Chapter 11
The Use and Abuse of Sea Resources

Abstract As a maritime country, the Philippines is a place of high fish consumption. Many coastal villages are populated by fishermen, who are amongst the poorest of working Filipinos. International comparisons show that the Philippine fisheries sector is mostly characterized by small inefficient fishing vessels, while some of the fishing methods are extremely destructive to the resource. Today, fishing moratoriums must be imposed in some areas to allow the reproduction of the fish. Poaching and illegal fisheries, including by foreign vessels, especially from China, plague the most important fisheries areas. Aquaculture has developed to counterbalance the decline of the natural resource, but it has negative ecological effects, among them the disappearance of mangroves. Today, efforts are underway to protect the marine resources of the country, through the implementation of Marine Protected Areas in this biologically rich area of the West Pacific. Part of the "Coral Triangle" initiative, the Republic of the Philippines encourages local efforts to rejuvenate coral reefs and mangroves, while allowing tourism to cohabit with more established uses of the coastal areas of the archipelago.

Keywords Fisheries • Aquaculture • Marine protected areas • Coral reefs • Mangroves

With its 7107 islands and 36,000 km of shorelines, the Philippine archipelago claims one of the world's longest coastlines. Sixty percent of the Philippine's population resides in the coastal zone. Marine fishing in the Philippines is more than an industry; it is a way of life. In the present state of the Philippines as a developing country with vast ocean jurisdictions, and dependence on these oceans, fishery resources are critical to the health and livelihood of the greater majority of its people (Encomienda 2014a, b). There are some two million fishermen in the country. Over 50% of the dietary protein requirements of coastal communities are derived from municipal fisheries and shallow coastal habitats (reef fishes, marine plants, and mangroves). In many coastal municipalities the most common job is fisherman. Fishermen's *bangkas* resting under beachside coconut trees are a classic coastal landscape around the archipelago. If rice is the staple food of the Philippines, fish provides most of the protein and daily diet of rural Filipinos (see Sect. 11.1).

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Most men in coastal communities are fishermen, owners of a tiny "banca" (or *bangka*) (Funtecha 2000). This elongated, banana-shaped dugout canoe, of Austronesian origin, has in most cases two outriggers (*katig*) made of bamboo, acting as stabilizers. The small bangkas are usually paddle driven, and typically used in shallow waters. Sometimes the small triangular sail of a *paraw* (Visayas region) helps fishermen to come back faster to shore. Wealthier fishermen have added a single cylinder pump motor to the back of their canoe. Traditional rituals involving bangkas reveal that they are a marker in Philippine society, not just a water vessel (Abrera 2005). From the selection of the tree, its felling, digging it out or hewing it into planks, to the construction and until its launching into the sea, the entire process is wrapped in rituals and religious meanings. The bangka directly reflects the indigenous animist belief system, including rituals involved in burial and the use of the bangka as a vessel to transport the departed to the next life.

Coastal populations are young and expanding at rates that exceed regional and national averages. It is common for children to work in the fisheries sector in dangerous conditions (Pomeroy 1987). Some of them are immersed in water for about 8 hours throughout the night to get fish to enter nets, while others dive 15 m deep to catch mollusks without protective equipment. These children are exposed to eardrums damage, injuries from falls, shark attacks, sea snakes bites or drowning.

Many women (Siason 2000) market their husband's catch, process fish, or gather shells and sea cucumber for sale, once the family food needs have been met. Their knowledge about fishery resources and their fishing activities are mostly associated with the intertidal zone, whereas men's knowledge is associated with coral reefs and offshore spaces. The progressive socialization of children into fishing reinforces this gender division of labor and space in the coastal zones (Siar 2003) (Fig. 11.1).

Fishing communities remain the poorest of the rural poor, with a poverty level of 39% in 2012 (Quirino 2014), and the resources are over-used (see Sect. 11.2). Prices of staple fish have increased rapidly in recent years: one kilogram of *galunggong* (round scad, *Alepes melanoptera*), "the poor man's fish" according to former president Corazon Aquino, cost about 87 pesos in 2010, but its price had reached 140 pesos by late 2014 (Gavilan 2015). Data from the Bureau of Agricultural Statistics show that there has been a decline in the production of the *galunggong*, due in particular to overfishing (Muallil et al. 2014a, b).

There is a need to take concerted action—among small and commercial fishers, government, private sector and NGOs to reverse the declining trend in fish catch and save the oceans by putting in place science-based fisheries management, and equally as important, making existing laws work. The crisis in fisheries (Green et al. 2003) has led to the development, as in other Asian countries, of fish farming (offshore, on lakes and inland) and to the adoption of strategies to better protect coastal environments such as mangrove areas through integrated coastal resource management (Fernandez et al. 2000; Parras 2001) (see Sect. 11.3). In some areas, fishermen have been told not to work at certain times of the year, to allow stocks to redevelop. Another way to manage the crisis in fisheries has been to establish a wide network of marine protected areas (MPA). However, such resource-focused fisheries management initiatives may result in further marginalization of the poor fishers and pose serious social problems in coastal communities (Muallil et al. 2014a, b).

Fig. 11.1 Bangkas on the beach, Barangay Mambugalon, Mercedes, Camarines Norte (July 2014)

11.1 Fish and Fisheries

11.1.1 The Consumption and Use of Seafood

The consumption of fish per capita (Tan-Garcia et al. 2005) in the Philippines has been estimated by the FAO in 2011 at 32.7 kg/year, well above the world average of 18.9 kg/year.[1] The Philippines is part of a large West Pacific and East/Southeast Asian domain where consuming fish is common (South Korea 60.4 kg/year/person, Palau 55.9, Malaysia 55.8, Burma 55.3, Japan 51.7, Vietnam 33.6, China 33.5). The country ranks 49th in the world out of 220, behind many small insular nations and territories (Maldives, Niue, Cook Islands, Nauru, Samoa…) and European countries (Iceland, Norway, Portugal, Spain).

Its ranking is much higher (27th) when considering the fish contribution to the total animal protein consumption: 39% (compared to a world average of 17%), higher than in Japan (37%).[2]

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[1] http://www.globefish.org/total-fish-consumption-per-capita-kg-and-fish-contribution-to-total-proteins-percent.html

[2] The Philippine archipelago is only surpassed in this index by Martinique (79%), the British Virgin islands (75%), the Maldives (72%), Sierra Leone (68%), Cambodia, French Guyana (66%), Guadeloupe (63%) Wallis & Futuna, Kiribati (61%), Tokelau (60%), the Solomon Islands (57%),

Varieties of fish popular with Filipino customers[3] include tilapia, catfish (*hito*), milkfish (*bangus*, *Chanos chanos*, the "national fish") (Carbine 1948), grouper (*lapu-lapu*, *Epinephelus fuscoguttatus*, called *pugapo* in Cebuano), mackerels (*galunggong* and *hasa-hasa*, *Rastrelliger brachysoma*), swordfish (*ispada*), tuna, sardines (often consumed as canned fish), as well as other sea foods such as shrimps (*hipon*), prawns (*sugpo*), oysters (*talaba*), mussels (*tahong*), clams (*halaan*, *tulya*), crabs (*alimango*) and squid (*pusit*). As in other Asian countries, condiments are made from seafood: fish sauce (*patis*), fish paste (*bagoong*) or shrimp paste (*bagoong alamang*). Canned sardines and *bagoong* (shrimp paste) are two of the most affordable food items for poor Filipinos.

Fish may be consumed fresh, grilled (squid also), dried salted (*tuyô*) or processed. A common breakfast of poor Filipinos is dried tilapia with rice. The popular *Sinigang na Isda* or Fish Sinigang is a sour tamarind soup of fish. The fish (*isda*) used most often is Milkfish *(Bangus)*. This rice water-based broth is flavored with tamarind (*sampaloc*) juice, tomatoes (*kamatis*), onions (*sibuyas*), *kangkong* (water spinach) leaves, sometimes eggplant (*talong*) and calamansi juice, together with fish sauce (*patis*), cooked with the fish cut into several pieces. In Legazpi City, Albay, *cocido* refers to a clear broth fish head soup. Fried calamares are a classic snack (rolled in flour, pepper, salt and coconut oil). *Adobo sa gata*, prepared in coconut milk with soy sauce, vinegar, garlic, onion and ginger can be made with different kinds of fish (lapulapu, tilapia – *ginataan tilapia* –, stingray – *pagi* –…). *Balaw* is a dish of shrimps cooked in coconut milk, with pepper, sili and salt. *Tinumok* is prepared with shrimps, pieces of young coconut and gabi leaves. *Paksiw na Isda* is a dish where fish is poached in vinegar and ginger, and cooked with eggplant and ampalaya. It can be prepared with *bangus* (Milkfish), *biya* (Gobies), *talilong* (Black Finned Mullet), *banak* (Long-Finned Mullet), buwan-buwan (Japanese Bigeye), *bidbid* (Ten Pounder) or *kitang* (Spadefish). The well-known *Bikol Express* is a spicy dish of small shrimps mixed with pork and cooked in coconut milk, with a generous amount of pepper and red hot chiles. *Kinunot*, another Bicol specialty, is made with shark or stingray meat in coconut milk, with chile, pepper, ginger, and of course rice. Complex dishes of Spanish influence, such as paella or *bacalao a la vizcaina* (Tayag 2015), are usually prepared for special occasions such as fiestas and birthdays.

Sri Lanka, Bangladesh (56%), Indonesia (55%), Ghana (52%), Sao Tome & Principe, the Seychelles (48%), Gambia (46%), Niue (45%), the Faroe islands (43%), Senegal, Nigeria, Myanmar, Laos (43%), Mozambique, Togo (40%), at the level of Tuvalu and Malaysia (39%).

