Mangroves, Fishponds, and the Quest for Sustainability

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As I write on this late June afternoon, my heart grieves amid news that a young couple, dearly loved former research colleagues living in the north of Panay Island in the Philippines where I work, had been shot over a fishpond dispute. The owner, it seems, did not want them to use a shortcut on his property that led to the pond the couple was renting from him. Bullets shattered the jaw, collarbone, and colon of the husband, a marine biologist who miraculously survived, but they proved fatal to his wife, an aquaculture nutritionist and university instructor.

The incident takes me back decades to my home island of Mindanao when rifle bullets strafed our campus cottage during a short-lived rebellion. My family and a neighbor crouched inside the bathroom, while the battle between rebels and government soldiers raged for 4 long hours. The growing insurgency forced me to give up my teaching job at Mindanao State University and flee to the quiet of the Visayas, in the central Philippines, where I accepted a research position with the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD).

Fast forward to the present, to another potential conflict elsewhere in northern Panay. This one is centered on the small-scale cutting of trees in and near a magnificent mangrove stand of Avicennia rumphiana trees, some of them up to 8 m in circumference. This location has been among our study sites since 1997. But to make an official complaint would place my colleagues and me in harm’s way from those who earn income by planting the cleared area with Nypa palm or converting it to ponds.

I have observed this difficult dynamic firsthand since the mid-1970s when the field of aquaculture, the farming of aquatic plants and animals, was getting started. Indeed, my first studies in this area—on the growth and survival of shrimp in earthen ponds and production of breeders for hatcheries—contributed to the foundation on which increasingly efficient shrimp farming developed, so often, as it has turned out, to the detriment of mangrove habitats.

Mangroves at Risk

Aquaculture ranks as a phenomenal success story in global food production. In 1975, when I joined the SEAFDEC/AQD, aquaculture contributed 8% to the overall yield of the world’s fish harvest; now it provides more than one-third of the yield of the world’s fisheries. Total aquaculture production in 2003 was 54.8 million metric tons, valued at $67.3 billion in U.S. dollars. More than 90% of this output comes from Asia, where aquaculture has its origins.

As with land-based agriculture, all of this aquatic food production and economic activity has come with environmental problems and social conflicts. Foremost among these is the loss or modification of habitat in places where aquafarmers clear mangroves for ponds and where they install cages or pens above seagrass beds and coral reefs. Other environmental effects include the loss of bycatch (unwanted fish and invertebrate species) during the collection of wild “seed” used for stocking in ponds and of adult broodstock for hatcheries, introduction of exotic species, spread of parasites and diseases, interactions of escapees from ponds or pens with wild populations, misuse of chemicals and antibiotics, salinization of soil and water, and coastal pollution. Many of these ecological impacts of shrimp aquaculture have brought...
along social problems, among them privatization of public lands and waterways, the decline of open-sea fisheries, rural unemployment, and social disruption.

Even the seemingly reasonable assumption that aquaculture is an efficient way to produce new protein is undermined by the dependence of shrimp, salmon, and other cultured aquatic carnivores on raw fish and on fish meal and oil in pelleted feeds. Careful calculations indicate that some cultured species actually are net consumers of fish.

In the 1980s, I began to ring warning bells about the perils of runaway shrimp farming.

Vanishing mangroves. The expanse of fish and shrimp pens in the foreground of this aerial view of Dagupan in the Philippine province of Pangasinan used to be filled with mangroves.

At the time, aquaculture was perceived as the coming Blue Revolution that would help solve world hunger, provide jobs, and fight poverty. Because of my cautionary views, I became marginalized in aquaculture circles. At some meetings I was ostracized and my research papers sometimes seemed harder to get through editorial decision-makers than the reviewers’ comments would have suggested. Even so, other researchers would subsequently confirm my conclusions on, for example, the boom-and-bust nature of unplanned and poorly managed shrimp culture. And in recent years, momentum to develop sustainable aquaculture practices has been building.

