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The IAEA Environment Laboratories were first established in Monaco in the famous *Musée océanographique* (Oceanographic Museum) in 1961. As the demands from Member States expanded, so did the need for additional laboratory space, and twice the laboratories have had to relocate within Monaco. Approaching 20 years of the Monaco-based laboratories in their current location on Port Hercules in the heart of Monaco, the IAEA Environment Laboratories continue to serve the Member States through scientific research and trainings with participants from around the globe, and participating in outreach events that engage even the youngest generations.

From January to June of 2018, staff of the Laboratories welcomed international experts on long-standing research themes including ocean acidification, radiometric dating and harmful algal blooms. They also reached out to students and school-age children in Monaco and in Vienna for annual events geared specifically to showcase the important work of science to those who are the future of environmental science: the youth.

For more information on the activities of the IAEA Environment Laboratories, please visit www.iaea.org/nael

David Osborn

Director, IAEA Environment Laboratories

(Photo: IAEA)

Harmful algal bloom workshop convenes with global participation

Sixty scientists from over 30 countries learned how nuclear techniques can be used to combat biotoxins from harmful algal blooms at a workshop organised by the IAEA in April 2018. Each year, these harmful algal blooms (HABs) are responsible for the poisoning of thousands of people worldwide due to the consumption of contaminated seafood and the inhalation of toxins in the air. Although strategies to control the impact of planktonic toxic HABs, which float in the water, are well-defined, there remain gaps in the scientific understanding of those on the ocean floor, known as benthic species. With the increasing number of corals dying, a proliferation in benthic harmful algal blooms and associated health risks are likely.

Experts come together in Monaco to learn how nuclear techniques can be used to accurately detect toxins in the marine environment and seafood. (Photo: C. Fruneau)

Taking place 9-13 April, the workshop was organized by the IAEA and RAMOGE – an agreement between France, Italy and Monaco to address pollution in the marine environment – in partnership with the Scientific Committee on Oceanic Research and the Intergovernmental Oceanographic Commission of UNESCO (IOC-SCOR Global HAB) and the United States' National Oceanic and Atmospheric Administration (NOAA). Participants came from both developed and developing countries from a wide range of regions: Latin America and the Caribbean, Asia and the Pacific, Africa and Europe, as well the Food and Agriculture Organization (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the WHO. The IAEA is working with scientists from around the world to develop capacity to accurately detect toxins in the environment and seafood, so that they can implement countermeasures such as fishery closures and bans on eating seafood when there is an elevated risk of poisoning (see The Science box).

Microscopic algae at the base of the marine food chain provide nutrients for marine organisms and are responsible for producing more than half of the earth's oxygen supply. However, factors such as the natural movement of water towards the surface and the accumulation of agricultural run-off into the sea can increase nutrient levels in coastal waters and trigger algal blooms, which can sometimes include toxic species.

One of the most common illnesses is ciguatera fish poisoning — a non-bacterial seafood intoxication caused by ingesting fish that has been contaminated by ciguatera toxin that comes from benthic harmful algal blooms.

The Science

The radioligand receptor binding assay (RBA) is one of the nuclear techniques used by the Environment Laboratories. It enables researchers to accurately detect biotoxins in samples such as fish and algae. This method is based on the specific interaction between the toxins and the receptor they bind (pharmacological target), in which a radiolabeled toxin competes for a limited number of receptor binding sites with the toxin in the sample being analysed, allowing quantification of the toxicity of the sample.

Back-to-back ocean acidification meetings

The Ocean Acidification International Coordinating Centre, or OA-ICC, of the IAEA Environment Laboratories was involved in two key meetings in June 2018, which convened several experts as part of a longstanding working group and then for the OA-ICC's own annual expert meeting. The working group, formally known as the SOLAS-IMBER working group on ocean acidification (OA), had its tenth meeting at the Institut de la Mer de Villefranche in Villefranche-sur-Mer from June 26th to 27th. The annual expert group meeting, attended also by SOLAS-IMBER working

group members, took place the following day and was hosted by the IAEA Environment Laboratories.

The SOLAS-IMBER working group convene for the 10th year in a row at a meeting hosted by the Institut de la Mer de Villefranche. (Photo: Samir Alliouane / Laboratoire d'Océanographie de Villefranche)

The SOLAS-IMBER working group, a collaboration between SOLAS and IMBER, were in fact the ones to suggest the establishment of an international coordination platform on OA which ultimately led to the launch of the OA-ICC in 2012. The OA-ICC is now represented in the working group which coordinates international research efforts in OA, undertakes synthesis activities in OA at the global level and maintains an OA website which it developed.