[3] http://www.infofish.org/wp-content/uploads/Country-Profile-PHILIPPINES-06-2012.pdf

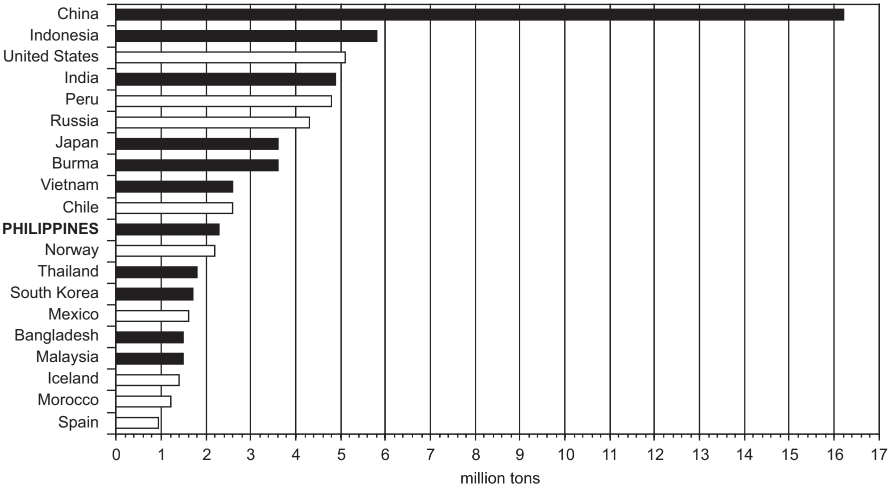

Fig. 11.2 2012 catch of fish, mollusks and crustaceans. Source: FAO, Fishery and Aquaculture Statistics Yearbook 2012, Table A1-c, http://www.fao.org/3/a-i3740t.pdf

11.1.2 Fisheries Production and Geography

According to FAO statistics, the Philippines were, in 2012, the 11th country in the world in overall tonnage of catch in fish, mollusks and crustaceans, and ranked 7th within Asia, a continent that dominates the world production. Its production of seaweeds was quite low (26th in the world, even if 4th in Asia, well behind China, Japan and Indonesia).

Fish production in the Philippines is attributed to three main sectors, aquaculture (49%), municipal fisheries (27%) and commercial fisheries (24%). The major fishing grounds include eight seas, ten bays, nine gulfs, three channels (Babuyan, Jintotolo and Maqueda Channels), five straits, and two passages. The largest of the fishing grounds is West Sulu Sea with an area of almost 30,000 sq km, followed by Moro Gulf and South Sulu Sea. The rest of the major fishing grounds have an area of less than 10,000 sq km. Five provinces from the southwestern Philippines (Palawan and western part of Mindanao) account for one third of total catches (Fig. 11.2).

The fishing grounds of the Philippines are found all over the archipelago, while there are many small fishing ports all around the islands, and the main wholesale market for the whole country (Navotas Fish Complex) is located in Navotas, a municipality within Metro Manila, just north of the port of commerce. Major provincial fish markets include Bacolod and Cadiz in Negros, Davao, Zamboanga and General Santos[4] in Mindanao, Cebu, Iloilo (Panay), Mercedes (Camarines Norte), Camaligan (Camarines Sur) and Tacloban (Leyte) (Figs. 11.3 and 11.4 and Table 11.1).

[4] The main port for Pacific tuna fishing

Fig. 11.3 Fish market in Mercedes, Camarines Norte (July 2014)

Fishing vessels are many and small. According to FAO statistics, the Philippines was the 3rd country in the world (476,178), after China and Indonesia, for the number of fishing vessels, with the lowest percentage of motorized fishing boats in Asia: 39%. Most boats are equipped with sails or moved by paddling. Only some African countries had a higher level of non-motorized fishing boats (Uganda 90%, Egypt 86%, Tanzania 82%, Nigeria 78%, Angola 65%). This reflects the mostly artisanal nature of Philippine fisheries, as shown also by the average quantity of catches by fishing vessel (Table 11.2 and Fig. 11.5).

Most fishermen come back to shore with less than 20 kg of catch per trip. Half of them target pelagic species (jacks, scads, tunas, mackerels, sardines, herrings, anchovies, needlefish), about a quarter each aim for reef-associated demersal species (groupers, snappers, parrotfish, emperors). An enquiry reveals that only 3% of fishermen consider fishing as financially rewarding, while half of them say it is barely providing the needed food resources for their household (Muallil et al. 2014a, b).

Some of the traditional techniques used by local fishermen have proved quite successful, as in the case of tuna fishermen off the coast of Mamburao, southern Mindoro (Evora 2014). Handline fishermen roaming the Mindoro Strait on outrigger boats, catch 70-kg yellow fin tuna using "*kawil*" (hook, line and sinker), attracting pelagic fish such as tuna, marlin and mahi-mahi (dolphin fish) in their "*payaw*" or fish aggregating device: these bamboo rafts attached with palm or coconut fronds and tethered to the sea floor with concrete blocks, provide shelter to the fish and

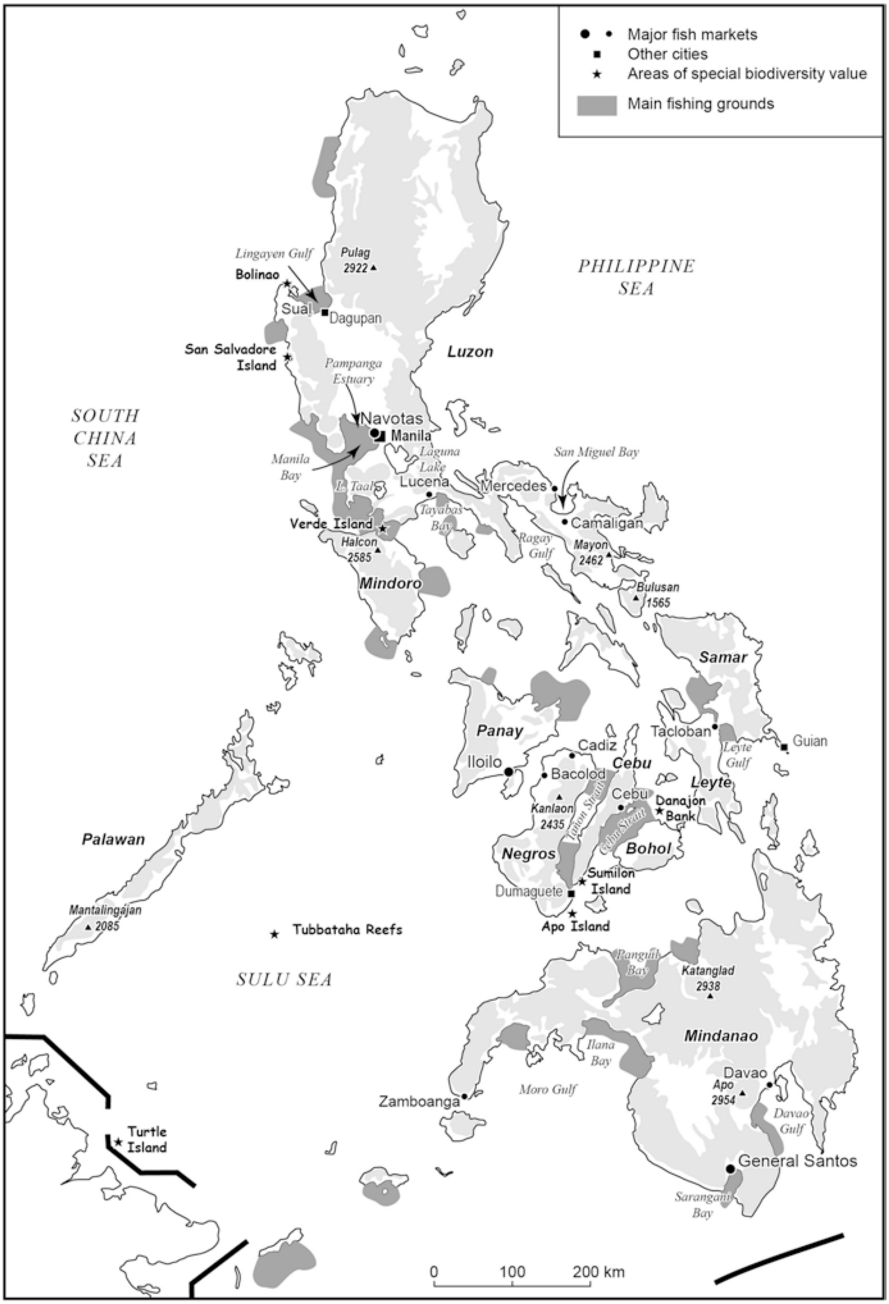

Fig. 11.4 Riches from the sea

Table 11.1 Top provinces for fisheries production in 2013

		Region	Island	Million tons	Percent of total (%)	Cumulative percentage (%)
1	Palawan	Mimaropa	Palawan	501.5	10.7	10.7
2	Tawi-Tawi	ARMM	Mindanao/Sulu	332.1	7.1	17.8
3	Sulu	ARMM	Mindanao/Sulu	312.8	6.6	24.4
4	Zamboanga City	Zamboanga Peninsula	Mindanao	247.9	5.3	29.7
5	South Cotabato	Soccsksargen	Mindanao	219	4.6	34.3
6	Pampanga	Central Luzon	Luzon	162.4	3.5	37.8
7	Zamboanga Sibugay	Zamboanga Peninsula	Mindanao	138.4	2.9	40.7
8	Quezon	Calabarzon	Luzon	135.3	2.9	43.6
9	Bohol	Central Visayas	Bohol	132	2.8	46.4
10	Pangasinan	Ilocos Region	Luzon	128.5	2.6	49
11	Maguindanao	ARMM	Mindanao	126	2.6	51.6
12	Metro Manila	National Capital Region	Luzon	123.9	2.6	54.2
13	Iloilo	Western Visayas	Panay	115.1	2.4	56.6
14	Batangas	Calabarzon	Luzon	102.5	2.2	58.8
15	Rizal	Calabarzon	Luzon	102.4	2.2	61
16	Capiz	Western Visayas	Panay	97.7	2.1	63.1
17	Zamboanga del Norte	Zamboanga Peninsula	Mindanao	97.5	2.1	65.2
18	Camarines Sur	Bicol	Luzon	97	2.1	67.3
19	Negros Occidental	Western Visayas	Negros	96.2	2	69.3
20	Zamboanga del Sur	Zamboanga Peninsula	Mindanao	90.8	1.9	71.2
21	Antique	Western Visayas	Panay	83.5	1.8	73
22	Lanao del Norte	Northern Mindanao	Mindanao	81.9	1.7	74.7
23	Cebu	Central Visayas	Cebu	76.6	1.6	76.3
24	Camarines Norte	Bicol	Luzon	72.5	1.5	77.8
25	Masbate	Bicol	Masbate	67.2	1.4	79.2

Source: https://psa.gov.ph/content/fisheries-statistics-philippines

within reach of their lines. The flesh of yellow-fin tuna caught by "kawil" remains intact and because each fish is caught individually, it hardly has any bruises on the body, which makes it more valuable on global markets.