For my part, I have received invitations from foreign groups, including the Global Wetlands Economics Network and the International Foundation for Science, to expose the plight of mangroves and share my ideas about aquaculture sustainability. At times, I have done so in high-profile media outlets, such as a BBC documentary in 2002. Although I had always been confident that even my early alarmist attitude was justified, I received my final peer vindication last year when Stockholm University presented me with a Ph.D. in science honoris causa for showing “… that mangroves are key areas for recruitment of fish and shrimp and that development of conventional shrimp farming may have far-reaching negative economic and social implications…”

For greater sustainability, the aquaculture industry must acknowledge its interdependence with fisheries and other stakeholders. Ecologically damaging practices need to be replaced with ecologically sound ones, such as locating culture ponds outside mangroves where possible, using native species whose inevitable escapes into nearby waters would be relatively innocuous, and stocking hatchery fry rather than wild seed whose collection entails the loss of bycatch.

Because surrounding waterways can be the source as well as recipient of contaminants and pathogens, systems of low water exchange between ponds and the surrounding environment can minimize such risks. Levels of suspended solids or sediment are reduced if pipes that provide aeration are set on the pond bottom, rather than on the surface, and also by means of settling ponds. Water quality can be maintained with natural biofilters such as clams and other bivalves. Probiotics are commercial suspensions of appropriate types of bacteria added to the pond that operate on the principle of competitive exclusion (of harmful bacteria). The so-called green water technique enhances shrimp growth and survival by means of a combination of phytoplankton and the presence of herbivorous fish in the pond. Finally, lower stocking densities of shrimp and their polyculture with suitable fish species can minimize waste levels and produce synergistic benefits.

Already, the culture of seaweeds and fish in cages in subtidal bays and rivers is compatible with adjoining mangroves and suitable for family-level operations.

But there remains a need for mangrove-friendly aquaculture technology in intertidal forests, in which mangrove trees spend high tides with their roots submerged and low tides with their roots exposed. That’s why one of my current projects, funded by the European Commission, is to develop sustainable so-called aquasilviculture. An approach I have developed, which combines the rearing of mud crabs inside intertidal pen enclosures, has been replicated by local people’s organizations in the Philippines. Meanwhile, several studies have shown that mangrove estuaries can process nutrients, such as those from fertilizers, in aquaculture pond effluents at least over short spatial and temporal scales. That opens up the possibilities of integrating intensive aquaculture with natural or constructed mangrove wetlands in a way that could be sustainable through careful management and planning.

A Menagerie of Mangroves

My earliest training was in zoology, and when I began studying the taxonomy of mangroves, I found the diversity of these habitats challenging. On a trip to the Mai Po, Hong Kong, mangroves in 1993, experts from Thailand and Vietnam effortlessly called off the scientific names of mangrove species—Avicennia marina, Kandelia candel, Aegiceras corniculatum, etc. Feeling ignorant, I vowed to master the Indo-Pacific species of mangroves. Indeed it took me 10 years to write and publish, with UNESCO support, the Handbook of Mangroves in the Philippines—Panay, which came out last year. The diversity of mangroves and their wide distribution in the archipelago in the past are reflected in the names of many coastal towns and villages. The name of the country’s premier city, Manila, derives from Maynilad, meaning there is nilad, referring to the mangrove Scyphiphora hydrophyllacea, which grew profusely along Manila Bay in pre-Hispanic times.

Mangroves, seagrass beds, and coral reefs bordering the 7150 Philippine islands have contributed appreciably to the livelihood and well-being of coastal communities over the centuries through their provision of various goods and services. Foremost among mangrove products are fish, shellfish, and other invertebrates that provide the most available and inexpensive protein in the Filipino diet. Other natural benefits afforded by mangroves include coastal protection, erosion control, sediment trapping, and recycling of nutrients from terrestrial run-off and river discharges.

