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A review of mangrove rehabilitation in the Philippines: successes, failures and future prospects

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Abstract From half a million hectares at the turn of the century, Philippine mangroves have declined to only 120,000 ha while fish/shrimp culture ponds have increased to 232,000 ha. Mangrove replanting programs have thus been popular, from community initiatives (1930s–1950s) to government-sponsored projects (1970s) to large-scale international development assistance programs (1980s to present). Planting costs escalated from less than US$100 to over $500/ha, with half of the latter amount allocated to administration, supervision and project management. Despite heavy funds for massive rehabilitation of mangrove forests over the last two decades, the long-term survival rates of mangroves are generally low at 10–20%. Poor survival can be mainly traced to two factors: inappropriate species and site selection. The favored but unsuitable *Rhizophora* are planted in sandy substrates of exposed coastlines instead of the natural colonizers *Avicennia* and *Sonneratia.* More significantly, planting sites are generally in the lower intertidal to subtidal zones where mangroves do not thrive rather than the optimal middle to upper intertidal levels, for a simple reason. Such ideal sites have long been converted to brackishwater fishponds whereas the former are open access areas with no ownership problems. The issue of pond ownership may be complex and difficult, but such should not outweigh ecological requirements: mangroves should be planted where fishponds are, not on seagrass beds and tidal flats where they never existed. This paper reviews eight mangrove initiatives in the Philippines and evaluates the biophysical and institutional factors behind success or failure. The authors recommend specific protocols (among them pushing for a 4:1 mangrove to pond ratio recommended for a healthy ecosystem) and wider policy directions to make mangrove rehabilitation in the country more effective.

Keywords *Rhizophora* · *Avicennia marina* · *Sonneratia alba* · Mangrove nurseries · Survival rates · Pond ownership · International development assistance · Community and local government initiatives

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Status of Philippine mangroves

The Philippines is an archipelago of around 7,100 islands bordered by 36,300 km of coastline along mangrove forests, seagrass beds and coral reefs. These marine habitats are important in providing food and other goods and services to more than half of the country's 1,500 towns and 42,000 villages.

Mangroves in particular contribute a wide array of fishery (seaweeds, fish, crabs, prawns, mollusks and other invertebrates) and forestry (timber, firewood, tanbark for dyes, fibers and ropes, corks, etc.) products. Mangrove amenities include coastal protection from typhoons and storm surges, erosion control, flood regulation, sediment trapping, nutrient recycling, wildlife habitat, and nurseries.

Major and minor mangroves (Tomlinson 1986) in the Philippines total some 30–40 species belonging to 15 families. At the turn of the century, mangroves covering around 450,000 ha (Brown and Fischer 1920) were so widespread that many coastal areas including the country's premier city of Manila were named after mangroves (Primavera 1995). Mangrove forest decline to only 120,000 ha in 1994–1995 (Primavera 2000) may be traced to overexploitation and conversion to agriculture, salt ponds, industry and settlements. However, aquaculture remains the major cause—around half of the 279,000 ha of mangroves lost from 1951 to 1988 were developed into culture ponds (Agaloos 1994; Primavera 2000). Ninety-five percent of Philippine brackishwater ponds in 1952–1987 were derived from mangroves (PCAFNRRD 1991). To minimize the impacts of pond construction on mangrove ecosystems and their associated fisheries, Saenger et al. (1983) suggested that "... the amount of mangrove forest converted into fishponds should not exceed 1 ha of ponds for 4 ha of natural mangrove kept untouched."

The increase of fish/shrimp culture ponds to 232,000 hectares in 1994 gives a ratio of only one-half hectare of remaining mangroves to 1 ha of pond (Fig. 1a). This is significantly below the 4:1 ratio recommended above (Saenger et al. 1983). To mitigate or reverse this extremely vulnerable condition, there is urgent need for immediate and massive mangrove replanting. The objective of this paper is to review mangrove planting programs in the Philippines, to evaluate the biophysical and institutional factors behind their success or failure, and to recommend specific protocols and wider policy directions to make mangrove rehabilitation in the country more effective.