However, the small fisherman in the Philippines (Ranada 2014a, b, c) is usually unable to compete efficiently with modern commercial fleets. Small fisher folk, according to the definition set by the Bureau of Fisheries and Aquatic Resources (BFAR), are those who use fishing boats of 3 gross tons or less. They are also known as "municipal fishers", in contrast to "commercial fishers"

Table 11.2 Fishing vessels in Asian countries in 2010

Country	Number of fishing vessels	Motorized fishing vessels	Pct. (%)	Non-motorized fishing vessels	Pct. (%)
China	1,065,645	675,170	63	390,475	37
Indonesia	742,369	430,910	58	311,459	42
PHILIPPINES	476,178	183,998	39	292,180	61
Japan	292,822	283,925	97	8897	3
India	237,321	133,266	56	104,055	44
Vietnam	130,963+	130,963	73[a]	n.d.	27[a]
Cambodia	108,145	46,427	43	61,718	57
South Korea	76,974	74,669	97	2305	3
Sri Lanka	54,128	25,973	48	28,155	52
Malaysia	49,756	46,779	94	2977	6
Bangladesh	43,217	21,097	49	22,120	51
Pakistan	35,162	17,205	49	17,957	51
Burma	32,919	15,865	48	17,054	52
Taiwan	20,766	20,327	98	439	2
Thailand	15,381+	15,381	95[a]	n.d.	5[a]

Source: FAO, Fishery and Aquaculture Statistics Yearbook 2012, p. 42, http://www.fao.org/3/a-i3740t.pdf

[a]Percentages in 2000 for Vietnam and Thailand

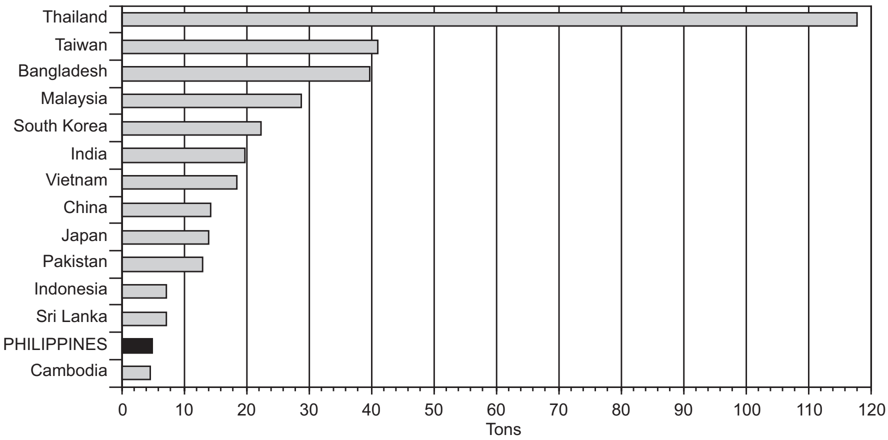

Fig. 11.5 Average catch of fish, mollusks and crustaceans by fishing vessel in Asian countries in 2010. Source: FAO, Fishery and Aquaculture Statistics Yearbook 2012, p. 42, http://www.fao.org/3/a-i3740t.pdf

In 2011, there were more than 469,000 municipal fishing boats. Marine municipal fisher folk caught more than 1.1 million metric tons of fish that year. The most common species of fish they catch are frigate tuna (*tulingan*), roundscad (*galunggong*), Indian sardines (*tamban*), anchovies (*dilis*), squid and yellowfin tuna (*tambakol*). Commercial fishing vessels, on the other hand, are bigger boats—more than 3 gross tons.

While small fisher folk are given priority access to fishing grounds within 15 km from the shoreline, commercial fishing vessels can only fish beyond the 15 km zone reserved for the small fisher folk. Some local governments, however, allow the bigger vessels from 10.1 to 15 km from the shoreline. Enforcing these regulations is tricky because of the "free access" nature of the sea. It has caused many problems for small fisher folk. Many commercial boats cross over to the small fisher folk's fishing grounds. Often, these vessels use large-scale fishing equipment such as trawlers or fine nets which catch everything in their path—whether mature or juvenile fish. The result is overfishing and, consequently, dwindling fish catch for the small fisher folk who were supposed to be given priority access to their own town's marine resources. In the 1970s, Filipino fisher folk would catch 20 kg of fish a day. Now, they catch only less than 5 kg a day. Can overfishing be conclusively attributed to the commercial fisheries sector? BFAR data show that although 99% of operators in 2002 were municipal fishermen, commercial fishermen raked in 48%—almost half—of total fish production that year, even if they made up only 1.2% of the total number of operators.

This may also explain why poverty incidence among fisher folk is so high. Almost half (41.4%) of Filipino fisher folk live below the poverty line, earning them the label, "poorest of the poor."

Overfishing and poverty have forced some small fishers to resort to illegal fishing practices (Muallil et al. 2013) like dynamite fishing and muro-ami. According to the BFAR, some 10,000 incidents of dynamite fishing are still recorded everyday. Illegal fishing practices used by some commercial fishing vessels are particularly devastating for fish stocks. Some common practices are the use of trawlers, fish nets with holes less than two centimeters, and "payao", a fish aggregating device that uses bright lights to attract big populations of fish. These are destructive because they catch all kinds of fish, regardless of size and age. Catching juvenile fish reduces the ability of fish populations to replenish themselves. According to the World Fish Center, fish are being caught at a level 30% above that at which they are capable of replenishing themselves.

The Philippine government has been seemingly unable to stop illegal fishing (Adlaw 2015). 10 out of 13 major fishing grounds in the country have already been overfished. Overfishing is just one of the many threats to fish supply and the fisheries sector.

The whole sector suffers from alarming threats to its resource base (Aliño 2002a, b; Silvestre et al. 2004; Ranada 2014a, b, c). Nowadays, Filipino fishermen are catching less from the Philippines's depleted waters due to decades of overfishing with extremely efficient methods (sonars, Danish seines, known locally as *hulbot-hulbot,*[5] or compressor fishing, a dangerous and unsustainable fishing practice introduced in the 1980s) (Castillo 2011), catching juvenile fish, the use of illegal fishing gear or overfishing by commercial vessels even in restricted or protected areas such as Verde

[5] This device, made up of a conical net bag with two long wings and long ropes extending from these wings to encircle a larger area, catches even juvenile fish and disturbs the seabed and corals.

Island passage between Mindoro and Luzon (Guieb 2015). From an average of more than 10 kg a day in the 1950s, fish catch drastically went down to less than 5 kg a day due to unsustainable practices. Another problem is that juvenile yellow fin and big-eye tuna gather around fish aggregating devices, and are caught along with skipjack tuna that are the target species. Boom times resulting from efficient fishing practices have led to crises in many fishing communities.

Most of the potential fishing grounds consist of uneven or sloping bottoms unsuitable for trawling and fishing, which can best be fished with traps. Managing small-scale fisheries in a developing country like the Philippines is very challenging because of high pressures from an expanding population, poverty and lack of alternative options (Briones 2007). The National Stock Assessment Program (NSAP) conducted by the Department of Agriculture's Bureau of Fisheries and Aquatic Resources (DA-BFAR) shows that most fishing grounds in the country have been heavily exploited and have reached their sustainable limits.[6] In addition, natural disasters such as typhoon Yolanda have devastated both the resources and the ability of local fishermen to work (destroyed houses and boats) (Millare 2014).

Demand for exports, especially to China (Fabinyi et al. 2012), has been a potent driver in the intensification of sea resources exploitation. Illegal fishing has become rampant. Groups of fishermen volunteers now operate 24-h patrols in some areas, trying to protect their local fishing grounds from poachers (*tulisan dagat*, sea robbers), confiscating hundreds of boats and illegal nets. Indonesia and the Philippines have agreed to common actions to eliminate illegal fishing in their respective wateters; many incidents have led to the arrest of Chinese or Vietnamese poachers off the coasts of the archipelago in highly disputed waters of the South China Sea where the Chinese coast guards also routinely detains Filipino fishermen (Datu 2014; Requejo 2014). Giant clams and corals for decorative purposes, sharks for their fins' soup, seahorses and snakes for their supposed medicinal properties, and sea turtles for their meat have been confiscated in recent years by Philippine authorities from Chinese poachers venturing into waters way beyond their shores, as far as the Sulu Sea and even Palau, perhaps laying the groundwork for a future territorial claim over the Pacific Ocean.

11.1.3 Reversing the Decline of Philippine Marine Fisheries

As in other parts of the world, several avenues can be explored to revive the fisheries in the Philippine archipelago. Fisheries management efforts should ideally result in "win–win" outcomes, both in improving sustainable incomes for fishers, and

[6]The same worrying decline occurs also in river fishing, as in the case of the Giant Ludong (*Cestraeus plicatilis*), a mullet famous for its unique taste and peculiar aroma when cooked, which may cost as much as P 5000 per kilo. Fishermen claim the fish is now seasonal and much more difficult to catch. It has almost become a endangered species, according to the Bureau of Fisheries and Aquatic Resources (See 2014).

facilitating recovery and resilience of depleted fisheries. With most of the Philippines' fishery grounds fully exploited or overfished, a reduction of overfishing will involve a rationalization of the fishing industry through a reduction of the number of fishermen and fishing boats (Dorente 2014; Capon 2015; Carillo 2015a, b), and a series of 3-month moratorium on fishing in the most critical areas (Lacson 2014; Rubio 2014; Araja 2015; Carillo 2015a, b; Galvez 2015; Pascual 2015; Yap 2015; Macabalang and Lacson 2016). Fishermen from diverse parts of the Philippines have demonstrated in Manila (Galvez and Badilla 2015) against a measure provision that bans commercial fishers from fishing and using fish nets and other destructive and active fishing gears within 15 km of municipal waters. Nevertheless, authorities are proceeding with operations to eliminate illegal fishing by dismantling equipment such as filter nets ("sanggab")[7] in Panguil Bay (Mindanao).

