Young Philippine chemist finds missing environmental data by turning to nuclear science

By Miklos Gaspar

Wilfren Clutario, a chemist, used nuclear science to study how the ocean handled pollution caused by a severe typhoon in 2013.
(Photo: M. Gaspar/IAEA)

When environmental chemist Wilfren Clutario wanted to understand the level of pollution in the ocean caused by the world's most severe typhoon to reach land, which claimed over 6000 lives and devastated two-thirds of Tacloban in 2013, he had a problem: there was no baseline data available.

"We could measure the concentration of nitrates and organic matter in the sea, but we did not know how much of it was natural and how much was the result of contamination by the typhoon," said Clutario. At the time, he was a researcher at Eastern Visayas State University using conventional techniques to measure the concentration of different compounds at sampling sites. The gusting winds of Typhoon Haiyan, which hit the city on 8 November 2013, caused tsunami-like waves that carried debris containing organic materials, contaminants and human and animal corpses from the land into the ocean.

Researchers and policymakers were unsure if the ocean would be able to cope with the volume of pollution that entered the ocean during the typhoon, which could have transformed the area into a dead zone lasting for decades. They needed to understand what was pollution and what was natural to know whether any measures were needed to assist the ocean in 'digesting' the debris so that it could return to its natural state of equilibrium, explained Clutario.

When Clutario presented his research problem at a conference in 2015, Raymond Sucgang, a senior researcher from the Philippine Nuclear Research Institute (PNRI) with expertise in the use of isotopic techniques to characterize water pollution, sat on the edge of his seat, eager to offer a solution to Clutario's dilemma. They have been working closely together ever since. "Ours is like a professional marriage made in heaven," Sucgang said.

Not only has Clutario learned how to use isotopic techniques to characterize the source of nitrogen and organic matter and its movement to the ocean (see The Science box), with help from the PNRI and the IAEA, in cooperation with the Food and Agriculture Organization of the United Nations, but he has also added the use of isotopic techniques to the curriculum at the Philippine Science High School — East Visayas Campus, where he teaches. He has since supervised several research projects by senior high school students on the use of these techniques in characterizing contamination in fresh water bodies in the area.

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—Wilfren Clutario, chemist, Eastern Visayas State University, Philippines

"We have no office in Tacloban, but we have Wilfren," Sucgang said. And indeed, on a sunny day in August 2018, one of the school's classrooms was filled with researchers from the city and the province who participated in a one-day PNRI workshop on the use of nuclear and isotopic techniques in a wide range of areas.

"Nuclear techniques can do so much, but most people, even in the scientific community, don't know it," said Clutario, who had participated in IAEA-led training courses in Australia and Malaysia to broaden his own knowledge of the subject. "When people, even researchers, hear the term 'nuclear', they only think about nuclear power, but there is so much more to it."

Spreading the use of nuclear applications in the scientific community is central to the mission of the PNRI, which looks to researchers like Clutario to assist, said Carlo A. Arcilla, Director of PNRI. "We are conducting workshops across the country to educate scientists."

Protecting the food chain

Clutario's research has revealed that relatively high concentrations of nitrogen in commercial and coastal areas were natural, while relatively lower concentrations in protected areas and neighbouring commercial fisheries could be traced back to biomass from land, such as cadavers.

"The nitrogen is the tracer, showing us where the pollution ended up," Clutario explained.

For the next step, the fish and sediment need to be studied to determine how much of these contaminants made it into the food chain. Checking the heavy metal concentration in fish is important because toxic substances may have entered the sea as part of the debris.

Clutario continues to take samples and PNRI offices near Manila analyse them using an isotope ratio mass spectrometer, a machine donated by the IAEA through its technical cooperation programme. These analyses will reveal whether the concentrations are decreasing and if this process is happening naturally. "There is a lot more to be done to better understand the ocean," he said

The catastrophic events in 2013 marked Clutario for life; and while history cannot be changed, he said he is glad he can help in the restoration work.

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THE SCIENCE

Stable isotope techniques

Isotopes are atoms of the same element with the same number of protons, but a different number of neutrons. While the chemical properties of all isotopes of one element are the same, their weight differs according to the number of neutrons they have. These weight differences enable scientists to distinguish them from each other when analysed using an isotope ratio mass spectrometer. Scientists can use this approach to identify the isotopic composition of a material.

For these studies on water pollution, researchers tracked stable isotopes of nitrogen and carbon. Species of different origins contain specific, unique levels of isotopes that reflect the food they eat and the environment they live in. Scientists can study this isotopic composition and use it like a fingerprint to identify the presence of different types of organic matter in their surroundings.

In the ocean, plants, like seaweed and seagrass, and stationary animals, like oysters, can tell scientists a lot about the current and past isotopic composition of the environment. Because these organisms do not move, as they take in food from seawater and grow, their isotopic composition develops to reflect the concentration levels of different substances in the ocean at that specific point in time. Therefore, researchers can measure the isotopic composition of these plants and animals to better understand the ocean's past.