The 5th annual meeting of the OA-ICC expert group meeting brought together 18 participants to report and foster discussion on coordinating OA-ICC activities in the past year and to plan for the upcoming year.

Uncertainty estimation in radioanalytical laboratories

A regional training course on uncertainty estimation in radioanalytical techniques took place from 9 to 13 April 2018 at the Centre National de l'Energie, des Sciences et des Techniques Nucléaires (CNESTEN) in Morocco. It was organized by the IAEA Terrestrial Environment Laboratory under an ongoing regional IAEA technical cooperation project. Twenty-seven participants from 21 African countries attended the training course.

Implementing a quality assurance programme is the quickest and most effective way for analytical laboratories to ensure both high quality and consistent measurement results, in addition to worldwide comparability. Quality assurance is key to produce reliable and valid results for determining radionuclides in environmental samples, a central activity of Member States' routine environmental radioactivity monitoring programmes. The proper estimation of uncertainty of measurement results – the topic of the training course - is one pillar of quality assurance in laboratories.

A training course in Morocco on estimating uncertainty brought together 27 participants from 21 African countries. (Photo: CNESTEN)

During the course, participants attended lectures on the theoretical approaches to uncertainty estimation in radioanalytical measurements. They also carried out practical group exercises based on real world examples, such as estimating the uncertainty of measurement results for the main natural and anthropogenic radionuclides that may be present in national environmental radioactivity monitoring programmes, and for all the major relevant radioanalytical techniques.

A Long Night of Research in Vienna

The IAEA Environment Laboratories participated in the Long Night of Research in Austria on 13 April, an event to communicate scientific research to the public. More than 1600 external visitors, including many young students, attended the event at the Vienna International Centre. At the booth of the Terrestrial Environment Laboratory, one of the four IAEA Environment Laboratories (NAEL), visitors learned why accurate measurement results are of crucial importance for protecting the environment. Staff of NAEL explained the principles of natural radioactivity and demonstrated how radionuclides are measured on site in the terrestrial environment using an in-situ gamma detector. Visitors also learned about naturally occurring radionuclides and measured how much radiation is emitted from household items using a

surface contamination monitor. Many also enjoyed testing their knowledge on radioactivity by participating in an interactive quiz.

More than 1600 external visitors, many of them schoolchildren, came to the Vienna International Centre to see the booths, including that of the Terrestrial Environment Laboratory, showcasing scientific research. (Photo: Sándor Tarján/IAEA)

In addition, a groundwater model was presented to demonstrate how pollutants are transported via groundwater streams and how related problems can be addressed on the basis of accurate measurement results obtained from samples taken in the field. The concepts of measurement accuracy and precision were illustrated by simple weighing experiments for both adults and children. In discussions with NAEL staff, visitors also learned about the application of stable isotopes to investigate climate change and how reference materials are used by laboratories worldwide to ensure reliable measurement results.

Using radiotracers in sediments for assessing coastal pollution trends

The IAEA Environment Laboratories work with Member States—each facing their own unique challenges regarding marine pollution—to use nuclear and isotopic techniques for determining the temporal trends and sources of various contaminants in their marine environments. To this end, the Laboratories held two concurrent meetings at their premises in Monaco, the second Research Coordination Meeting and a technical meeting on coastal pollution trends. The Coordinated Research Project (CRP) involves the study of temporal trends of pollution in selected coastal areas by the application of isotopic, radiotracer and nuclear analytical methods. The coordination meeting took place from 25-29 June 2018 while the technical meeting took place from 25-27 June 2018, each bringing together scientists representing over a dozen countries.

Participants in the technical meeting break into working groups and discuss how to use lead-210 for radiometric dating. (Photo: T. Misra/IAEA)

As part of this CRP, the Laboratories work with Member States to enhance existing coastal pollution monitoring programmes as well as provide insight into temporal trends of pollution where monitoring data is missing. Understanding the behaviour of contaminants entering the marine environment in the past allows scientists to better predict the impact of future contamination events.