To put more teeth into existing fishery regulations, the Philippines recently put in place Republic Act (RA) 10,654 in February 2015, amending the Philippines Fisheries Code of 1998 (RA 8550). Its most striking features are much stiffer penalties (Diega 2015) for crimes that fall under illegal, unreported, and unregulated (IUU) fishing. For fishing in marine protected areas, operators large-scale fishing vessels (above 150 gross tons) will be fined P1 million ($22,400) or twice the value of the ship's catch. For failure to secure a fishing permit before fishing in distant waters (or foreign waters), large-scale fishing vessel operators can be fined P16 million to P45 million ($358,000–$1 million) or 5 times the value of the ship's catch. Under the new law, commercial fishers are also supposed to shoulder expensive vessel monitoring equipment to be installed in their boats so that they are easily traced by the government's monitoring, control and surveillance system. The law also makes it unlawful for commercial fishing vessels to fish in municipal waters. If the toughest sanctions are placed on commercial fishing entities, small fishermen are against a provision in the law which disallows fishing using purse seines (*pangulong*) and ring nets (*taksay*) and limits fishing activities 15 km from the shore. A difficulty will be to implement the surveillance, considering that there are only about 800 official enforcers for 36,000 km of shore line and more than a million fisher folk. The government is encouraging the reinforcement of local sea patrols, known as *bantay dagat*.

The government emphasizes its call to eradicate all forms of unsustainable use of marine resources that are detrimental to the ecosystem and to the welfare of fisher folk who depend on these resources, but this policy is not popular among fishers, who complained of not being consulted (Ranada 2014a, b, c), who may be forced to remain idle and get no income for many weeks (Olea 2012). Threats on fishing activity may also come from distant countries: in 2014, the European Union threatened to ban fish imports from the Philippines, giving the Philippines six months to clamp down on illegal fishing or face tough sanctions, a threat lifted a few months

[7] A filter net, or *sanggab* as the locals call it, is a cone-shaped fine net that is placed and positioned against the current during high tide. It catches even the smallest fry, without escape. About 2000 *sanggab* of varying sizes, length and capacity are spread across the waters of eight municipalities of Panguil Bay (Enerio 2015).

later (Moss 2014; Diola 2015; Ranada 2015a, b). The Philippines was exempted from a ban on tuna fishing in the West Pacific in 2008 by the 25-countries Western and Central Pacific Fisheries Commission (WCPFC), but it may not enjoy this privilege for ever (Espejo 2012, 2015; Galvez 2013). To avert fishery collapse, more than half of the fishing grounds should be protected or half of the active fishers in towns with unsustainable fisheries exit the fishery business (Muallil et al. 2014a, b). Since it will be socially difficult (Muallil et al. 2011, Cruz 2013, Muallil et al. 2013), there is a dire need to provide supplemental or alternative livelihoods for fishers, particularly in the case of small fishers who are mired in poverty and are fishing to survive. Facilitating such livelihood shifts and improving safety nets for coastal communities through skills enhancement (Uychiaoco et al. 2000) should be major elements of fisheries management.

Efforts to reduce pressures on coral reefs often include attracting fishers to non-extractive, non-fishery, supplemental livelihoods. Tourism-based and low-capital requirement mariculture (sea ranching) appears to be a more realistic evolution than engaging fishermen into high-capital aquaculture businesses (Cruz-Trinidad et al. 2009). Policy conservation policies (see section 11.3) have the potential to generate conflicts between groups of stakeholders in terms of perceived benefits and costs of conservation and tourism (Majanen 2007; Lucas and Kirit 2009). Fishing is marked by increasing levels of intensification, while tourism has the potential to exclude fishers from many of its purported benefits after the establishment of marine protected areas by foreign and local conservationists. Dive tourism, which is strongly promoted by conservationists and local governments, arguing that the user fees generated by dive tourism can potentially generate income and satisfactory outcomes for all stakeholders, appears in fact to be a source of increasing conflicts with fishers, as have been shown in Calamianes Islands (Fabinyi 2008, 2010) and in Mabini (Calumpan Peninsula of Luzon) (Oracion et al. 2005), where the coastal economy has two bases, harvest of fish on one coast, and dive tourism for recreationalists from metropolitan Manila on the opposite coast. Subsistence fishers may find themselves as the weakest stakeholders, due to their lower rates of knowledge of and participation in conservation activities. The governance of small fisheries must not only look at the management of fish stock, but also at social inequalities in fishermen communities (Fabinyi et al. 2015). Fishers must be involved in conservation efforts and understand how marine reserves benefit local fisheries and food security (Russ et al. 2004; Abesamis et al. 2006a, b; Cruz-Trinidad et al. 2014), and how habitat protection can lead to improvements in their quality of life (Gjertsen 2005).

They may also oppose any measure banning them from living near the coast in the areas most exposed to typhoons, as has been proposed in Leyte and Samar after the devastation of coastal communities brought by Yolanda/Haiyan in 2013 (Ranada 2014a, b, c). In fishing communities across the Philippine archipelago, most fishermen have their boats by the doorways of their homes. They need only push them across the sand to get to the shore a few meters away.

It is not enough to organize small fishers to better repel commercial fishing boats that intrude into municipal waters, or help them into new sources of income. An improved utilization of harvests is also in order. To reduce the discard of spoiled products, investments have to be made into the post-harvest facilities (cold chambers) and a better training of fishermen in proper post-harvest handling of their catches. Better transportation facilities will allow a faster transfer of the products from the fishing grounds to major markets such as Manila.

Fishermen's advocates also suggest the creation of a national Department of Fisheries instead of just a Bureau of Fisheries and Aquatic Resources under the Department of Agriculture. This would mean bigger funding for the fisheries sector and better recognition of the role of fishermen in Philippine society and economy.

11.2 Aquaculture in the Philippines

According to the FAO, more fish for human consumption now originate from farms than from wild capture fisheries. The total global capture has stopped growing and over 29% of fish stocks are overexploited. A great majority of the future increase in global fish production is expected to come from aquaculture (FAO 2013). By 2030, 70% of the whole fish production will come from fish farming, and some 90% of the growth in global fish production will be from Asia. China will be a key producer, and also a major consumer. It will be a major importer of shrimp, mollusks, crustaceans, tuna and others by 2030.

The Philippines islands appear well–positioned to capitalize on this trend, due to the tradition of fishing, eating fish and developing fish farming for many years. However, the country's aquaculture and seafood exports are among the lowest in the ASEAN: less than 20% that of Thailand, a quarter of Vietnam's, and a third of Indonesia's. The main culprit is low farm productivity and under-utilized resources. The export intensity of Philippines' aquaculture was last among ASEAN peers in 2014, at $33,300 per km of coastline, to be compared with Indonesia ($71,200), Malaysia ($179,000), Vietnam ($1,518,000) and Thailand ($1,982,900). The Philippine aquaculture sector, as for many other segments of the archipelago's economy, begs for investments (Dy 2015).

Since capture fisheries, both commercial and municipal, are on a continuous decline due to overfishing, use of deleterious gears, and degradation of habitats that support fisheries, aquaculture, on the other hand, has steadily contributed to food supply in the Philippines, which is one of the few countries where it plays a large role in people's nutrition (Branellec 1984). Aquaculture is viewed as a way to increase fisheries production, address food security concerns, and increase income and employment.

Philippine aquaculture can be traced to the fourteenth century, before the Spanish conquest, with the use of traditional, low-density pond culture of milkfish. Only in the 1940s was aquaculture recognized as an important industry, with 20,000 t of production, and since then has grown rapidly. Total aquaculture production has increased from 0.29 million t in 1980 to 2.54 million t in 2012, comprising 42.5% of total fisheries output in 2013. Its steady growth, together with increased commercial fishery production, allowed the fishery sector to recover from a contraction in growth the previous year. It has had an average annual growth rate in production volume of 8.6% from 1997 to 2008, and the production value is now nearly triple the amount in 1996.

Philippine aquaculture involves many species and farming systems. There are now 16 reported aquaculture species, among which four are considered most important: seaweeds, milkfish (“bangus”, *Chanos chanos*), Nile tilapia (*Oreochromis niloticus*) and tiger shrimp (*Penaeus monodon*) (Smith et al. 1985).

Seaweeds belonging to the genus *Caulerpa* are all eaten fresh in many parts of the Philippines. *Caulerpa lentillifera* was the first species to be commercially cultivated in brackish water fishponds in Mactan Island (Cebu) in the early 1950s. As a response to strong world demand for phytocolloid carrageenan, the farming of *Eucheuma* was developed in the 1960s. Its success has made the Philippines the world’s largest producer of semi-refined food-grade carrageenan, alkali-treated chips, and raw dried seaweed, and fourth biggest producer of refined carrageenan, exported to United States of America, Europe, China, France, Hong Kong, and Thailand. Carrageenan, extracted from red seaweeds, is used in making ointments, as additive, binder, and emulsifier in food, pharmaceutical, beverage and cosmetics, and as texture agent in toothpaste and powder. The Autonomous Region in Muslim Mindanao (ARMM) is the largest producer. Seaweed resources have the potential of becoming the most accessible energy source for coastal and island communities of the Philippines, through the techniques of methane fermentation and anaerobic digestion of seaweed biomass (Marquez et al. 2014). In 2011, according to BFAR data, seaweed represented 70.6% of overall production in tonnage (1.84 million t), followed by milkfish, 14.3% (372,580 t), tilapia, 9.9% (257,385 t), shrimps and prawns, 1.9% (50,159 t). Other products amounted to 3.3% (87,162 t).