Mangrove planting/rehabilitation

The earliest documented mangrove plantations in the country more than 100 years ago are those of *bakhaw Rhizophora* species (for firewood and charcoal) and the nipa palm *Nypa fruticans* (for alcohol, roof shingles, etc.) around Manila Bay, sometimes extending 20 km inland (Brown and Fischer 1920). Sediment

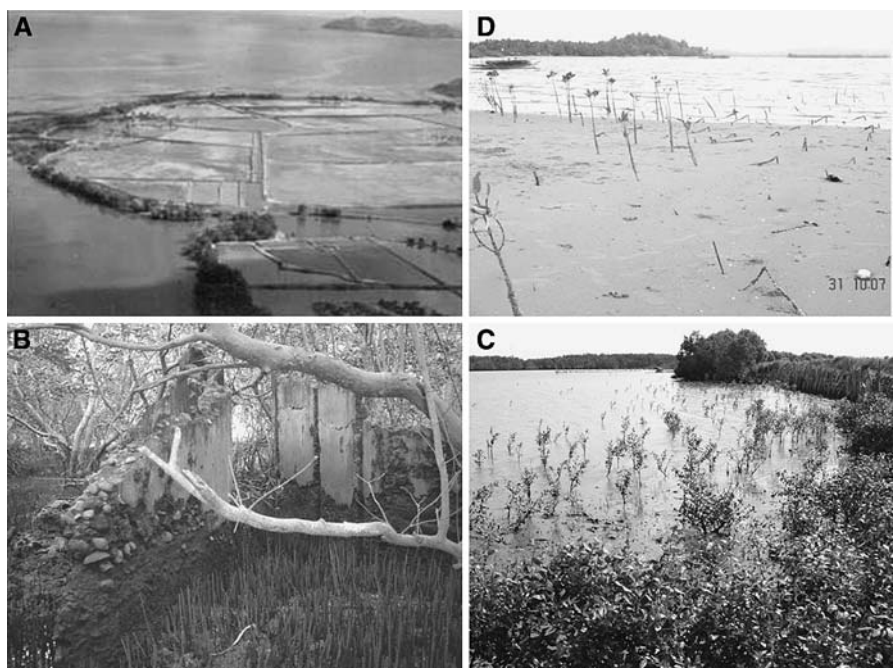

Fig. 1 Aerial view of Philippine ponds shows lack of greenbelt, and a very low mangrove: pond ratio (**a**). This can be improved by allowing abandoned ponds to revert to mangroves, such as this 20-year old site in Batangas (**b**) whose concrete gate is partly covered by mangrove branches. *Avicennia marina* is the natural colonizer along coastlines (**c**), which explains why seedlings of *Rhizophora*, favored by most replanting programs suffer high mortality when planted in these habitats (**d**). Photos by V. Mancebo and J. H. Primavera

trapping by *Rhizophora* roots in mudflats increased land elevation such that cutting of trees for firewood was often followed by fishpond construction (Brown and Fischer 1920). Mangrove planting for coastal protection has been undertaken mainly in the Visayas, central Philippines whose numerous islands are more vulnerable to typhoons than the bigger islands of Luzon to the north and Mindanao to the south. As early as the 1930s–1940s in Negros, and the 1950s–1960s in Bohol, local communities planted mangroves primarily for wood supply and typhoon protection (Agaloos 1994; Primavera 2000; Walters 2000, 2003).

In 1976, the National Mangrove Committee (NMC) was formed and mandated to design a comprehensive, integrated program that would rationalize mangrove planning and management procedures, and to review all fishpond leases and timber licenses at the time (National Mangrove Committee 1987; Walters 2003). The research and survey activities of the NMC provided the bases for the proclamation of 4,300 ha of mangroves in various islands as wilderness areas and 74,300 ha representing the entire province of Palawan as mangrove forest reserves. Government-sponsored mangrove planting under the National Forestation Program started only in the 1980s—the first project covered an area of 4,560 ha in the islands of Marungas, Sulu (Yao 1986; Agaloos 1994). The first mangrove project with large-scale international development assistance was the World Bank-funded Central Visayas Regional Project in 1984. Since then, a number of externally-assisted mangrove projects have been launched by the national government and implemented at the grassroots level with local government units (LGUs), nongovernment organizations (NGOs), and local communities through people's organizations (POs). The scope of this paper is limited to international development assistance projects channeled through the Philippine national government. Except for case studies from the provinces of Bohol and Pangasinan, and planting trials in Panay (supported by the Pew Fellowship grant of the senior author), this paper excludes smaller programs initiated by local communities and NGOs.

