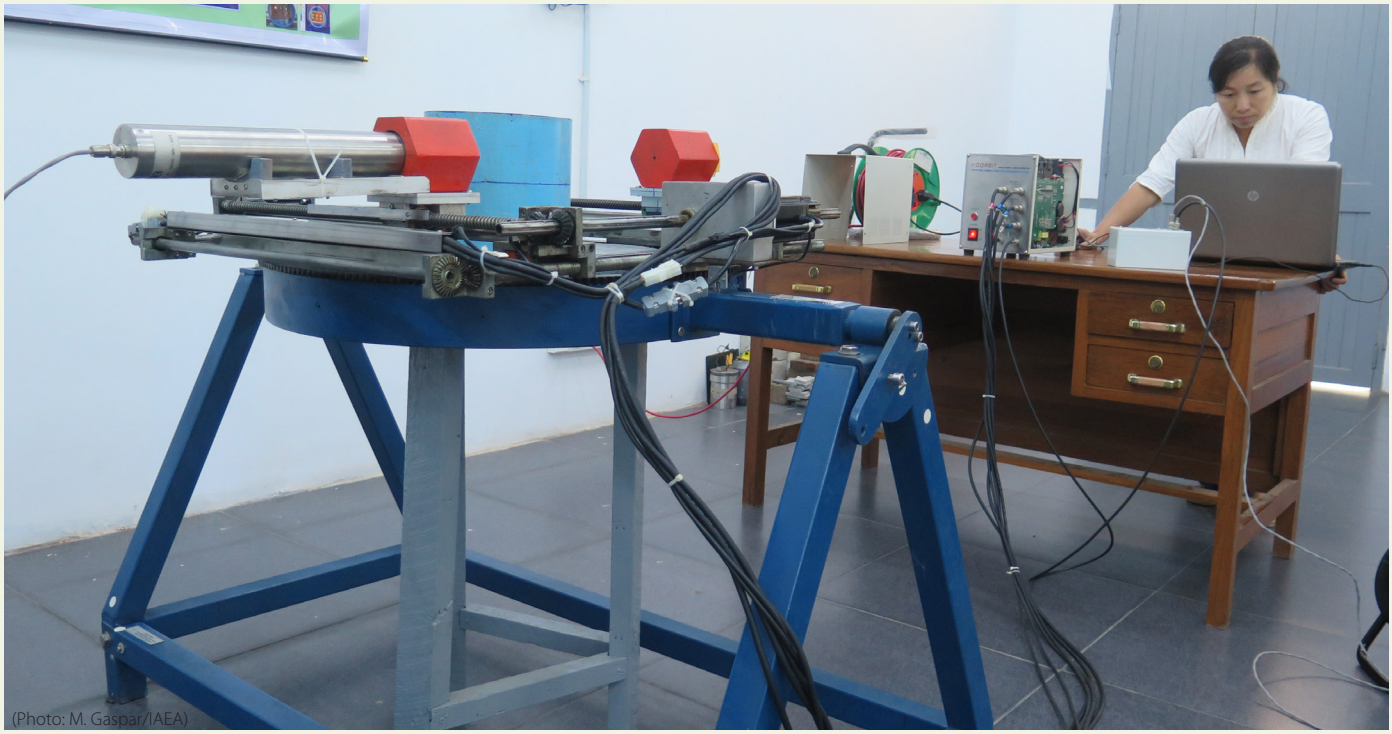
Sustainable Socioeconomic Development

The technical cooperation programme

The technical cooperation programme is the primary mechanism for delivering IAEA development assistance to Member States. It builds national capacity in the peaceful application of nuclear science and technology and helps countries develop the relevant infrastructure. The programme also facilitates networking and knowledge sharing and, very importantly, the fostering of suitable development partnerships at all levels. The main tool employed by the technical cooperation programme is the provision of training, expertise and procurement.

The programme's strategic aim is to create a tangible socioeconomic impact by contributing to the achievement of the major sustainable development priorities of a country. The programme is guided by requests for assistance from Member States, in accordance with national priorities, and provides guidance to Member States on the best way to address their needs using nuclear technology.

Japan to support use of non-destructive testing for disaster recovery in Asia and the Pacific



(Photo: M. Gaspar/IAEA)

In February 2017, Japan supported an IAEA initiative to use nuclear technology for the verification of the integrity of buildings following earthquakes and other natural disasters. The donation was channelled through the IAEA's Peaceful Uses Initiative.