The production system of aquatic species (milkfish, *Chanos chanos*) relies on a fish /environment symbiosis, for infrastructures (ponds) as for methods (natural feeding). The evolution of this traditional activity is going two different ways: intensification of producing methods or integration in the activity of rural communities. The challenge is to keep aquaculture sustainable (Platon 2003; BFAR-Philminaq 2007), both as a way to fill the gap between demand and production of marine products, and to preserve fragile coastline and inland water bodies, even as its productivity is growing (Garcia and Sumalde 2013). Questions have been raised about the ecological impact of aquaculture, in particular with regard to bio-diversity and mangrove destruction, about the equity of its development (Coull 1993, Primavera 1997) and about its food security benefits.

11.2.1 Fishponds for Milkfish

For a very long time, aquaculture in the Philippines was virtually synonymous with milkfish culture (Bagarinao 1998; Tacio 2010), specifically in brackish water ponds, using naturally occurring fry (“kawag-kawag”) from tidal waters, since these species did not reproduce in captivity. This involved large crowds of men, women and children looking for baby fish alongside the shores. There was huge variability in quality and quantity between seasons and regions. In the late 1970s, farmers finally were successful in spawning from milkfish kept in sea cages (Marte and Lacanilao 1986). The eggs would then generate a constant supply for farms. The first phase of the production cycle, henceforth, has nothing to do with farming techniques. It is based solely on availability, in the natural environment, of fry ready for fattening. This interdependence is the basis of the whole milkfish production system. Unlike intensive aquaculture methods that tend to act primarily on the animal (genetic selection, artificial feeding), in an environment far removed from wild living conditions (enclosed pools, high population density), milkfish farming here is based on a symbiosis between the fish and the environment around it. It is mostly a question of monitoring its growth by acting on environmental parameters. At any stage of the bangus' life cycle, fattening methods are based on natural food. They are raised in earthen ponds previously treated with fertilizers to promote the growth, on the pool's bottom, of microorganisms, the "lab-lab" or "lumut",[8] forming a sort of mat where milkfish find their food. This widespread method allows yields of several hundred kilograms to more than one ton per hectare per year, depending on the intensity of fertilization, the quality of ponds and breeding techniques, with no added food.

Fishponds have been mostly developed on lagoons and mangrove areas. The long-standing use of these biologically rich areas has resulted in irreversible changes to the landscape. The aquaculture development of fishponds is done mostly by hand, with teams of men working several months to clear the forest, build embankments, excavate and level these wild lands into a well-organized space structured by channels, dikes and dams.

This same system is used for raising penaeid shrimp (Primavera 1991). Shrimp has always been an incidental harvest in brackish water ponds for milkfish. Due to a marketing campaign in the mid-1970s, black tiger shrimp became popular in Japan. As a trial shipment, 450 kg of black tiger shrimp were exported to Japan in 1975. Before the 1980s shrimp farming had already made some inroads in the Philippines, but the real boom in production began in the mid-1980s, as wealthy families in the Negros Province began converting their sugar plantations in earnest. They saw shrimp farming as a more profitable alternative to sugar. Shrimp became a top marine product export from the Philippines. However, disease problems in the early 1990s caused a significant decline in production, leading to diversification into a shrimp-tilapia polyculture (Cruz et al. 2008).

Filipinos were well aware that their traditional aquaculture was only a stepping-stone towards more intensive aquaculture systems such as Taiwan's. In the early 1970s, Laguna de Bay (Delmendo and Gedney 1976, Israel 2008, Tan et al. 2010), the large lake just South of Manila, saw the development of large fishpens for the breeding of freshwater milkfish, with yields about ten times higher than with the

[8] "Lab-lab" is a complex of filamentous and unicellular blue-green algae and diatoms benthic algae association and microscopic animal organisms forming a kind of carpet. "Lumut" are filamentous green algae originally planted on the pool bottom.

traditional methods. Similar developments also occurred in the Lake Taal. Both play a major role in the provision of fresh fish for the National Capital Region (Saguin 2013, 2014). In the early 1990s milkfish culture in fish pens spread to shallow marine bays and estuaries, particularly in the Lingayen Gulf area. Milkfish culture soon spread to net cages (Sotelo 2016), which were fixed or floating in both freshwater and marine water. Fishpens in Lake Taal and Laguna de Bay, as well as Lake Buhi (Camarines Sur), are also used for tilapia farming. Clusters of large-scale, industrial fish and shrimp farming have emerged around Bani (Pangasinan), Macabebe and Sasmuan (Pampanga) (Hejdova 2007), Malolos (Bulacan), Balasan and Ajuy (Iloilo) and Kabasalan (Zamboanga Sibugay).

The intensification of aquaculture in the Philippines was not the product of structural or technological revolutions, but rather obtained by refining the existing techniques, especially through the growing use of fertilizers and artificial food for the fish. For small fish farmers, the increase in natural productivity of ponds was the best way to promote the growth of their fish. There was a “natural” gradual transition from fertilization with organic manure and agricultural waste to a fertilization based on the use of manufactured minerals. Artificial feeding was done by providing fish with agricultural waste products (rice bran) and fishmeal, which had not undergone much transformation. Sometimes it was also the provision of protein-rich plants such as “ipil-ipil” (*Leucaena leucocephala*) or water spinach (“kangkong”, *Ipomoea aquatica*).

The culture of milkfish in cages depended upon and was hastened by the development and marketing of commercial feed by the feed millers. The shift to a truly artificial feeding in the form of so-called compound feed cannot be imagined without a radical change requiring large investments and applied to species of high commercial value.

Only large production units can make such a conversion, for example to develop the production of *Penaeus monodon*, a giant tropical shrimp that sells at high prices on local and international markets. It has caused a number of negative effects in coastal areas: ecological costs (mangrove conversion into ponds; use of antibiotics and chemicals leading to drug resistance; dumping of pond effluents which affect neighboring ecosystems; and pumping of groundwater that causes saltwater intrusion and vulnerability to floods) and social costs (reduction in domestic and agricultural water supplies; decreases in the production of food fish and other food crops; further marginalization of coastal fishermen; displacement of labor; and credit monopoly by big businessmen) (Primavera 1991). The trend is inevitable simply because of the maximum profitability. But in these conditions, it may be done by a handful of large fish farmers (Irz and Stevenson 2012). In 2014, there were 17 operations with fishpond areas over 50 hectares, the largest being 200 hectares, in Iloilo. In this context, traditional fish farming by small producers may have a difficult time to survive, except for local markets.

Fig. 11.6 Fishponds developed in a mangrove area (Barangay Cayucyucan, Mercedes, Camarines Norte, July 2014)

11.2.2 Subsistence Aquaculture?

In the Philippine agriculture, most owners of farms are not working them, and most farm workers do not own the land they work on. The picture is similar in aquaculture, where being independent requires initial investment comparable to the purchase of land in the countryside. The people employed in that aquaculture are mostly, salaried employees and “tenants” working on lands belonging to the state. Smallholders are a minority.

There is yet another category of potential fish farmers: farmers and small fishers. Rural communities are tight-knit, and it is conceivable for them to add aquaculture as an additional source of protein needed to balance their diets without totally eliminating the possibility of selling a portion of aquatic products. Aquaculture can provide new employment opportunities for the poor, women and youth, despite constraints that include lack of skills and licenses to fish farms (Fig. 11.6).

For this purpose, various aquaculture experiences were conducted in rural communities. In the inland plains, for example, the option chosen is rice-fish farming (Darvin 1992; Torres et al. 1992; Fermin 1992) that combines fish farming and the cultivation of rice in flooded land. The most suitable fish species for this proved to be *Tilapia nilotica*. This prolific freshwater African fish is now acclimated and requires only very simple techniques. Now that highly pest-resistant rice species have been developed, the reduced use of pesticides allows to safely[9] introduce fish in rice fields, reviving ancestral practices of rice-fish farming which are part of Asian cultural heritage (Horstkotte-Wesseler 1999), allowing farmers to diversify in major rice areas such as Luzon central plain (Pampanga, Tarlac, Nueva Ecija, Pangasinan) (Katon et al. 2005). In the amphibious delta of the Pampanga river, often flooded, fishponds have largely taken over land previously used as rice fields: since the 1980s a significant proportion of the pond extensions in the Pampanga delta occurred at the expense of 11,000 ha of paddy cropland (Mialhe 2010; Mialhe et al. 2015).

Fish farming can also be integrated into traditional agriculture by increasing the use of environmental resources by the rural poor. In coastal, lake or river villages whose economy is based mainly on fishing, declining catches due to overfishing make fishers more interested in alternative activities, such as fish cages. These units can be small (a few cubic meters) and require low initial investment. The fisher can thus retain the independence inherent to his profession. The manufacture of cages uses local materials (bamboo, plant fibers) that people commonly use. Except for the risk of destruction by typhoons, such a low-scale fish farming can be profitable in a short time.

The significant decrease in the wild mud crab population highlights the need to manage the resources and domesticate crabs. Raising mud crabs in net enclosures set in mangrove areas (Aldon 1997; Quinitio et al. 2011) is thus another, non environmentally-intrusive, possible development for small-scale commercial culture.

In all these cases, experience has shown that coastal populations are open to innovation, provided that technical monitoring is properly done. Importing a technique without working with fishers would be a sure way to destroy their receptiveness. There is also the problem of juveniles' supply for rice-fish and fish cages methods. Finally, the most crucial sticking point remains the financial loans to start new businesses, since most of the poor have no savings to invest into this type of innovation. Such a alternative fishing development policy must therefore go hand in hand with a system of loans to small farmers. Although the Philippine government intensified the implementation of nationwide fisheries credit assistance through a program known as "Biyayang Dagat Program" (BDP) in the late 1970s and early 1980s, it reached only 65% of the initial target group.

Nevertheless, even if aquaculture is not an ideal remedy to malnutrition, poverty and unemployment, it remains a thriving sector within in the national economic development of the Philippines. Fisheries, mariculture and aquaculture farming are agriculture-based and will assume a greater role for the future food security of the country as populations rapidly expand and the fisheries wild resource base is unsustainably strained to feed a growing population (Encomienda 2014a, b).

