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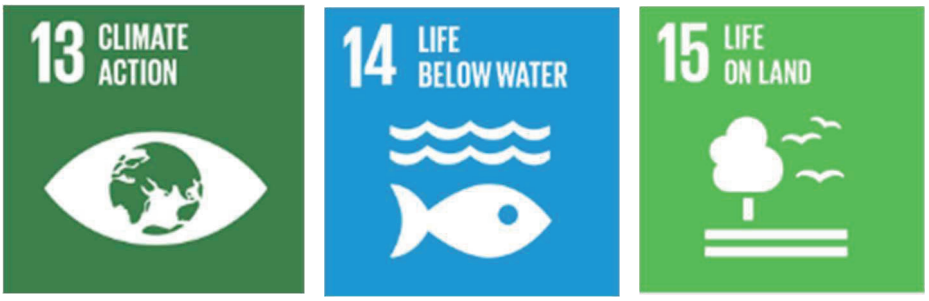
Contents

In this Edition: Working toward the Sustainable Development Goals

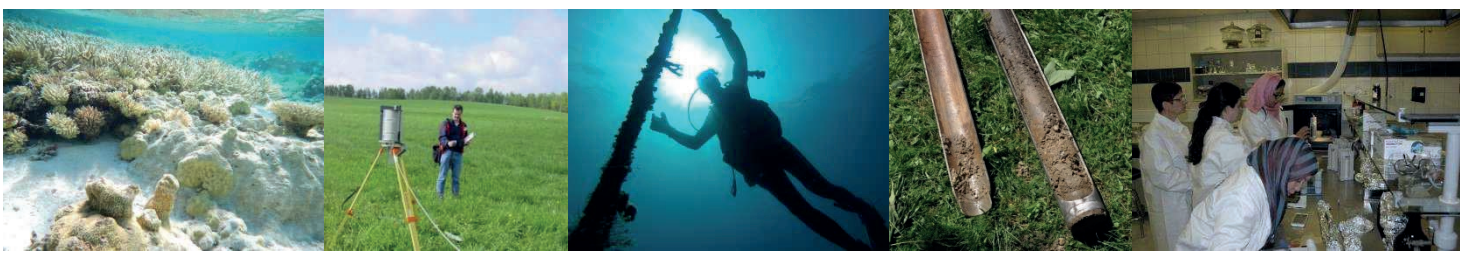


The IAEA Environment Laboratories work with Member States to tackle their environment related challenges, and this work, whether directly or indirectly, can contribute to achieving the Sustainable Development Goals (SDGs).

This edition of the Environment Laboratories newsletter provides an overview of recent IAEA Environment Laboratories' projects that contribute towards the Sustainable Development Goals as well as highlighting some of the other projects underway from January to June 2017.

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

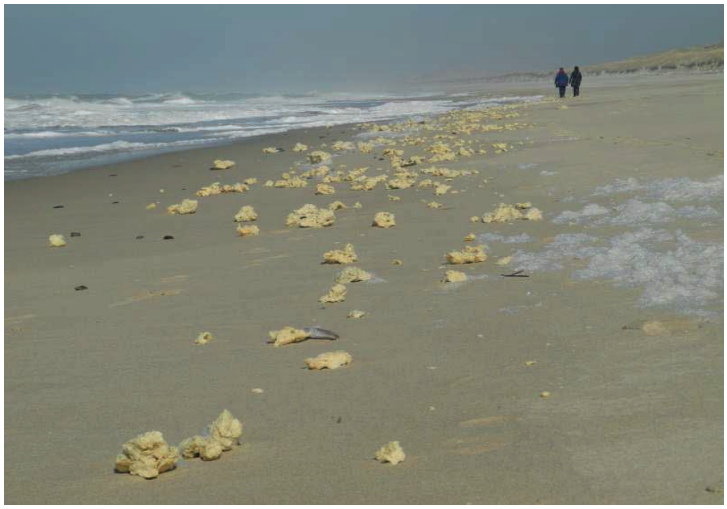
David Osborn
Director, IAEA Environment Laboratories



(Photos: P. Swarzenski, R. Cassi, G. Kis-Benedek / IAEA)

Tracking the sources of paraffin in the marine environment

In 2014, more than 50 tons of paraffin washed ashore on the island of Sylt in the North Sea. Varying from several millimetres to more than 25cm in diameter, these deposits pose a threat to local ecosystems and wildlife.