Community and local government initiatives

Pagangan Island, Bohol (Yao 1986, 1999b; Agaloos 1994)—From this small island, villagers could only reach the mainland of Calape town during low tide, so they built a 4.5 km causeway in 1950. The coral limestone structure was only 2 ft above high tide level, and therefore easily damaged by typhoons. In 1956, school principal Felix Ytac organized primary and secondary school students to plant *bakhaw R. stylosa* propagules along the causeway. The practice was continued by other school officials until it became a yearly event during the Scouting Month of October. Propagules were sourced from neighboring islands and planted at high densities to increase protection from waves. Interestingly, the south side of the island with natural recruitment of *Sonneratia alba* and *Avicennia marina* needed no planting. The small-scale plantings covered a total of 54 ha by 1999, and later plantings were harvested for fuelwood. The valuable lesson of Pagangan was the community's self-help approach to mangrove planting, which prospered without any government assistance. This community-led method also helped provide shelter, a basic requirement for survival, to Pagangan villagers.

Banacon Island, Bohol (Yao and Nañagas 1984; Yao 1985, 1999a; Cabahug et al. 1986; Walters 2003)—In the early 1950s, local residents contested a concession granted to harvest fuelwood (for sale to bakeries) from the 400-ha Banacon Is., Getafe mangroves. Their efforts were in vain: decades of indiscriminate cutting resulted in wood scarcity in Banacon. The residents' response was to plant mangroves, with Eugenio (Nong Dencio) Paden pioneering the effort to plant *bakhaw R. stylosa*. Although propagules had to be sourced from neighboring towns, *bakhaw* was preferred to the dominant *A. marina* and *S. alba* because of its high survival rates when planted in upper intertidal sites. Planting costs were US$66–78 and $59–68/ha at 0.5 × 0.5 m and 1.0 × 1.0 m spacing, respectively.

The profitable sales of poles from harvested mangroves encouraged other families to follow Nong Dencio's lead of starting *bakhaw* plantations, eventually causing boundary problems. To address this dispute, the plantations were placed under the Communal Tree Farm program of the Bureau of Forest Development and 5–40 m wide sealanes were recommended for boat navigation around the plantations. Aside from wood, the mangroves provided typhoon protection, other livelihood sources (fish, crabs, and shrimps, *amatong* or brush pile fisheries with 1 m deep × 1 m wide holes yielding 3–4 kg of fish every month), and also expanded the land such

that the mangroves covered close to 600 ha. For his pioneering effort and visionary spirit, Nong Dencio was given the Likas Yaman Award by the Department of Environment and Natural Resources (DENR) in 1989, and the Best Farmer Award by FAO and the King of Thailand in 1991.

Bani, Pangasinan (Roldan 2004; Dizon-Pascua 2006)—Decades-long fishpond conversion of the lush mangrove forest in Bani had marginalized fisherfolk in 13 coastal and riverine villages.

To reverse this negative trend, local government officials and community members requested PhP522,000 ($21,500) from the DENR to buy propagules for expansion of their remaining mangrove area of only one hectare and promised to supply labor (for planting, security and maintenance) as counterpart.

In 1996, the mangrove site won the Best Community-Based Coastal Project Award and the PhP1 million cash prize was used to put up a protective fence (to keep out poachers and firewood collectors) and mangrove nursery. Additional assistance from the FRMP (see later section) expanded the project to ~42 ha of protected area which now boasts of 38 species of migratory birds, including the endangered Philippine wild duck or mallard, and over 15 species of commercially important finfish and shellfish. It has also become a popular ecotourism site with the construction of an observation deck and 300-m boardwalk.

New Buswang, Kalibo, Aklan, 1990–1996, OECF (Primavera and Agbayani 1997; Primavera and Ashton 2005)—In 1989, the Overseas Economic Cooperation Fund (OECF) of Japan gave a PhP561,705 ($23,100) loan for a Mangrove Reforestation Project to the Kalibo, Aklan LGU. Technical assistance for the project came from the DENR and assistance in community organizing from the NGO Uswag. The PO KASAMA (Kalibo Save the Mangroves Association) planted a total 45 ha of *Rhizophora* and 5 ha of nipa. At the time of the project turnover in 1993, seedling survival was 97%. Additional plantings were funded by a second OECF loan of PhP305,343 for 13 ha of nipa, PhP100,000 from the Countryside Development Fund of then Congressman Quimpo for a 7-ha expansion, and allocations from the Kalibo LGU, e.g., PhP1.5 million in 1996–2000.