[9] With the needed control of an indigenous pest, the destructive rice eel ("monopterus albus", *kiwet*), which feeds on fish fry and can bore holes in rice paddy walls, causing irrigation water to flow out. These pests may, however, be exported to Japan as a valuable food commodity (Lagasca 2011, 2013; Roque 2011; Lazaro 2013).

Areas such as Dagupan, Pangasinan,[10] attempt today to promote quality by applying for regional branding and prevent other areas to market their milkfish under the certification of origin " Dagupan bangus" (Sotelo 2012; Cardinoza 2014a, b; Inigo 2015a, b). Looming problems may be the low availability of water in times of drought (Cardinoza 2014a, b; Beleo 2015)—and its opposite the damage to fishponds caused by massive flooding[11]—the sanitary risks associated with epidemics and massive fishkills due to heavy concentration of fish in limited spaces, and the pollution associated with urban and industrial areas. Problems are already evident in Manila Bay[12] (Lesaba 2011; Chavez and Manalo 2012; Inigo 2015a, b) and Laguna de Bay (Molina et al. 2011; Molina 2012; Chavez 2015), which may limit further expansion of the aquaculture industry near the capital city of the Philippines

11.3 Protecting a Rich Marine Environment Under Threat

11.3.1 Marine Biodiversity

As an archipelagic country located in the tropical zone, the Philippines is richly endowed with aquatic resources (Briones 2007). Philippine waters contain some of the world's richest ecosystems, characterized by extensive coral reefs, sea-grass beds, dense mangrove forests, lower reaches of rivers and intertidal flats. Information available[13] reveals a remarkable variety of marine life: 648 species of mollusks, 3212 varieties of fish (including 731 considered commercially important), 486 species of corals, 820 species of bottom-living algae and thousands of other organisms. Five of the seven sea turtle species (*pawikan*) known to exist in the world today occur in Philippine waters (Bagarinao 2011). All are on the list of endangered wildlife (Mayuga 2016), whose trade is prohibited under the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

The Philippines coral reef area, the second largest in Southeast Asia, is estimated at 26,000 sq km and holds an extraordinary diversity of species. With the Malay archipelago, Papua New Guinea and Australia, the country forms the 'Coral

[10] The Province of Pangasinan is one of the main centers of aquaculture production in the Philippines. Aquaculture in marine areas is particularly extensive in the coastal waters of Western Pangasinan where the largest areas of coral reefs and seagrasses in Western Luzon are found.

[11] In Central Luzon north of Manila (Bulacan and Pampanga provinces), fish farming is strongly affected by flood events, but at the same time fishpens in the Pampanga delta are considered as potent factors in flooding since they slow down the flow of water. Government authorities have ordered the destruction of some facilities to better fight the floods in the region (Manuel 2013; Carhiles 2015).

[12] Manila Bay has a wide range of environmental problems that need to be addressed—land-based and sea-based sources of pollution, harmful algal blooms, subsidence and groundwater extraction, overexploitation of fishery resources, habitat conversion and degradation (Prudente et al. 1997, Chang et al. 2009, Su et al. 2009).

[13] http://www.haribon.org.ph/index.php/news-and-media/238-philippine-marine-biodiversity-a-brief-profile

Triangle,' where some 400–500 species in 90 genera of reef-forming corals are believed to exist (Hoeksema 2007; Veron et al. 2009). One of only two double-barrier reefs in the world is in Bohol province, it is commonly known as the Danajon bank. The Sulu-Sulawesi Sea, a 900,000 sq km marine eco-region that lies at the apex of the Coral Triangle is home to some 2500 species of fish. A 2005 study (Carpenter and Springer 2005) even suggests that the Philippines is not only part of the center but is, in fact, the epicenter of marine biodiversity, with the richest concentration of marine life on the entire planet (Go et al. 2015). Because of its larger area, Indonesia may have a greater overall marine biodiversity than the Philippines but there is a higher concentration of species per unit area in the Philippines than anywhere in Indonesia.

33 species of fish are endemic to the Philippine waters, including the sea catfish (*Arius manillensis*), the blue-spotted angelfish (*Chaetodontoplus caeruleopunctatus*), the Philippine anchovy (*Encrasicholina oligobranchus*), the dwarf sawtail catshark (*Galeus schultzi*), etc.… The entire archipelago is a large marine ecosystem with such biodiversity that has become an important feeding and breeding grounds for high-value commercial fish species such as tuna, endangered marine mammals such as the dugong, the *Butanding* (whale shark, *Rhincodon typus*) (Orante 2015) and the extremely rare planktivorous "megamouth shark" (*Megachasma pelagios*) (Morrissey and Elizaga 1999). 716 species of mollusks have so far been recorded in Palawan and more than 200 species have been recorded in Tubbataha Reefs Natural Park (Dolorosa and Dangan-Galon 2014).

Factors that contribute to this exceptional range of biodiversity include:

- A warm climate and stable water temperatures (rarely below 28° Celsius)[14];
- Abundant sunlight to fuel the photo-synthesis process that supports the growth of algae, coral, and other organisms;
- Relatively low sediment loads, due to the lack of major rivers, allowing light to pass deep into the water;
- Generally low fresh water inputs that maintain a salinity level between 30 and 36 per thousand;
- Currents, clean water, and hard substrates that provide optimal conditions for corals and other aquatic life to thrive.

Such richness may be explained by the geologic history of the archipelago: the complex events leading to the integration of islands that created the archipelago and the isolation of smaller seas within the central Philippines during the Pleistocene. The accretion of the archipelago has increased diversity, if it is correct to assume that the different elements of the Philippines developed their own endemic biotas.

The barrier reefs off the Philippine islands are amongst the world's richest marine biodiversity hotspots. The country is trying to capture the best economic value from its biodiversity, such as in the UNESCO World Heritage Tubbataha reefs in the Sulu Sea (Subade 2007). However, the effects of the soaring population of coastal populations

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[14] However, climate change impacts (increased sea surface temperatures (SSTs), ocean acidification) may hurt this biodiversity in coming years.

on reefs have been devastating (Aliño 2002a, b). Coral reefs have sustained serious damage (Gomez et al. 1994; Roberts 1995) from illegal fishing with dynamite[15] and cyanide, indiscriminately killing everything within their reach,[16] and from the *muro-ami* fishing technique by which young swimmers pound the coral with rocks attached to ropes to drive the fish into nets. NGOs have denounced illegal fishing activities, particularly dynamite and cyanide fishing, and commercial vessels are operating with impunity in Tañon Strait, the country's largest marine protected area between Cebu and Negros islands (Murcia 2015). Intense fishing and habitat degradation and subsequent species declines at local scales suggests that this exploitation is having a cumulative effect on the overall species richness of the Visayan region, considered as having the highest concentration of coral reef fishes (Lavides et al. 2009; Nañola et al. 2011). Today, six of the 27 varieties of lapu-lapu known in Philippine waters are under threat (Domingo 2014). Coral also was damaged by silting from erosion caused by deforestation, and inland freshwater lakes were polluted from industrial and agricultural wastes.

This large marine ecosystem, including its coastal landforms (sandy beaches, rocky headlands, sand dunes, coral reefs, mangroves, seagrass beds, wetlands, estuaries, tidal flats, lagoons) and its fisheries resources are directly exposed to serious threats and degradation on account of human activities: illegal fishing and overfishing, pollution from mineral resources extraction (seabed/subsoil or land-based), excessive soil erosion inland due to unwise farming and logging practices, run-off pollution from rivers and lakes, and international and domestic seaborne trade (shipping). The destruction of beachside nesting grounds, linked to massive land reclamations around the archipelago, is a major cause of the decline of the population of the marine turtles, as well as egg harvesting by ignorant beachgoers.

In addition, the effects of climate change (Mcleod et al. 2010; Horigue and Licuanan 2013; Mamauag et al. 2013), global warming and sea-level rise have led to increased beach erosion, cliffs erosion and stronger tropical storms, all affecting the marine and coastal resources.

11.3.2 Coastal Resource Management

With fisheries declining, coral reefs battered, mangrove forests under threat, pollution levels rising, and coastal communities experiencing increased poverty, the Philippines faces severe challenges in managing its coastal resources.

[15] Dynamite fishing became rampant in the Philippines after the Second World War. US soldiers would sometimes throw grenades into shoals of fish, providing local fishing communities with a new means of catching more fish. Today, blast fishermen use powdered ammonium nitrate (usually from fertilizer), kerosene and small pebbles, which are packed inside a glass bottle covered with a blasting cap. A single blast produces shockwave, which can travel up to 1500 meters per second, killing or paralyzing every fish in range, often liquefying internal organs. Coral reefs that have taken hundreds of years to grow, are reduced to pieces in a matter of seconds.

[16] 150,000 kg of sodium cyanide are sold yearly and an average of 10,000 blasts occur daily, according to the Bureau of Fisheries and Aquatic Resources (BFAR).

Local anthropogenic threats to the coastal environments include increasing population and coastal settlement, habitat modification & coastal pollution, illegal fishing or destructive fishing. The main changes in land use are the conversion of mangrove areas, the proliferation of fish pens and cages and the construction of houses on stilts on the shoreline. Global threats linked to climate change include higher water temperatures, coral bleaching, ocean acidification, sea level rise, coastal erosion exacerbated by increased intensity of tropical storms leading to more powerful storm surges and bigger waves.

Remedies are well known in principle: addressing immediate anthropogenic threats to the ecosystems, and improving the health of the ecosystems for better chances of recovering from the adverse effects of global change, while adapting the lifestyle of the population to global change and mitigating any harmful effects from global phenomena on local communities.

In the Philippine case, the ecosystems' resilience can be improved by reducing the fishing effort, eliminating destructive fishing, controlling coastal pollution and establishing marine protected areas (MPA) and MPA networks.

The central Visayan region (Negros, Panay, Cebu) is key (Nañola et al. 2011). This part of the Philippine archipelago historically has the highest concentration of coral reef fishes anywhere in the world, but the Visayan region and the southern Philippine Sea region have the lowest species richness in the Philippines. They have unusually low counts of species typically exploited in fisheries and for the aquarium trade. Parallel reports about intense fishing and habitat degradation indicate that excessive exploitation has had a cumulative effect on the overall species richness of the Visayan region. Successes in Marine Protected Areas in this region in increasing species richness at local scales suggests that improved management of these protected areas coupled with much more intensive fisheries management will be key to reviving a healthy biodiversity in the Visayas.