An emerging environmental problem, paraffin solidifies in contact with cool waters and can accumulate along beaches for several kilometres. Over 50 tons washed ashore on the North Sea island Sylt in 2014. (Photo: M. Ludwig, Naturschutzgemeinschaft Sylt e.V., Germany)

So what is paraffin? Paraffin is a hydrocarbon by-product omnipresent in our everyday lives: it is used in the waxes covering cheeses, in chewing gum, in skincare products and candles among others. It is transported as a liquid in heated tankers. Variable quantities can be discharged at sea as the tankers transporting it are washed down with water releasing paraffin into the marine environment. In contact with cooler waters paraffin solidifies and can be seen accumulating along beaches for several kilometres.

The IAEA Environment Laboratories in Monaco hosted the Thirteenth Expert Meeting of the Bonn Agreement Oil Spill Identification Network of Experts (Bonn-OSINet) from 25 to 27 April 2017. The annual meeting brought together organisations from all around the world which work on oil spill identification. This year the participants discussed paraffin, a hydrocarbon by-product which is becoming increasingly prevalent in the marine environment.

The IAEA Environment Laboratories have worked on petroleum hydrocarbon monitoring for many years and have developed methodologies which can be used to trace the source of hydrocarbons and their derivatives. One method, which can be applied to paraffin, uses chemical biomarkers to identify its chemical signature. The Laboratories have also developed methods using stable carbon isotopes. This isotopic technique examines the specific "fingerprint" of the carbon compounds, and enables investigators to trace the source of spills and improve the reliability of analyses.

"The combination of chemical and isotopic fingerprinting provides a powerful forensic tool which can be used by Member States for legislative purposes," said Imma Tolosa, an organic research scientist at the IAEA Environment Laboratories.

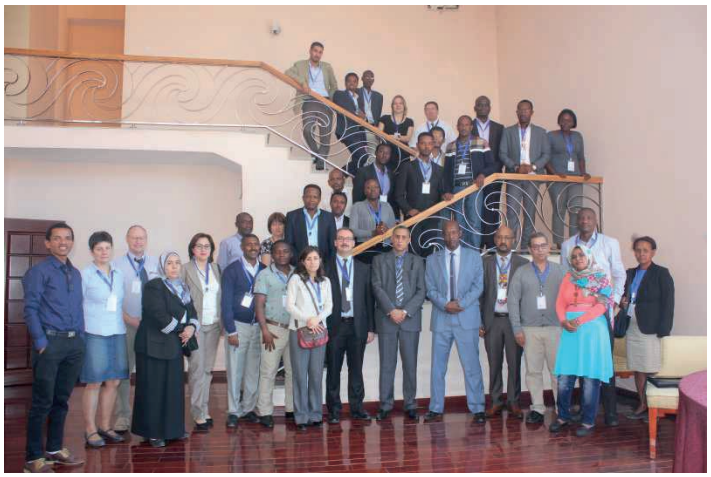
"In the case of a collision or an illegal release, governments need to know where the hydrocarbon or paraffin comes from," added Mrs. Tolosa. These environmental forensic applications allow Member States to better plan remediation activities and determine where the responsibility for remediation lies. Through her work on paraffin, Imma Tolosa has co-authored several reports as well as a chapter on paraffin wax spill identification by Gas Chromatography – Flame Ionisation Detector (GC-FID) and Gas Chromatography – Mass Spectrometry (GC-MS), which will be published by Elsevier Inc. as part of the book *Oil Spill Environmental Forensics Case Studies* later in 2017. This is an output of a project to develop methodologies to trace oil pollution in marine waters funded by the US through the Peaceful Uses Initiatives (PUI) programme.