The rehabilitated mangrove stand in Kalibo has stabilized the shoreline and provided a buffer zone against typhoons; contributed to food security; and improved family incomes through direct wages (for mangrove planting and maintenance activities, and employment at the newly established Eco-Park) and sales of crabs, shrimps, fish, and mollusks from the mangrove site. Shipworms of the Family Teredinidae, called *tamiluk* and considered a delicacy by local folks, have recently been harvested from decaying trunks and branches of *bakhaw*. Since the late 1990s, the New Buswang Mangrove Eco-Park has attracted many local and foreign guests and is averaging 3,000 monthly (earning PhP300,000 in entrance fees in 2005). LGU officials from different municipalities also arrive on cross-visits. The Buswang Mangrove Project was awarded the 1994–1995 Galing Pook (Oustanding Locale) Award from the Department of Interior and Local Government (DILG) and the 2004 UN-FAO Excellence in Forest Management in the Asia-Pacific Award, among many others.

Factors behind the success of the New Buswang Mangrove Project include excellent coordination among the LGU, national government agencies, Uswag and KASAMA, diversification of livelihood options including land-based (conference/restaurant/lodging facilities, weaving) and aquatic (boat hire) activities, and long-term land tenure through legal instruments like the FLMA and CBFMA. The latter has been key to people empowerment because Philippine mangroves are *de facto* open access (Primavera 2000).

Early problems involved physical and legal maintenance of the plantation. Survival of young mangrove trees was threatened by infestation of barnacles and tussock moth larvae which devoured leaves of the mangrove saplings. Plantation managers also found interpretation of national and local laws problematic. Pruning of multiple *Rhizophora* stems started only in 2006 because of a provision in Republic Act 7161, which imposes a total ban on cutting of mangroves. In 1995, KASAMA members caught a cow and her calf foraging in the plantation site, despite municipal ordinances banning stray animals. The calf died in captivity, KASAMA was subsequently charged in court and even paid damages to the calf owner. A graver problem is illegal pond construction by a retired judge in the 1990s. More recently, the discovery and subsequent report to the authorities stopped another pond development of 4 ha in the inner plantation (A. Quimpo, KASAMA, personal communication). The bulldozer used to construct the dikes remains stuck in the mud to this day.

International development assistance: large-scale government projects

Central Visayas Regional Project, IBRD 1984–1992 (Calumpong 1996; De Leon and White 1999; Courtney and White 2000; Walters 2000)—This region wide rural development project in 11 sites covering 4 provinces in Central Visayas adopted a community-based approach with grassroots organizations trained in leadership, management, and legal matters, among others. Of a total $35 million funding ($25.6 million loan from the International Bank for Reconstruction and Development and $9.8 million from the Philippine Government), $3.5 million went to nearshore fisheries projects that included mangrove reforestation to increase fishers' catches and incomes. By 1991, 1490 stewardship certificates had been granted to 2,549 households for 994 ha of mangrove plantation. But mangrove survival rates were low—17–19% covering around 491 ha in Cebu-Bohol as of December 1995—and were traced to barnacle infestation, poor species (unsuitable *bakhaw*) and site selection. Nevertheless, baseline information was insufficient to evaluate the results such that many potential lessons from this comprehensive program were lost. Nevertheless, the major achievement of CVRP was its holistic, community-based watershed management approach using tenure as a major incentive to heighten awareness in resource management in the project sites. Twenty-five year Certificates of Stewardship Contract over a mangrove area were awarded to families who agreed to maintain healthy forest cover.

Forestry Sector Program, JBIC, 1993–2003 (NFDO-DENR 2003; JBIC 2006)—The Forestry Sector Program which had total funding of ¥9,294 million ($89.4 million, 1993), was financed by the JBIC. Its objectives were (1) to reverse the process of upland and mangrove forest degradation, (2) to ensure long-term sustainability in the management of natural resource-based enterprises and community development in general, and (3) to improve the material well-being of rural communities by integrating sustainable resource utilization activities into a solid economic base (http://www.tanggol.org/environmental_laws/DAO_93-16.html) (Table 1).