Coastal management efforts in the Philippines started in 1974 with the establishment of small marine protected areas (MPAs) (White et al. 2006a, b). This general term is applied to any defined marine area established for conservation and protection, where activities are managed based on specific rules and guidelines. It includes several types of MPAs

- A Marine Reserve is an MPA where all uses are controlled or regulated to the extent necessary (e.g. Apo Island Marine Reserve, El Nido Marine Reserve)
- A Marine Park is an MPA where multiple uses are allowed through zoning regulations like a marine reserve and where conservation-orientated activities are emphasized (e.g., Tubbataha Reef National Marine Park, Apo Reef Natural Park) (White and Palaganas 1991; Dygico et al. 2013)
- A Marine Sanctuary, synonymous with "No-Take Zones" (NTZs) (Abesamis et al. 2006a, b), may be located within a marine reserve or marine park (e.g., Turtle Island Wildlife Sanctuary, Pulong Bato Fish Sanctuary Verde Island.)

Early models on Sumilon (Cebu, as early as 1974) (Russ 1989) and Apo (Negros oriental) Islands, and others, allowed to develop a framework for coral reef management aiming at enhancing fish yields to traditional fishers (Alcala 1988; Russ and

Alcala 1999) as well as protecting and maintaining near-shore coral reef habitats for biodiversity and multiple economic uses (White et al. 2002). It was a pioneer effort later followed by other tropical countries (Christie and White 1997). A major national policy shift (Alcala and Russ 2006) occurred in 1991 with the passage of the Local Government Code (Republic Act 7160), when the Philippine government transferred many coastal management responsibilities to local government units and fostered increased local participation in the management of coastal resources (White 2006), each municipal authority exercising management powers and responsibilities over their 15-km municipal waters. This management approach through a variety of community-based and co-management schemes (Baticados 2004; Fernandez 2006; Aldon et al. 2011; Casiwan-Launio et al. 2011) has proven successful in gaining community acceptance and achieving local-scale fisheries and conservation objectives (Courtney et al. 2002; Uychiaoco et al. 2005). In Apo Island (Negros), the marine protected area was initiated by Angel Alcala, a marine scientist from Silliman University in Dumaguete, who met local fishermen to convince them of the importance of creating a marine sanctuary in the area. Initially, there was hesitation on the part of the locals, but after three years of discussions, local fishermen and the staff of the university's Marine Laboratory selected an area extending 500 m from 450 m of shoreline as the sanctuary site.

As the number of MPAs increased in the 1980s and 1990s, to reach a total of about 1800 in 2014 (Cabral et al. 2014), their usefulness appeared limited since they were not connected in networks (Horigue et al. 2012). Indeed, if managed in isolation, coastal and marine protected areas (MPAs) are vulnerable to natural resource development and exploitation occurring outside these areas—in particular, overfishing, alteration and destruction of habitats, and water pollution.

Despite considerable success in enforcing regulations associated with small MPAs such as Balicasag and Pamilacan Islands (Bohol) (Christie et al. 2002), a trend of declining fish abundance and species richness among economically valuable species immediately outside the no-take areas highlights the limitations of small and isolated MPAs. Thus, protection of coastal and marine areas—of species, habitats, landscapes, and seascapes—should be integrated into spatial development strategies for larger areas (Lowry et al. 2009), under the umbrella of integrated coastal and ocean management (ICM) (Courtney and White 2000; Balgos 2015). The municipal scale appeared too limited to provide efficient ecosystem-based management of the sea resources, for example on the Danajon Bank double barrier reef off northern Bohol Island (Armada et al. 2009) or in Verde Island Passage (Horigue et al. 2015). In Southeast Cebu, the expansion from a single municipality to a much broader collaboration at the intermunicipal scale has made easier the fight against degradation of key coastal habitats, overfishing, and dwindling fish stocks (Eisma-Osorio et al. 2009). Likewise, the Southern Iloilo Coastal Resource Management Council (SICRMC), with five member municipalities, has implemented a uniform ordinance in order to promote integrated management, reduce conflict, and contribute to efficient fisheries law enforcement (Espectato et al. 2012a, b). In Zamboanga Sibugay province, inter-LGU cooperation for better fisheries control implementation included a color coding of boats, a registry of fishers and fishing vessels to check permits and licensing, a zoning of coastal waters, incentives and rewards for enforcers; and a list of prohibited acts and penalties (Baird et al. 2013). In the northern part of the country, a bioregional approach was initiated by involving the provincial governments as well as the state universities and colleges to design policies of marine spatial planning (Pajaro et al. 2013).

The need for a convergence of MPAs within Integrated Coastal Management programs appeared necessary around the year 2000 (Cicin-Sain and Belfiore 2005; White et al. 2005; Balgos 2015) and was set in motion by Executive Order 533 series in 2006. MPAs are financed both by government funding and international support, but also through the imposition of user fees. For example, in Tubbataha Reefs National Marine Park (Palawan) (Tongson and Dygico 2004), the entrance fee is a hefty 75 US dollars or 3000 Philippine pesos (no fee for Palawan residents). In Apo Island Marine Reserve, established in 1986 as a fisheries intervention using a community-based approach, protection efforts resulted not only in increased fish standing biomass and harvest but also in the preservation of its coral reefs (Maypa et al. 2002). However, the unregulated number of tourists diving and snorkeling in the sanctuary has raised concerns among members of the community and the Protected Area Management Board (PAMB) of the damage it has caused to the corals. Fees for access to the undersea corals have been set very high to limit the number of visitors: if the general admission is 100 pesos/person/day, with lower rates for local residents and students; there is an extra PHP50/person/day for snorkeling, PHP 300/person/dive for scuba diving and PHP 5000/day for video filming. This puts the coral scenery out of reach for most Filipinos, however it allows the park to experience substantial income every year.

International cooperation in Coral Triangle countries to compare progress and practices, and protect resources on a large scale, both for fisheries and tourism, is increasing (Cabral et al. 2013; Walton et al. 2014; Weeks et al. 2014; White et al. 2014; Pomeroy et al. 2015).

Numerous experiments in coastal management have been conducted that range from broad area management planning for whole bays to small community-based MPA projects. They require a well-articulated process (Fabinyi et al. 2010) that includes community participation and ownership in collaboration with single or multi-municipal governments, the continued active engagement of local non-government organizations, strong support from the national government and from marine science academic and research institutions, the involvement of multiple stakeholders, the influx of donor-assisted marine conservation programs, the creative use of financial mechanisms to create long-term self-supporting MPAs, and the need for localized periodic monitoring and evaluation to provide feedback to managers. Many parameters must be considered (Ratner et al. 2012) to assess the effectiveness of such policies, such as an island location, a small community population size, class, ethnic, and gender differences among fisher folk (Eder 2005), minimal effect of land-based development, application of a bottom-up approach, use of a scientific information database, community empowerment, gender issues (D'Agnes et al. 2005), alternative livelihood schemes (Kühlman 2002), tangible management results (Weeks et al. 2010), continued involvement of external groups after reserve establishment, and small-scale project expansion (Beger et al. 2004).

Analyses of these policies (Maypa et al. 2012) seem to indicate that, despite the struggle of most MPAs with budgetary constraints or lack of sustainable financing (Milne and Christie 2005), as well as weak law enforcement (Samoilys 2007), they are making progress with notable improvement in management leading to better health of the coral reefs (Alcala 1988; White and Vogt 2000; Russ et al. 2004; Maliao et al. 2009), as shown in the Visayas (Pollnac et al. 2001). Communities have obtained tangible benefits through enhanced fisheries production associated with MPAs (Van Mulekom 2008), revenues from user fees (Samonte-Tan et al. 2007) and enhanced community pride (Lamug 2005), especially if there is trust between stakeholders and effective involvement of the primary users, fisher folk (Andalecio 2011; Bacalso et al. 2013; Chaigneau and Daw 2015), who also need to follow regulations (Baticados and Agbayani 2000). The Marine Conservation Project for San Salvador Island, Zambales (MCPSS) has shown that the use of destructive fishing techniques such as blast, sodium cyanide, and others particular to the site can be stopped by community action (Christie et al. 1994; Katon et al. 1999).

There has been a gradual evolution in fisheries management from a focus on sustainability of a single species or stock and resources to a focus on marine ecosystems, with the promotion of ecosystem based fisheries management (EBFM) on a multi-jurisdictional level, often at the geographical level of the numerous bays and gulfs (Lingayen Gulf, San Miguel Bay, Ormoc Bay, Davao Gulf…) alongside the Philippine coastline (Bundy 1997; Pomeroy et al. 2010). Most recently, with the support of USAID-Philippines, the 5-year, ECOFISH project (Ecosystems Improved for Sustainable Fisheries), building on the earlier FISH project (Fisheries Improved for Sustainable Harvest) (Christie et al. 2007) will work on conserving biological diversity, enhancing ecosystem productivity and restoring the profitability of fisheries in eight Marine Key Biodiversity Areas (MKBA),[17] using the Ecosystem Approach to Fishery Management (EAFM) as a cornerstone of improved social, economic and environmental benefits, to achieve broad-based and inclusive growth. Aquaculture also needs to be included in the definition of coastal zone management policies (Stead et al. 2002).

However, managing small-scale fisheries alongside MPAs in a developing country like the Philippines is very challenging because of high pressures from expanding fishing population, poverty and lack of alternative options (Pollnac and Pomeroy 2005; Segi 2014). Thus, resource-focused fisheries management initiatives such as Marine Protected Area (MPA) establishment or projects such as FISH or ECOFISH may result in further marginalization of the poor fishers, which could pose more serious problems in coastal communities (Fabinyi 2011). MPAs alone may not be enough to avert fishery collapse even if MPA size is increased from the current

[17] These eight MKBAs are (1) Lingayen Gulf, (2) Verde Island Passage, (3) Calamianes Island Group, (4) Ticao-San Bernardino-Lagonoy Gulf, (5) Danajon Reef, (6) South Negros Island, (7) Surigao del Sur and del Norte, and (8) Sulu Archipelago.