Efforts to identify and understand the sources of oil and paraffin spills are a key step in preserving the ocean, a central component of SDG 14: life below water.

Supporting environmental radioactivity monitoring in Africa

Environmental radioactivity monitoring programmes are essential for monitoring possible radioactive releases into the environment from nuclear power plants or nuclear research reactors as well as non-

nuclear activities like mining or fertilizer industries. Monitoring programmes involve taking environmental samples (e.g. soil, groundwater, and air) at relevant locations and the measurement of radioactivity levels in those samples using *in-situ* and laboratory



Participants in the training course in Addis Ababa which aimed to improve the measurements of radionuclides in environmental samples. Photo: A. Pitois / IAEA

radioanalytical techniques. The programmes' efficiency and effectiveness depend on the quality of the environmental radioactivity measurement results.

To support African radioanalytical laboratories and improve the measurement of radionuclides in environmental samples, the IAEA conducted a training course on best practices and supported a conference on quality management, both organised locally by the National Metrology Institute of Ethiopia in the framework of the regional Africa technical cooperation project RAF7017. Entitled 'Promoting Technical Cooperation among Radio-Analytical Laboratories for the Measurement of Environmental Radioactivity,' the training course took place in Addis Ababa from 6 to 8 March 2017 with thirty-two participants from 18 African countries. IAEA experts and participants discussed difficulties encountered in the implementation of radioactivity monitoring programmes and gauged areas needing assistance. The course highlighted the importance of participating in proficiency test exercises, like those the IAEA Environment Laboratories organise annually.

Also in Addis Ababa from 9 to 10 March 2017, the 4th African Conference on Quality Management in Nuclear Industry and Research Laboratories was the latest in a conference series launched by the IAEA in 2005. Approximately 60 participants from 21 African countries attended.

The conference on quality assurance broadly focused on the latest developments in the implementation of quality systems in laboratories and facilities applying nuclear and nuclear-related techniques. Specific guidelines for quality assurance implementation which Member States can use to establish and/or improve quality assurance programmes in their nuclear analytical laboratories were disseminated.

Improved radioactivity measurements are crucial for proper environmental monitoring which contributes to the protection of human health, economic growth, and the sustainable use of terrestrial ecosystems which contributes to SDG 15: life on land.

Studying corals to understand climate change

The IAEA Environment Laboratories in Monaco are managing a Coordinated Research Project (CRP) which aims to study past climate records to investigate climate trends, variability and the occurrence of extreme events. With each growth cycle, corals form growth bands which record information on their environment, and as such constitute valuable archives of past conditions. The aim is to provide Member States with information to better predict and prepare for such events in future climate scenarios. Such research is timely as recent years have seen some of the most significant climate events ever recorded. This research can contribute to SDG 13 on taking action to combat climate change and its impacts. As part of this project, the IAEA Environment Laboratories hosted a research coordination meeting in March 2017 to examine how radioanalytical and isotopic studies of marine paleo-records provide insight into climate trends and variability.

The most recent El Niño event, which occurred between 2014 and 2016, is now considered to be the strongest event to date, with the previous three years (2014, 2015 and 2016) being sequentially the hottest years on record. During this time, atmospheric carbon dioxide levels surpassed 400 ppm, which is more than 40 % higher than pre-industrial levels (280 ppm).

Past climate records in the marine environment provide insight into how the climate system will respond to a warming Earth: the growth rings of corals

form a detailed archive of the physical and chemical

Participants in the project to study past climate records to investigate climate trends gather at the Environment Laboratories in Monaco. Photo: Sarah Jones Couture / IAEA

properties of the seawater in which they have grown. This is similar in principle to dendrochronology – the study of tree rings. During the meeting, the members of the CRP agreed to collectively investigate the poorly studied monsoonal pattern of the Indian Ocean using corals collected from Sri Lanka. This collaborative endeavour will complement the proposals of the individual CRP members whilst advancing the scientific understanding of a climate system that directly impacts the Indian subcontinent, home to more than 1.7 billion people. The CRP Member States include Australia, Cuba, Indonesia, Singapore, Sri Lanka, the UK, and the USA.

