NASA satellites help plan future for Palau fish stocks

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The government and fishermen of Palau are setting up sustainable aquaculture farms near their shores in an effort to ensure food security for generations to come. Their planning work uses information from NASA's satellites to protect the country's rich ecosystems. Credit: Courtesy of Fabio Siksei

It's the weekend, and freshly caught fish sizzles on the grill. The view: an unforgettable beach and the cobalt blues of the Pacific Ocean in the backdrop.

This is not paradise. It's a typical Sunday for many people in Palau, an archipelago nation in Micronesia.

"We would go to the Rock Islands, spend a couple of nights there, and we would go fishing," recalled Fabio Siksei, a fisheries specialist with Palau's Bureau of Marine Resources, about growing up near the country's famed Rock Islands Southern Lagoon. "Most Palauan kids have almost the same experiences growing up."

People in Palau, a small nation with a population of about 20,000, consume more wild fish per capita than nearly any other country in the world. But in recent years, populations of rabbit fish and other staples of their cultural diet began to dwindle because of a combination of factors, including increasing food demand and changing ocean conditions.

To meet the country's need for food supplies and keep traditions alive for future generations, Siksei and others are working with international scientists to build sustainable aquaculture farms in the ocean. Their projects are using NASA's satellites to help protect the nation's pristine waters, coral reefs, and shorelines.

"We found that fish stocks were declining due to [our waters] being unable to produce enough to maintain the population of the fish, and that was reason enough for the fishermen to start thinking about management issues," Siksei said. "We talked with fishermen about ensuring that our fish are there and our resources are there, also about ensuring that our culture continues to thrive for generations to come, because fish is a big part of our life."

With more than 300 small islands amounting to a landmass about twice the size of Washington D.C., Palau is one of the tiniest nations in the world. Surrounded by a 200-mile radius of scenic ocean and coral reefs that make for a scuba diver's paradise, the country's economy relies primarily on tourism and fishing.

But even though tourism serves as an important driver for the economy, Palau's islands are under pressure to provide the resources to sustain the hundreds of thousands of people who visit the country in normal, non-pandemic times, Siksei said.

For several years, Siksei and others in Palau have been working with scientists at The Nature Conservancy to manage the aquaculture sector and find the best locations within Palauan shores to build marine aquaculture farms necessary to meet future food production needs.

The idea, Siksei said, is to breed fish and shellfish without disrupting marine ecosystems and other aspects of the country's nature, culture and economy. For that, the team is focusing on rabbit fish and giant clams, two types of seafood entrenched within the cultural history of the nation.

"We don't want to stop people from fishing or stop people from doing what they usually do," Siksei explained. "We're trying to find a way where they can continue to make a living and enjoy these resources."

The Potential of Marine Aquaculture

As part of a nation that cherishes its natural resources, the government and fishermen of Palau teamed up with scientists at the Nature Conservancy more than 30 years ago to establish marine protected areas, improve the management of fisheries, and meet other environmental and societal needs.

In its early stages, the collaboration included conversations with aquaculture farmers who needed to gain a better understanding about the circulation of the ocean, the ideal distance to farm from the shore, and other parameters that can make aquaculture economically and environmentally viable for the country.

The team is also integrating several layers of satellite data into maps that the people of Palau can use to assess their objectives when setting up aquaculture farms. In recent years, the team also secured support from NASA's Earth Science Applied Sciences Program, and is now producing interactive mapping tools Palauans can use to identify areas that can serve as a better fit for sustainable aquaculture.

Marine aquaculture has much more potential to be sustainable than other forms of animal protein production, said Robert Jones, who leads The Nature Conservancy's global aquaculture program. But when done the wrong way, farms situated in the ocean can put more stress on marine ecosystems. Preventing that problem is one of the key goals that the project seeks to address.

"Almost every coastal country in the world has an aquaculture development plan, and all of them are saying we need to boost production to meet increased demand for animal protein and seafood," Jones said. "But there's so few people who actually know how to do the right industry planning and siting work to ensure the environment is protected while achieving development goals."

If done with inappropriate procedures, aquaculture can lead to poor water quality near Palau's shores. That's especially significant for fish farms, since fish also produce waste that can muddy the water and change ocean conditions, blocking some of the sunlight that organisms like coral need to survive.

"If you have fish in a pen, they poop," Jones said about the cage or net system used in aquaculture farms. "If we have coral in the proximity of that plume coming out of the fish pen, that can really damage [the coral's] ability to survive. It puts further stresses on the coral that's already experiencing [stress] from climate change."

Fish Farms Seen From Space

Jones's team integrates several layers of satellite data into maps that the people of Palau can use when setting up aquaculture farms—including maps that estimate the clarity of the water. That's important for giant clam farms, which also need sunlight to penetrate the water to survive.

"We can look at the area and find out where you might have a better chance of sunlight reaching the giant clams to help produce their energy," said Jonathan MacKay, a Marine Spatial Scientist with The Nature Conservancy and NOAA, who leads the team's data and mapping efforts.

To create these maps, which analyze chlorophyll concentrations and the cloudiness of the water, MacKay uses satellite data from the MODIS instrument aboard NASA's Terra and Aqua satellites. He also uses sea surface temperature data from the NASA Making Earth System Data Records for Use in Research Environments Program.

"Part of this project is also looking ahead at climate

change, and how that might affect things like sea surface temperature," MacKay said. "We can see where warm water sits in the lagoon and see if there's maybe not a lot of ocean circulation with water sitting still and warming up more than the surrounding waters."

One of the highlights of the mapping tools relies on satellite images that estimate the bathymetry, or underwater depth, of shallow areas in the ocean. To do that, the project team uses data from Landsat 8, a joint mission of NASA and the U.S. Geological Survey that has been tracking changes on the surface of the planet since 1972, and generating the longest continuous record of its kind.

The maps also include nearly 30 layers that overlay vital environmental data, such as locations of dugongs and other marine animals protected by the government of Palau—as well as social data on World War II historic sites or scuba diving sites that play an important role for tourism.

A Promising Tool for a Global Challenge

Already, these mapping products are being shared with people in Palau through an online web map and hands-on training modules focusing on geographic information systems, remote sensing, and other key topics needed to establish new marine aquaculture farms.

Led by MacKay and hosted by The Nature Conservancy's conservation training website, these courses are administered in partnership with the Palau Community College to students from various backgrounds of the government, such as the country's Environmental Quality Protection Board.

Helping Palauans to continue using the maps with new data layers in the future is a top priority for Siksei, Jones, and MacKay. And it's an aspect of their work that NASA values tremendously, according to Maurice Estes, who helps manage the NASA program that supports the project, because it can offer a promising toolset for coastal communities worldwide that depend on the ocean and fisheries for food supplies.

"They've developed a novel method in terms of using Landsat data to estimate the bathymetry in shallow areas," Estes said. "The challenge of sustainable food supplies being addressed by this project is a global challenge."

Provided by NASA's Goddard Space Flight Center