Following an earthquake or flood, critical civil structures, even when they remain standing, may have developed hidden flaws, which could pose further risks if not detected early and remediated quickly. Industrial testing using nuclear technology involves the use of ionizing radiation — along with other methods — to test the quality of materials, without causing any damage to them or leaving any radioactive residue. Such non-destructive testing (NDT) was successfully used in the aftermath of the devastating earthquake in Nepal in April 2015 to test the integrity of critical buildings such as hospitals, schools and historical attractions.

"NDT technology allows countries to quickly and efficiently test structures using simple and easily portable equipment," said Joao Osso Junior, Head of the Radioisotope Products and Radiation Technology Section at the IAEA. "It can help countries that are particularly prone to natural disasters."

The new activity will complement ongoing IAEA work under a technical cooperation project to support the preparation and recovery of civil infrastructure following natural disasters in Asia and the Pacific. Experts from countries in the region will be offered training and, when needed in the aftermath of a disaster, NDT equipment.

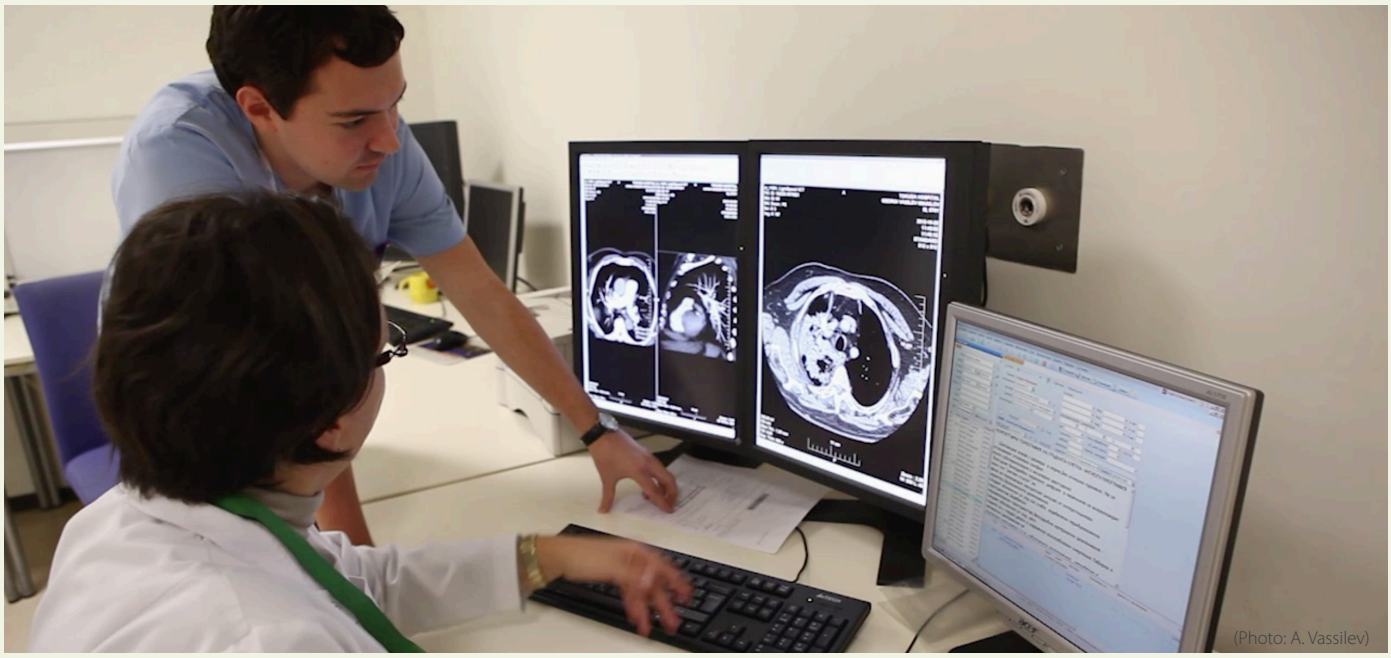
Japan's contribution will include the organization of training courses and storage of equipment at the IAEA Response and Assistance Network (RANET) Capacity Building Centre (CBC) in Fukushima prefecture, which was opened in 2013. The IAEA has since conducted training activities at the RANET CBC to help local, national and international participants to prepare for response to nuclear and radiological emergencies. Now the scope of training activities will be expanded to include NDT technology.