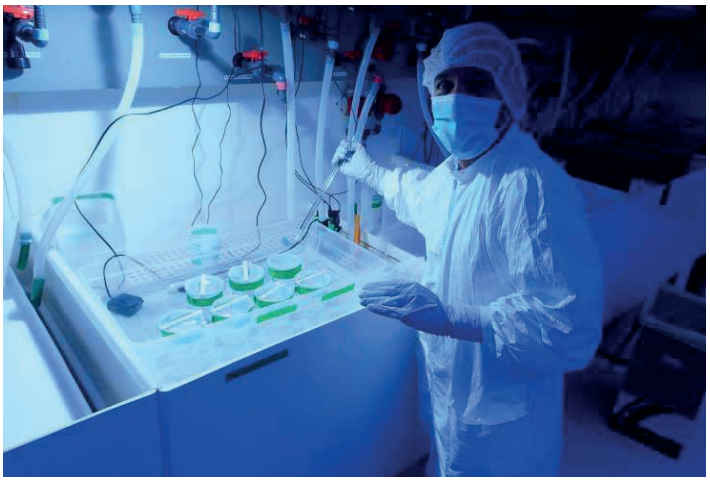
Working with Cuba to understand the threats to coral reefs

The IAEA Environment Laboratories in Monaco are hosting an ICTP fellow from Cuba for 6 months to study how ocean acidification affects calcifying marine organisms such as corals. Together, they will also examine how coral reefs can be used as natural archives to reconstruct the pH profiles of marine waters around Cuba. Minimizing and addressing the impacts of ocean acidification, including through enhanced scientific cooperation, is in fact one of the exact targets of SDG 14 on life below water.

Coral reefs are the foundation of marine ecosystems. The tourism industry, fisheries and aquaculture depend on coral health. The national economies of Caribbean countries are closely connected to the ocean and coral reefs: nearly 60 % of their GDP comes from their marine resources. A large part of the Caribbean population relies on seafood as their primary source of animal protein. Thus, ocean acidification has the potential to impact local economies and food security

Miguel Gomez Batista, the visiting scientist from Cuba, said that the "technical capacities in the Caribbean to assess the current and historical trends of ocean acidification and its impacts on the regional marine environment are limited". He added that the "application of nuclear and isotopic techniques are essential instruments for the project" and he is benefitting from IAEA expertise which is enhancing his capabilities.

Certain massive reef-building corals grow very slowly and act as a record of past climate and environmental conditions. Isotopes are locked in their calcium carbonate skeletons and bands as they grow, providing a chronology of changes in their surroundings. Nuclear and isotopic techniques can contribute to the understanding of what can have an impact on marine organisms and affect their physiological functions. Calcium-45 in living corals and x-rays of coral cores provide insight into calcification and growth rates. Studying the isotopic ratio of boron (δ 11B) in coral cores allows scientists to reconstruct a history of the pH profile of seawater and see how corals fared under different acidity levels. This can help to anticipate how corals could react with the current trend towards



Miguel Gomez Batista from Cuba examines how ocean acidification could impact the corals of the Caribbean. Photo: F. Oberhaensli / IAEA

an increase in ocean acidification.

Little is known about the actual long-term trend and natural variability of seawater pH for the past century because of temporally and spatially limited

instrumental pH records. Therefore, to elucidate the natural variability of ocean pH and assess the actual trend in ocean acidification, time series of reconstructed pH from massive coral archives are required.