By using nuclear and isotopic techniques, scientists can analyse natural environmental archives like marine sediments, shells and corals to create a history of coastal pollution. Contaminants which end up in the marine environment accumulate layer by layer in, for example, the coastal sediments. Scientists can use the presence of lead-210, a naturally occurring radiotracer in the accumulated sediment, and its decay rate to calculate how old each layer is. Because lead-210 is particularly well-suited for radiometric dating of the last 100-150 years, it is very useful for analysing contaminants from a period where human activity is a dominant factor for pollution. Radiotracers present in the marine environment that are of anthropogenic origin can also be used in parallel to date the layers in marine sediments. Combining these with methods used to detect organic and inorganic contaminants, scientists can reconstruct a timeline of various pollutants entering the marine environment, which is important for pollution management and control.

Training in advanced computer models to assess radioactivity

Course participants doing hands-on exercises to practice using the RESRAD computer model for assessing the impact of environmental radioactivity. (Photo: A. Iurian/IAEA)

Assessing the amount of radioactivity present in the environment is crucial for mitigating the adverse risks of radiation exposure and safeguarding public health. To this end, the IAEA, through its Environment Laboratories organized a two-week course to train participants in the necessary skills to develop their respective countries' capacities for radiological assessments on dose risk and authorized limits at contaminated sites. The course was attended by 15 participants from 12 Member States, supported by the IAEA technical cooperation programme and hosted by Argonne National Laboratory (ANL) in Illinois, USA from 30 April to 11 May 2018.

The course is part of ongoing cooperation between the IAEA Environment Laboratories and the Member States on monitoring environmental radioactivity and conducting environmental impact assessments. Impact assessments provide the basis for the management of radionuclides that are either naturally present in the environment, or result from anthropogenic causes. The assessments inform Member States about the possible impact on humans and the environment of any radioactivity that is present so that appropriate actions may be taken.

At the centre of the course was training in the 'family of codes' of RESRAD (RESidual RADioactivity), a computer model that estimates radiation doses and risks through various exposure pathways—for example, eating or drinking certain contaminated foods or water. Based on these types of complex estimates, regulators and government officials can decide how to manage any consequences of exposure to radioactivity. Since the participants all work in government authorities or organizations involved in radiological environmental assessment and monitoring, they can implement the family of codes in their respective countries' institutions and share what they learned with their peers.

Over the two weeks, participants in the course had the opportunity to take part in discussion sessions, coordinated exercises and lectures delivered by leading experts in the field as well as by staff at Argonne National Laboratory where the RESRAD family of codes were originally developed. The five codes covered in the training (RESRAD-BIOTA, RESRAD-ONSITE, RESRAD-OFFSITE, RESRAD-BUILD, RESRAD-RDD) involved different radiation exposure situations for both human and non-human biota, such as whether exposure takes place in a contaminated building or on top of contaminated soil or how long after a radiation release the exposure takes place.

Seven years of Monacology

For the 7th year in a row, the IAEA Environment Laboratories in Monaco participated in Monacology, a week-long annual event in June to raise environmental awareness among schoolchildren. This year the NAEL laboratories highlighted the topic of ocean acidification.

The impact of ocean acidification on marine organisms with calcium carbonate shells was demonstrated in two aquaria of different acidity: while mussels in the tank with natural pH were looking very healthy, the ones in the acidic tank were starting to bleach. In a hands-on experiment, schoolchildren compared the reaction of a natural pH indicator with the water from those two aquaria and that of known acidic substances like lemon juice. With an artificial mini-factory that enclosed a hidden carbonation device, staff from the Laboratories concluded the experiment by showing the schoolchildren how carbon dioxide emissions as usually produced from combustion of fossil fuels in a factory can be linked to ocean acidification.

H.S.H. Prince Albert II speaks with IAEA Environment Laboratories Director David Osborn
(Photo: T. Misra / IAEA)

Monacology is one of several important outreach activities the Environment Laboratories undertake to promote awareness about their work in the region. The event was attended not only by schoolchildren of all ages from all over Monaco but also H.S.H. Prince Albert II who thanked the IAEA for their continued attendance at Monacology over the years.

Intern spotlight

Mr John Peterson was awarded an internship at the IAEA Environment Laboratories from 2 October 2017 to 28 September 2018. Originally from Antioch, California, USA, he is pursuing a Master's in Nuclear Engineering at the University of Idaho and working closely with the Idaho National Laboratory in his research endeavours. John's work at the Radiometrics Laboratory (RML) in Monaco involves software development and the application of modelling techniques to improve the accuracy and precision of analyses of low-level environmental samples by high purity germanium (HPGe) detector gamma-ray spectrometry.