The Malaysian Government, which hosts an IAEA collaborating centre on NDT, has also contributed to this new initiative. IAEA collaborating centres promote the practical use of nuclear techniques for research and development worldwide — in the case of Malaysia, in the fields of industry and NDT.

NDT methods include radiography, a type of radiation technology, and gamma tomography, which is based on the differential absorption in different materials of gamma rays emitted from a radioactive source. Through the measurement of the rays that pass through the material without being absorbed, its make-up and structure can be identified. These techniques are able to identify structural defects that cannot be discovered using traditional testing methods.

— By Miklos Gaspar

Protecting patients: promoting safety culture in diagnostic imaging


(Photo: A. Vassilev)

Unintended and accidental patient exposure to radiation through diagnostic imaging can be significantly reduced by increasing awareness of safe practices, participants at an IAEA meeting heard in March 2017.

"Even though incidents related to unnecessary and extreme exposure conditions are rare, they can be avoided and their severity can be substantially reduced if imaging procedures are performed appropriately," said Jenia Vassileva, Radiation Protection Specialist at the IAEA Technical Meeting on Preventing Unintended and Accidental Medical Exposures in Radiology, held at IAEA Headquarters in Vienna from 6 to 8 March 2017.

Participants in the meeting, which brought together regulators and health professionals from 25 countries and a number of international organizations, found that accidents and incidents in X-ray imaging typically happen because of a lack of awareness among professionals and patients regarding the potential harmful effects of unintended medical exposure. This may be caused by insufficient knowledge of the risks and relevant contributing factors among medical professionals and regulatory and public health authorities.

Over 4 billion radiology procedures are conducted annually worldwide. Medical imaging techniques, such as X-ray radiography, computed tomography and image guided interventional procedures, are valuable sources for the diagnosis of several health conditions and for guiding treatment. However, experts acknowledge that there may be health risks associated with unintended exposure. These can include skin injuries, hair loss and, if a woman is pregnant without knowing it, risk to the foetus.

Dina Farag Husseiny, a radiologist from the Egyptian Atomic Energy Authority, explained the potential impact of radiation exposure in pregnant women. "Diagnostic imaging requires extreme caution, particularly when it is used in female patients who are suffering from irregular menstrual cycles or long-standing periods of infertility," she said, adding that such patients tend not to realize they are pregnant until the later stages owing to these pre-existing conditions; as a result, they can be accidentally exposed to radiation in the first 5-11 weeks of pregnancy.

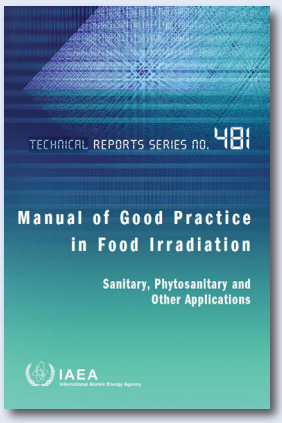
Participation from across disciplines was key to the success of the meeting, said Donald Frush, Chair of the Image Gently Alliance, a coalition of health-care organizations dedicated to providing safe, high-quality paediatric imaging worldwide. "Having all the separate voices here is very important from my standpoint, because you get a dynamic sense of what various professional inputs in areas of expertise are," he said.

The IAEA's role

At the meeting the IAEA presented its reporting and learning system for image guided interventional procedures with risks for skin injuries, called Safety in Radiological Procedures (SAFRAD).

"The IAEA will continue to support Member States to implement the International Basic Safety Standards through various actions," said Vassileva. "Our online platform, Radiation Protection of Patients (RPOP), assists the medical community and patients through various education and training materials. Our free webinars provide opportunities for professionals to participate from anywhere to learn about the latest topics in radiation protection in medicine."

— By Nanako Kogiku

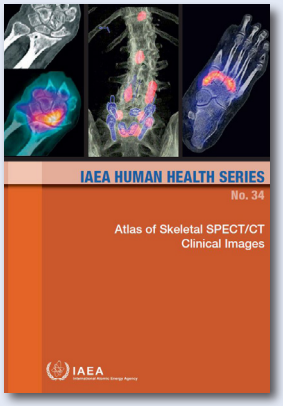


Manual of Good Practice in Food Irradiation

aims to help operators of irradiation facilities to appreciate and improve their practices in the process of irradiating food. The manual provides detailed, yet straightforward, technical information for stakeholders such as food regulators, manufacturers and traders, who also need to understand 'good practice'. Making sure that the practice of irradiating food delivers the desired result consistently is essential for the correct application of the technology and will help to inspire consumer confidence in irradiated food.