For proper management of ocean acidification, it is necessary to gain better understanding of trends and processes. This is lacking in the Caribbean and around the Cuban coastal zone. The results of Miguel's work will contribute to fill in the gaps of information and better predict future ocean acidification scenarios.

Environmental behaviour of radioactive particles at contaminated sites

In many regions around the world, a significant fraction of the radioactivity measured in contaminated environments is composed of radioactive particles. These particles may vary in their composition of radionuclides, structure, size and other physico-chemical characteristics depending on their formation and release processes. Once released into the environment, those radioactive particles may have very different environmental behaviours. Limited information is currently available on their behaviour in the environment and on their potential biological impacts. This was the rationale behind a Coordinated Research Project (CRP) on assessing the long-term environmental behaviour and potential biological impact of radioactive particles in the terrestrial environment (CRP K41013) initiated by the IAEA Environment Laboratories.

Project participants gathered in Vienna to discuss achievements and next steps. Photo: A. Pitois / IAEA

CRPs are important mechanisms set up by the IAEA to address issues, which require a joint effort from many research laboratories worldwide, to tackle new emerging challenges. The CRP on environmental behaviour of radioactive particles includes 12 research institutions from 11 countries working together to gain insight on this topic. The project participants, as well as observers and representatives of several European initiatives in this field, met at the Research Coordination Meeting (RCM) at the IAEA Headquarters in Vienna from 6 to 9 June 2017 to discuss research achievements and the way forward.

Presentations provided an overview of advances in the methodology and ability to characterize radioactive particles collected from the environment of various contaminated sites. New data were obtained on the transport properties, bioavailability and radiation exposure potential of these radioactive particles. Novel aspects of dosimetry related to radionuclides contained in the radioactive particles were also discussed, in particular the pathways and associated risks from inadvertent exposure, inhalation or ingestion of radioactive particles. Suggestions for the way forward included classification of radioactive particles collected in different environments linked to their formation and release scenarios as well as to their environmental behaviour. Participants emphasised that obtained results were already being widely used in many countries to plan the remediation of contaminated sites. The meeting also identified existing gaps in the knowledge on environmental behaviour and on the human and environmental impact of radioactive particles, and it provided recommendations for further research in this important area of radioecology.

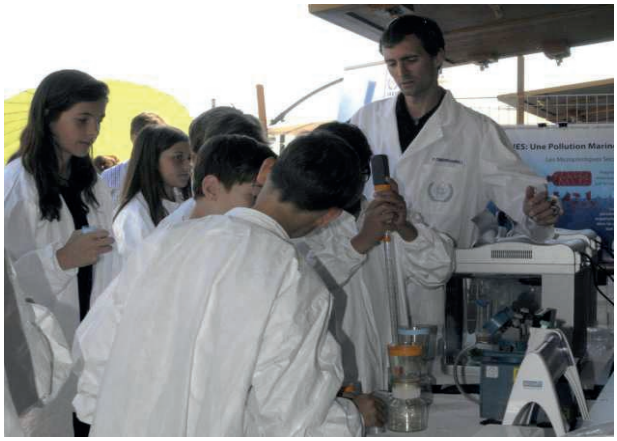
Monacology: the Monaco environment awareness week

The IAEA Environment Laboratories in Monaco participated in Monacology, an annual event in

HSH Prince Albert II of Monaco visits the IAEA Environment Laboratories' booth at Monacology. Photo: S. Jones Couture / IAEA

Monaco that raises environmental awareness among schoolchildren. With this year's theme being the sustainable development goals, the Environment Laboratories ran a booth which addressed SDG14: life below water. Through fun, educational activities, children learned about microplastics as well as marine ecosystems.

Visitors had the chance to become scientists and analyse water samples, highlighting the fact that pollutants like microplastics may be invisible to the human eye but are omnipresent in the oceans.



School children learn how to take water samples and filter them for plastic pollution. Photo: S. Jones Couture / IAEA

They also learned how the oceans are complex, interconnected ecosystems where organisms rely closely on each other and their environment to survive. The impact of human activities can disrupt this delicate balance and create an unsustainable future for the oceans.