Project activities were focused on 12 subproject sites, and targeted the rehabilitation of 11,175 ha of a total 68,748 ha in all mangrove sites. The rehabilitation cost PhP48.8 million, a fractional amount of total project cost of PhP357.7 million for watershed plantations. Five of the project sites (range of 100–1,296 ha) reported operation costs between PhP1.2 to 20.9 million (Table 2). Expenses ranging from PhP6,759/ha (Palawan) to PhP15,484/ha (Zamboanga del Sur) cover both plantation (seedling production, plantation establishment, maintenance and protection, infrastructure, administration) and monitoring costs. But reclassification of these items shows that only half of total allocation went to actual planting expenses—the balance covered overlapping items such as administration/supervision and project management (Fig. 2). Nevertheless, this JBIC project was noteworthy for incorporating 3-year post-planting monitoring costs in the budget (Table 3).

Fisheries Sector Program, ADB and OECF, 1990–1997 (ADB 1999; Courtney and White 2000; Roldan 2004)—Two loans from the Asian Development Bank totalling $80 million funded the Fisheries Sector Program (FSP), with an additional $80 million equivalent provided as co-financing by the OECF. The FSP had the Department of Agriculture as executing agency and the BFAR, DENR, Agricultural Credit Policy Council and the Philippine Fisheries Development Authority as implementing agencies. The Program constituted the first comprehensive strategy of the Philippine government to address the most pressing problems of the fisheries sector through four major policy reform measures. These included provision of trade incentives and provided funding for activities in fisheries resource ecological assessments, coastal resource management (CRM) and resource regeneration activities in 12 priority bays in major fishing areas. CRM was the main strategy for resource rehabilitation and NGOs were recruited to undertake community organizing work. A total of 30,000 ha of mangroves were targeted but only 7,000 ha were planted, due to inadequate supply of propagules, bad weather, and lack of qualified NGOs and local staff to manage the reforestation work.

In 2003, Roldan (2004) surveyed ~1,400 ha or 10% of the original FSP sites and reported a range of 0.5–90% survival with a trend "... toward high survival in most sites", yet supporting data were not provided. Most of the plantations used *Rhizophora* species whose propagules are easy to collect and plant, but which cannot withstand wave action. Hence only 10% of these plants survived in open seaward sites in Calauag Bay, Quezon. This was in contrast to 85% survival of *Sonneratia* and *nipa* planted in their natural habitats in

Table 1 Major externally funded mangrove rehabilitation projects in the Philippines, 1957–2006

Name	Source[a]/amount of loan	Implementing agency[b]	Years	Location	Area (ha)	Species planted	Ave. survival[c]
Kalibo, Aklan	OECF:PhP561,705 (US$23,100)	LGUs, POs	1989, 1993	Aklan, Central Visayas	50	*Rhizophora apiculata*, *R. mucronata*	97% (1993)
	OECF: PhP305,343				13	*Rhizophora apiculata*, *R. mucronata*	High
Central Visayas Regional Project (CVRP)	WB: $35 million ($3.5 million for Nearshore Fisheries)	LGUs, POs	1984–1992	Central Visayas (4 provinces)	994	*Rhizophora* sp.	17–19% (1995)
Forestry Sector Program	JBIC: Yen 9,294 million ($89.4 million)	Dept. of Environment and Natural Resources	1993–2003	10 provinces nationwide	11,486	*Rhizophora* sp.	No data
Fisheries Sector Program (FSP)	ADB: $80 million	DA- Bureau of Fisheries	1990–1994	12 priority bays in major fishing areas	7,000 (orig. 30,000 ha)	*Rhizophora* sp.	Range: 0–90%
Fisheries Resources Mngt. Program (FRMP)	ADB & JBIC: $38 million ($18.1 million for mangroves)	DA- Bureau of Fisheries	1999–2004	18 bays nationwide	1,900	Predominantly *Rhizophora* sp., <10% *Avicennia marina*, *Nypa*	No data
Community-Based Resource Mngt. Program (CBRMP)	WB: $38 million	Department of Finance	1999–2006	4 regions nationwide	5,302	*Rhizophora* sp.	35.2% (Dec. 2005)

[a] WB, World Bank; ADB, Asian Development Bank; OECF, Overseas Economic Cooperation Fund of Japan; JBIC, Japan Bank of International Cooperation

[b] LGU, Local government unit; PO, people's organization; DA, Department of Agriculture

[c] Calumpong (1996); Roldan (2004); CBRMP (unpub.)