3–15% of the municipal waters, i.e. up to 15 km from the shore, as required by the Philippine law (Muallil et al. 2014a, b).

Since access to food, education, and health services for Philippine fisher folk families is directly dependant upon the fish harvest and related health of the marine environment, a grassroot coalition of more than 6000 village fishers and their families, Pamana Ka Sa Pilipinas, has developed an "ecohealth strategy" linking the health of coastal people and that of their surrounding marine ecosystem. It aims at strengthening food security and nutritional status through empowerment of the small village fishers (Añabieza et al. 2010).

11.3.3 Restoring Mangrove Ecosystems

Mangroves are defined by the presence of trees ("piapi", *Avicennia lanata*, "bungalon"*, Avicennia marina*, "langarai", *Bruguiera parviflora*, "pagatpat"*, Sonneratia alba,* "bakauan", *Rhizophora species*, "malatangal", *Ceriops decandra*, "saging-saging", *Aegiceras corniculatum*, "tabigi", *Xylocarpus granatum*, "nipa", *Nypa fructicans*) (Calumpong and Meñez 1997; Primavera et al. 2004; Juario and Ontoy 2005; Almazol et al. 2013; Benecario et al. 2016) that mainly occur in the intertidal zone in the tropics. The aerial roots of mangroves provide a substratum on which many species of plants and animals live. Above the water, the mangrove trees and canopy provide important habitat for a wide range of species: birds, insects, mammals and reptiles. Below the water, the mangrove roots are overgrown by sponges, algae, and bivalves. The soft substratum in the mangroves forms habitat for various species, while the space between roots provides shelter and food for prawns, crabs and fishes. Mangrove litter is transformed into detritus, which partly supports the mangrove food web. Mangrove forests are known to be the best defense for coastal communities against typhoons and storm surges (Holtz 2013; Lozada 2014), and for erosion control, flood regulation, sediment trapping, nutrient recycling, wildlife habitat (Rönnback et al. 1999, Nagelkerken et al. 2008), and nurseries for aquatic animals. Mangrove forests can also reduce carbon emissions as they serve as carbon sink, being five times better in capturing carbon than rainforests (Kristensen et al. 2008). Mangroves produce organic biomass (carbon), contributing 1800–4200 g of carbon per square meter per year. The capacity of mangrove forests to act both as a source and sink of carbon makes them key ecosystems on the mitigation strategies against climate change (Bigsang et al. 2016). Coastal residents who use mangroves and their resources may have considerable botanical and ecological knowledgeable about these forests. A wide variety of forest products are harvested in mangroves, especially firewood, thatch material (Nypa species) for homes, mangrove poles for lumber and construction materials, tannins and medicines (Walters et al. 2008; Sinfuego and Buot 2014).

A large proportion of the Philippine mangrove forests were cleared to construct fishponds, seriously damaging the coastal ecological system (Kelly 1993; Walters 2003; Garcia et al. 2014). Heavy cutting of mangroves for the commercial sale of firewood has occurred since the 1930s. Cutting for domestic consumption of fuel and construction wood by local people has been widespread, although rates of cutting vary according to changing demographic pressures and in response to cutting restrictions imposed by firewood concessionaires and government officials.

If small-scale wood harvesting has weakened the coastal forests (Walters 2005), further impacted by conversion to agriculture, salt beds, industry and settlements, most mangroves were lost due to the creation of fishponds for commercial fish and shrimp farming (Primavera 2000; Walters 2003), especially on Panay island and Pangasinan province (North Luzon). Cutting to make space for fish ponds and residential settlement has dramatically reduced the distribution of mangroves, although coastal forests expand near the mouth of the largest rivers, where soils from deforested hillsides have been deposited as sediments along the coast.

The history of fishpond development in the country includes a government-sponsored fishpond boom in the 1950s and 1960s, a pro-conservation decade in the 1970s followed by a shrimp fever in the 1980s. Often these fishponds were then left abandoned and, by law, they should be returned to the Department of the Environment and Natural Resources for reversion to their previous state. Mangrove forests in the country went down from 500,000 hectares in 1918 to 350,000 in 1950, 250,000 in 1975, 133,000 in 1988, only 117,000 hectares in 2010,[18] a loss of almost 80% in less than a century, according to the Bureau of Fisheries and Aquatic Resources (Visperas 2012; Lacsamana 2014). As of 1990, a total of 230,000 ha of mangrove forests had been converted to fishponds (Honculada Primavera 1995). Of the remaining 117,000 hectares, 95% represents secondary growth and only 5% constitutes old or primary mangroves mostly found in Palawan and Mindanao. Most mangrove areas in Luzon and the Visayas are made up of reproduction brush and young growth. They are of much lower quality than a century ago. Mangrove forested areas in the Philippines have been steadily transferred from a common property resource, of multiple use and benefit to a large number of people, to a private good, principally as a consequence of the emergence of the single use for shrimp ponds, whose profits are narrowly channeled to the benefit of a select few (Nickerson 1999; Cabral and Aliño 2011).

Efforts toward restoring lost mangroves in the Philippines have been immense, specifically since the 1990s. They started often locally, at a small community scale, as in Cogtong Bay (Bohol) (Katon et al. 2000; Maliao and Polohan 2008), but now coastal villages collaborate with the national and local government units in resource rehabilitation. Timber production was the initial motivation for early mangrove reforestation projects: people have responded to declining local forest availability by planting mangroves in order to have a ready supply of posts for construction of fish weirs.

Many mangroves have also been planted to protect fishpond dykes and homes from storm damage, and to establish tenure claims over mangrove areas. Benefits from protection against erosion and extreme weather events and direct improvements in livelihoods and food security are perceived as justifications for such restoration

[18] Satellite imagery analysis has yielded higher numbers for the remaining Philippine mangroves (about 250,000 hectares), which still would be half of the coastal forest extent in the beginning of the 20th century (Long and Giri 2011; Long et al. 2014).

efforts (Walton et al. 2006). It must be good for the environment, good also for the economy, including at the local scale (Samonte-Tan et al. 2007; Carandang et al. 2013; Samonte et al. 2016). For protection purposes, seafront planting of fringing mangroves is necessary because coastal populations will not move to safer ground by choice, or cannot move due to poverty.

However, in many coastal communities in the Philippines, mangrove rehabilitation projects by replanting from scratch have been slow and poorly implemented (Ranada 2015a, b). There is a widespread tendency to plant mangroves in areas that are not the natural habitat of mangroves (Primavera et al. 2011), converting mudflats, sandflats, and seagrass meadows subjected to frequent inundation and wave action into often monospecific *Rhizophora* mangrove forests. In these non-mangrove areas, the *Rhizophora* seedlings have experienced high mortality. Of the few that survived (often after persistent replanting), the young *Rhizophora* individuals planted in these non-mangrove zones have reached very small sizes in comparison to those individuals thriving at the high intertidal position and natural mangrove sites.

A more rational focus of the restoration effort (Samson and Rollon 2008) should be to replant of mangroves in the brackish-water aquaculture pond environments, the original habitat of mangroves (Abrogueña et al. 2012). The adoption of a mangrove aquasilviculture[19] system may be an alternative to the current extensive fishpond practice. It would reverse unproductive, underutilized and abandoned fishpond areas into their former productive and pristine condition when these were still mangrove areas.

The BFAR has undertaken a massive mangrove reforestation project in 62 coastal towns nationwide. Following the catastrophic Yolanda typhoon, the government has allotted P1 billion for mangrove and beach forests development in disaster-risk areas in the country (Jen-Indino 2014). The funds will be used to provide socioeconomic benefits to affected local communities and are part of the long term program to mitigate the negative impacts of climate change (Larano 2013; Green et al. 2014). International cooperations with NGOs (Maluyo 2015) and environmental institutions have been developed. The Community-Based Mangrove Rehabilitation Project in the Philippines (CMRP), based in Iloilo province, led by retired mangrove scientist Jurgenne Primavera and funded by the Zoological Society of London, supports and trains local communities in the central Philippine provinces of Aklan, Capiz and Guimaras to rehabilitate abandoned government-leased fishponds and degraded nipa palm. It has developed the Ibajay Mangrove Eco-Park in Aklan,[20] with over 1 km of boardwalks for visitors to explore the extraordinarily diverse mangrove forest and associated wildlife. Highlights of this eco-park are the centuries old mangroves in the centre of the forest which are over eight metres in diameter. This eco-park is managed by local community groups and helps raise awareness of the

[19] A mangrove-friendly system of growing fish and other aquatic organisms in enclosed areas within mangrove forests. Unlike in fishponds, the aquasilvi system does not allow the cutting of any mangrove tree so the natural balance among all elements of the ecosystem is not disturbed.

[20] http://www.ibajay.net/Ibcom/Images/I-Tourism/Katunggan/katunggan_Text.htm

importance of mangroves, while providing valuable additional income for the local communities who manage the park. Other mangrove eco-parks have been constructed in Panay (Sarmiento 2011; Umahag 2015), as well as Palawan and Negros. The area of Sabang in Puerto Princesa has among the most diverse mangrove forests in the island with hectares of mangroves thriving lusciously and offers tourists paddleboat tours of the mangroves.

Efforts are also underway to revive coral beds. In 2005, two coral nurseries were established in Bolinao, the Philippines, in front of Silaqui Island (Pangasinan province, Luzon), based on the “gardening with corals” concept (Shafir et al. 2006; Shaish et al. 2008, 2010). The first phase is the establishment of in situ nurseries (preferably mid-water floating nurseries in which large numbers of coral fragments are reared to sizeable coral colonies under controlled and favorable conditions. The second phase is engaged with the transplantation of these nursery-grown coral colonies onto denuded natural habitats (Cabaitan et al. 2008). In Bolinao, despite the impact of typhoons, the one-year nursery phase, with a high survival rate of 85%, produced sizeable colonies, especially of branching forms, suitable for transplantation. As in the case of mangroves, community-based coral restoration must involve the local community, with public-adapted lectures on coral biology and ecology, coral transplantation training and actual transplantation done with active community participation.

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