Latest estimates, as of 2000, have placed the global coverage of mangroves at 15 million hectares (ha), a drastic decline from 18 million ha in the 1990s. The losses have been particularly heavy in South-East Asia, which hosts a third of total mangrove area. The anthropogenic causes of such losses...
include overexploitation of mangroves and conversion of mangroves to settlements, rice fields, salt beds, tourist resorts, and industrial facilities. But brackishwater pond culture, which dates back to 1400 in Java, has also taken its toll. Many thousands of hectares of culture ponds in the Philippines and Indonesia were carved out of mangrove swamps because these habitats were considered ideal for growing milkfish (Chanos chanos), a food fish favored by local people. Around half of the 279,000 ha of Philippine mangroves that disappeared between 1951 and 1988 were converted into ponds mainly for milkfish, but also for shrimp.

Aggressive mangrove and wetlands development became national policy in the Philippines in the 1950s. Some of these policies supported aquaculture development by enforcing a form of rent control on the mangroves. The original fee for leasing a pond was PhP50, or about $2/ha per year. This fee was way out of line with the estimated values of $538/ha per year and $42 to $156/ha per year, respectively, for fish and wood harvests from Philippine mangroves. By underpricing the rights to harvest public forests and by not penalizing low pond productivity, these policies and practices encouraged rampant conversion of mangroves to aquaculture ponds.

Both a 1991 decree and one in 1992 mandated an increase in the rental to PhP1000, or about $20/ha per year, but its implementation was delayed indefinitely on both occasions by a strong fishpond industry lobby. In the past 2 years, the government presented a series of expert witnesses, including myself, who cited published valuations from the mangrove literature and aquaculture studies of mangroves and fishponds to justify the pond rental increase. The court is expected to rule within the year.

Actually, numerous laws, decrees, and ordinances aim to protect remaining mangrove areas. These include guidelines for mangrove-pond conversion and reversion of abandoned ponds to forest. Ownership policies, such as the Mangrove Stewardship Agreement that legitimizes de facto claims of local communities over coastal resources, improve the success rate of replanting programs. Even so, coordination is lacking between the national forestry and fisheries agencies tasked to administer mangroves and ponds. Legislation to conserve, protect, and rehabilitate Philippine mangroves has not been wanting—it is their implementation that is generally weak, hampered by inadequate manpower and resources, and overall lack of political will to enforce the laws.

Consider the requirement by a number of “greenbelt” proclamations that a mangrove strip of 20 to 50 m along riverbanks and one of 50 to 100 m facing the open sea be maintained regardless of the economic activity in the area. Today, an aerial view of the Philippine coastline will show a monotonous succession of ponds with hardly any green signs of such mangroves.

As the December 2004 tsunami has shown, this is not merely a matter of aesthetics. Man-made structures such as shrimp/fish farms and tourist resorts along the coastline are no match for rampaging waters. It is time to enforce these greenbelt and other mangrove-preserving laws, because only a solid wall of trees can slow down a moving wall of water. More than ever, there is a need to preserve or rehabilitate mangrove-beach forests and coral reefs to serve as natural barriers that diminish the tremendous wave energy generated by tsunamis, as well as by typhoons. Tsunamis appear every 20 to 50 years in the Philippines, but in a single year 20 typhoons may devastate the country by inflicting massive losses of life and property.

Mangrove Sense

Only a fifth of the 500,000 ha of Philippine mangroves at the turn of the 20th century remain, whereas brackishwater ponds have increased almost fourfold, from 61,000 ha in 1940 to 230,000 ha at present. Many of these ponds have no associated legal papers—either the lease has expired or the application is pending. Often single families own up to hundreds of hectares of pond area. Twenty hectares is the most that a Filipino pond operator can realistically manage by himself, so many ponds are underutilized or abandoned, and productivity is low compared to that of Thai shrimp farms, which average 2 ha or less. By reducing farm sizes, Filipino aquaculturists can increase pond yields and afford to pay the still modest lease fee of PhP1000/ha per year. The remaining areas, especially those facing waterways, could be reverted to greenbelts, finally coming into compliance with Philippine laws. Also, by redressing