Field work off the Peru coast

In May 2017 staff from the IAEA Environment Laboratories in Monaco participated in a research expedition off the Peruvian coast as part of "Climate-Biogeochemistry Interactions in the Tropical Ocean," a large research programme funded by the German Research Foundation since 2008. The goal is to increase knowledge of ocean deoxygenation, its impact on oxygen minimum zones and its consequences for the global climate-biogeochemistry system.

Oxygen levels in the ocean have an impact on the organisms that live there, as well as other natural processes such as the movement of water currents, climate, and transfer processes between the atmosphere and the ocean. Yet, under a changing climate, oxygen minimum zones could increase across the globe.

One of the targets of SDG 14 on life below water calls for increasing scientific knowledge to improve ocean health, among other things. In order to increase the global understanding of processes that impact climate, the IAEA Environment Laboratories were tasked with quantifying the organic carbon exported from the productive surface waters to the ocean floor. Isotopes of the naturally occurring decay series Uranium-238 can provide unique insight into these processes. This is done by an indirect method which consists in measuring the disequilibrium between the particle reactive Thorium-234 and its parent radionuclide, Uranium-238.

IAEA researcher deploys a pump off the coast of Peru. Photo: B. Gasser / IAEA

In biogeochemical models, the exported carbon needs to be quantified in order to balance nutrient fluxes in the water column. These fluxes can be assessed by measuring radionuclides Radium-228/Radium-226 and Radium-224/Radium-223 ratios to indirectly estimate the input rates of nutrients across the benthic boundary layer and its distribution into the water column. As part of the expedition, IAEA researchers took water samples using *in situ* pumps to measure these radionuclides. The research is a collaborative effort which provides samples and data to both the IAEA Environment Laboratories and German partners and illustrates the effective use of radionuclides to better understand marine processes.

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Upcoming events

Dates	Description	Location
11-13 September 2017	Consultancy Meeting on addressing the challenges of marine plastics using nuclear and isotopic techniques	IAEA Environment Laboratories, Monaco
21 September 2017	A side-event on Monitoring contaminants for safer seafood to be held during the IAEA General Conference	IAEA Headquarters, Vienna
28 September 2017	Fifth Annual Meeting of the Advisory Board of the Ocean Acidification International Coordination Centre	IAEA Environment Laboratories, Monaco
2-6 October 2017	Indo-Pacific Fish Conference	Papeete, Tahiti, French Polynesia
15-17 October 2017	Fourth International Workshop on Bridging the Gap between Ocean Acidification Impacts and Economic Valuation – "From Sciences to Solutions: Ocean Acidification Impacts on Ecosystem Services – Case Studies on Coral Reefs"	Oceanographic Museum, Monaco
23-26 October 2017	1st Latin-American symposium in Ocean Acidification	Buenos Aires, Argentina
23-25 October 2017	14th ALMERA Coordination Meeting	Stockholm, Sweden
27-28 October 2017	"Ocean Acidification workshop – developing regional capacity for ocean observations in support of SDG target 14.3"	Dar es Salaam, Tanzania
30 October-3 November 2017	Capacity building workshop for scientists in the Pacific Islands under the Enhancing Capacity for Ocean Acidification Monitoring and Mitigation in the Pacific Islands, Latin America and the Caribbean (OAMM) program	Suva, Fiji
30 October – 10 November 2017	MED POL Training Course on the Analysis of Organochlorinated Pesticides and Polychlorinated Biphenyls (PCBs) in Environmental Samples	IAEA Environment Laboratories, Monaco
30 October– 10 November 2017	MED POL Training Course on Analytical Techniques for the Determination of Trace Elements in Environmental Samples.	IAEA Environment Laboratories, Monaco
11 November 2017	COP23: UN Oceans Side Event "Ocean and Climate: A Resilient Ocean for Future Generations"	Bonn, Germany

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