HEALTHY OCEAN, HAPPY PLANET

Scientists use nuclear techniques to get a better understanding of the El Niño, a phenomenon in which the changing sea surface temperatures of the Pacific Ocean can cause disastrous effects. In 1972 Peru's anchoveta fishery collapsed, at the time the world's largest, partly due to El Niño. (Photo: iStockphoto)

Looking down at our planet from space, we are enchanted by a veritable 'sea' of blue, because most of our planet is made up of water, and most of its surface area is ocean. The world's saltwater bodies influence the planet's climate, and provide a home to millions of the world's plants, which also produce the oxygen we breathe.

Since the oceans and seas are so critical to human survival, scientists continue to study and attempt to fully understand the processes and mechanisms that control them. Nuclear techniques are some of the most precise research methods that are being employed in this endeavour. By monitoring stable isotopes in different locations and measuring the decay of radioisotopes, scientists can better understand how marine environments are changing, and how they changed in the past.

This kind of understanding improves humanity's ability to keep the marine environment healthy.

Ocean Acidification

One sign of an unhealthy marine environment is ocean acidification. This is the name given to the disruption of the sea's normal acid/alkaline balance, an imbalance that can cause some marine species to die off, because they are incapable of adapting to a more acidic environment, thereby disrupting the entire ecosystem and food webs.

Time Travel

"Understanding the effects of ocean acidification on marine organisms and ecosystems is critical if we are to identify where these systems are vulnerable and evaluate the potential impact on fisheries, aquaculture and ecosystems," says David Osborn, Director of the IAEA Environment Laboratories in Monaco.

To do this, researchers need accurate models that will help predict future conditions and thus help governments develop the appropriate strategies.

Marine radioisotopes provide a powerful tool both to help diagnose problems in ocean models and to help orient the development of new models.

Beneath the Surface

"We see only the surface of the ocean. But it is so much more extensive in mass and function than we initially perceive. Marine life produces between 50% and 85% of the earth's oxygen and is a key element in the global climate system," says Michail Angelidis, Head of the IAEA's Marine Environmental Studies Laboratory in Monaco.

To understand ocean acidification, harmful algal blooms (HABs), El Niño or La Niña events, or any number of dangerous phenomena occurring in the marine environment, we must first understand how the ocean itself works; understand how it acts as a heat sink and as a carbon sink; how it moves, when and why; how it transports plants, animals, soil, gases and heat from one part of the globe to another; and how it interacts with the wind and sun, regulating weather and climate.

For example, scientists use nuclear techniques to pinpoint the age of sediment at the bottom of the ocean and date coral skeletons, which give them accurate data about the state of the oceans hundreds of thousands, even millions of years ago.

This kind of information is invaluable when attempting to forecast the effect that current conditions will have on the oceans. And this information is used to extrapolate what will most probably happen to our planet decades and even centuries from now.

Occasionally, very warm ocean water temperatures will cross over from the western Pacific and stop the upwelling of cold and nutrient-rich water off the western coast of South America and influence climatic changes around the world. This is called the El Niño event, which has wide ranging effects, as it may cause e.g. enhanced melting of polar ice, reduced production in fish in Peru, decreased growth of maize in Africa and increased rainfall and flood in Florida. El Niño's intensity and characteristics in terms of salinity and temperature vary widely, thus making its impact hard to predict. So scientists have collected radionuclide, stable isotope and trace element records in corals and ocean sediments in order to reconstruct the patterns left by past El Niños going back several hundred years. These studies enable scientists to predict the sea surface temperature and salinity, and the frequency and intensity of future El Niños with much greater accuracy.

Radionuclides

Since the amount of time it takes for radionuclides to lose half of their radioactivity (known as half-life) is well known, scientists can use those radionuclides as a kind of clock to study how quickly or slowly ocean processes are occurring. Radionuclides are also being used to monitor the transfer of energy/mass in the food chain, providing critical information about key marine organisms, including those at the base of the marine food chain, and whose demise could very well mean the collapse of ocean ecology as we know it.

Isotopic techniques also provide information about these species' metabolism, photosynthesis, pollutant accumulation, calcification and their basic ability to survive under specific conditions.

Marine radioisotopes also contribute to the study of how rising ocean acidity together with increasing temperature disrupts the ecophysiology of coral reefs that serve as coastal protection and act as a habitat for countless marine species.

Pollution

"Science by itself cannot save the world, but science can provide the necessary knowledge and tools that humanity needs to make the right decisions; decisions which can save the world," says Hartmut Nies, Head of the IAEA's Radiometrics Laboratory in Monaco.

Nies' team of scientists at the IAEA helps Member States use natural radioactive tracers (such as uranium and thorium and their decay chain products) and man-made ones like plutonium or radiocaesium to understand sea dynamics and monitor for toxic elements.

Also, by studying pollutants' different isotopic signatures, scientists can find out where a particular pollutant is coming from. For example, lead from gasoline and naturally occurring lead have different isotopic signatures, which can be analysed using isotopic techniques. Knowing exactly where a pollutant is coming from helps authorities stop the flow of harmful substances into the sea.

Jacques Yves Cousteau, the renowned oceanographer and former Director of Monaco's Oceanographic Institute, with which the IAEA signed an initial agreement on joint exploration and research, said "The sea, the great unifier, is man's only hope. Now, as never before, the old phrase has a literal meaning: we are all in the same boat."

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