Technical Reports Series No. 481; ISBN:978-92-0-105215-5; English Edition; 48.00 euro; 2015

www-pub.iaea.org/books/iaeabooks/10801/Food

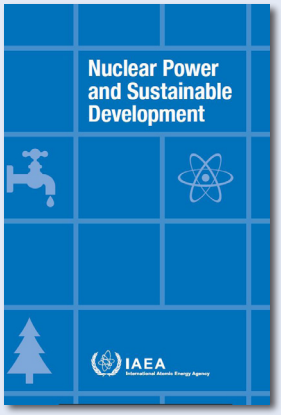


Atlas of Skeletal SPECT/CT Clinical Images

focuses specifically on single photon emission computed tomography/computed tomography (SPECT/CT) in musculoskeletal imaging, and thus illustrates the inherent advantages of the combination of the metabolic and anatomical components in a single procedure. In addition, the atlas provides information on the usefulness of several sets of specific indications. The publication, which serves more as a training tool than a textbook, will help to further integrate the SPECT and CT experience in clinical practice by presenting a series of typical cases with many different patterns of SPECT/CT seen in bone scintigraphy.

IAEA Human Health Series No. 34; ISBN:978-92-0-103416-8; English Edition; 75.00 euro; 2016

www-pub.iaea.org/books/iaeabooks/10936/Atlas



Nuclear Power and Sustainable Development

explores the possible contribution of nuclear energy to addressing the issues of sustainable development through a large selection of indicators. It reviews the characteristics of nuclear power in comparison with alternative sources of electricity supply, according to economic, social and environmental pillars of sustainability. The findings summarized in this publication will help the reader to consider, or reconsider, the contribution that can be made by the development and operation of nuclear power plants in contributing to more sustainable energy systems.

Non-serial Publications; ISBN:978-92-0-107016-6; English Edition; 45.00 euro; 2016

www-pub.iaea.org/books/IAEABooks/11084/NPSust

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How the IAEA contributes to the Sustainable Development Goals

Poverty, hunger, human health, clean water, affordable and clean energy, industry and innovation, and climate change are areas in which the IAEA has been working for 60 years. Here's an overview of some of the ways the IAEA helps Member States in achieving the Sustainable Development Goals (SDGs).

The IAEA activities are relevant to many of the SDGs. Specifically, the Agency:

helps tackle hunger and malnutrition in least developed countries through nuclear and isotopic techniques;

helps establish and strengthen nuclear medicine, radiotherapy and radiopharmaceuticals production;

supports effective water management globally through nuclear and isotopic techniques;

fosters the efficient and safe use of nuclear power around the world;

improves industrial production and safety through the use of nuclear technologies;

contributes to both climate change mitigation and adaptation by, for example, assisting countries in reducing their greenhouse gas emissions and measuring the impact of climate change;

trains scientists in the use of nuclear techniques to monitor and manage marine environmental phenomena;

supports the use of isotopic techniques to reverse land degradation and restore soils;

facilitates technology transfer through partnerships with its Member States and other international organizations.

Because the SDGs are interlinked, the IAEA's work also contributes to Member States' efforts in reducing poverty by controlling animal and plant diseases (SDG1), improving education by giving support to schools and offering training courses, fellowships and expert visits (SDG4), fostering gender equality by promoting women staff recruitment and science and technical education for girls and women (SDG5), and furthering peace, justice and strong institutions (SDG16) by providing legal and regulatory advice, among others.

"Our work in these areas is vital. I expect it to intensify in light of the SDGs, bringing us closer to achieving the long term plan of improving people's lives and protecting the planet for future generations."

— IAEA Director General Yukiya Amano during the United Nations Sustainable Development Summit, New York, 27 September 2015

ISSN 0020-6067

17-0699

INTERNATIONAL MINISTERIAL CONFERENCE

Nuclear Power in the 21st Century

30 OCTOBER – 1 NOVEMBER 2017

ABU DHABI, UNITED ARAB EMIRATES

iaea.org/meetings
CN–247

Organized by the

IAEA 60 Years Atoms for Peace and Development

Hosted by United Arab Emirates Government through Ministry of Energy and Federal Authority for Nuclear Regulation

UNITED ARAB EMIRATES MINISTRY OF ENERGY

FANR الهيئة الاتحادية للرقابة النووية Federal Authority for Nuclear Regulation

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