High quality measurements of environmental samples using this technique require many different sorts of information including nuclide data, measurements of reference standards and the samples themselves, and model calculations. John has created software that efficiently manages the compilation and integration of this information and performs current best practice calculations to enhance the speed and accuracy with which results can be reported and to support RML's preparation for ISO 17025 accreditation.

John's work involves software development and the application of modelling techniques to improve the accuracy and precision of analyses of low-level environmental samples by high purity germanium (HPGe) detector gamma-ray spectrometry.
(Photo: T. Misra / IAEA)

John has developed models of RML's key HPGe detectors to facilitate measurement of any sample geometry and matrix. He has also combined these models to develop a virtual environment describing RML's entire Underground Laboratory, which can be used to simulate the influence of background radiation from naturally occurring radioactivity in surrounding materials and from cosmic rays and to assess measures for its reduction.

"While working at the IAEA, I have been able to work with experts from a variety of fields, contribute my own expertise, and make meaningful contributions that directly support the quality of the work done at the Radiometrics Laboratory," John said, reflecting on his internship thus far. "This has been an invaluable opportunity to learn about the diverse applications on a global scale that a single branch of science can have."

The IAEA is grateful to the Argonne National Laboratory and the US Department of State for their support to this internship.

Selected Publications

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Selected Upcoming Events

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Dates	Description	Location
9-3 July 2018	Expert meeting on gap analysis and action planning for assistance in marine environment	IAEA Environment Laboratories, Monaco
16-27 July 2018	Advanced Regional Training Course on Measurement of Naturally Occurring Radionuclides in Environmental and NORM Samples by Gamma-ray Spectrometry (RAF7017)	Karlsruhe, GERMANY
6-10 August	Technical Cooperation Workshop: Contributing to climate resilience in the Caribbean Region	IAEA Environment Laboratories, Monaco
10-21 September 2018	Regional Training Course on Rapid Assessment of Radionuclides in the Marine Environment (RAS7028)	Argonne, USA
17-21 September 2018	IAEA General Conference / Scientific Forum	IAEA, Vienna, AUSTRIA
24-28 September 2018	First Consultancy Meeting for the preparation of the IAEA Technical Report Series "The Environmental Behaviour of Tritium"	IAEA, Vienna, AUSTRIA
25-27 September 2018	Identification of Data Gaps in the Adriatic and the Black Sea and Harmonization of Field Sampling Strategies for Strengthening Regional Capacities in Coastal Management (RER7009)	Varna, BULGARIA
1-5 October 2018	ALMERA Training Workshop on In Situ Methods for the Characterization of Contaminated Sites	Kurchatov, KAZAKHSTAN
8-10 October 2018	15th Coordination Meeting of the IAEA's Network of Analytical Laboratories for the Measurement of Environmental Radioactivity	Amman, JORDAN
8-12 October 2018	Consultancy Meeting for development of IAEA Training Materials on Sampling for Environmental Radiological Monitoring	IAEA, Vienna, AUSTRIA
19 October 2018	20th Anniversary of IAEA Environment Laboratories	IAEA Environment Laboratories, Monaco
22-26 October 2018	Technical Meeting on the Management, Analysis, and Quality Control of Ocean Acidification Observation Data	IAEA Environment Laboratories, Monaco
29-31 October 2018	ALMERA Training Workshop on the Determination of Characteristic Limits Used in Nuclear Analytical Techniques	London, UNITED KINGDOM
29 October – 9 November 2018	UNEP/MEDPOL Training Courses	IAEA Environment Laboratories, Monaco
5-9 November 2018	Coordination Meeting and Workshop on the Use of Nuclear / Isotopic Techniques in the Marine Environment for SIDS	Cienfuegos, CUBA
5-7 December 2018	Joint IAEA-EC/JRC Workshop on Low-level Radioactivity Measurements and Applications	IAEA Environment Laboratories, Monaco
10-12 December 2018	Pre-CRP Meeting (K41019) on the Application of Radioecological Tracers to Assess Coastal and Marine Ecosystem Health	IAEA Environment Laboratories, Monaco

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