Table 2 Breakdown of mangrove reforestation and enrichment planting projects under the JBIC-funded Forestry Sector Project by plantation and monitoring costs (in Philippine pesos, PhP), 1993–2003[a]

	Carles & Balasan, N. Iloilo	Pisaan-Sungayan, Zambo. Sur	Palompon, Leyte		P. Prinsesa, Palawan		Tapul, Sulu	
			Direct	Nursery	Reforestation	Enrichment	Reforestation	Enrichment
General								
Total area (ha)	531	850	1,296	100	713	963	502	448
Total cost (PhP)								
Plantation	6,252,820	12,408,246	19,856,118		11,044,832		6,513,127	736,579
Monitoring	551,000	753,050	1,031,546		1,201,288		803,525	
Total project cost	1,176,280	13,161,296	20,887,664		12,246,120		8,053,231	
A. PLANTATION COST (/ha)								
1. Seedling prod.	0.74	2.94	0.87	2.70	0.85	2.12	0.99	0.44
2. Plantation establishment	2,261.5	2,579.0	3,118.0	5,718.0	2,860.1	1,135.2	575.9	276.6
3. Maintenance & prot.[b]	4,557.1	7,728.7	1,733.4	1,720.5	746.9	385.4	4,288.8	205.2
4. Infrastructure[c]	39,000	207,625	200,000		60,000		53,272.0	0
5. Administration & supervision	1,735.5	2,046.2	6,404.3		787.8		1,371.6	170.2
6. Contingency/ others	0	0	5,000 (demo farm)		226.2		0	0
Subtotal[d]	11,765.8	14,598.0	14,220.5		5,934.0		12,974.0	1,644.0
B. MONITORING COST (/ha)								
1. Physical validation	632.2	633.0	598.2		543.4		619.5	
2. Inst. & project benefit assessment	404.6	252.9	140.6		102.0		226.3	
Subtotal	1,036.8	885.9	738.8		645.4		845.7	
Total cost (\ha)	12,794	15,484	14,960		6,579		15,464	

[a] *Source*: FDO-DENR, 2003

[b] Tools not included

[c] Computation of unit cost not clear

[d] May not be exact subtotal

Gingoog Bay, Misamis Oriental. The reasons cited for poor survival were typhoons, waves, floods, pests and diseases, animal grazing, and human factors such as pollution, fishing, gleaning, and boat traffic. Like the earlier CVRP however, the project suffered from a lack of baseline information for evaluation purposes.

Fisheries Resource Management Program, ADB and JBIC, 1999–2004 (FRMP 2003; Roldan 2004)—The Fisheries Resource Management Program was the second phase of the FSP and was co-financed by ADB and JBIC for $38 million. The Program addressed fisherfolk concerns and needs (poverty, declining income, lack of alternative livelihood) by implementing resource management measures to control illegal fishing and overfishing. More specifically, it targetted promotion of fisheries resource management through mangrove reforestation, establishment of artificial underwater reefs, procurement of coastal patrol boats, establishment of fishery statistical data collection system, institutionalization of fishing licensing system, and enhancement of living standards of fisherfolk through the formation of fisherfolk associations and alternative sources of livelihood. It targetted 18 bays nationwide, with JBIC contributions of 2,824 million Japanese yen ($8.1 million in 1998) allocated for 1,900 ha of mangrove sites.

Community Based Resource Management Project, WB, 1999–2006 (CBRMP 2006a, b unpub.; REECS 2006)—The CBRMP addressed problems of rural poverty, environmental degradation, natural resource depletion and decreasing coastal and upland productivity by enhancing the capacity of local governments and communities to manage their natural resources and rural development programs. The $38 million loan from the World Bank covered coastal and nearshore fisheries (in addition to upland agriculture and forestry, livelihood projects and small-scale infrastructure subprojects). The CBRMP was implemented by the Department of Finance in collaboration with the DENR, DA-BFAR, NEDA, DILG and the National Commission for Indigenous Peoples.

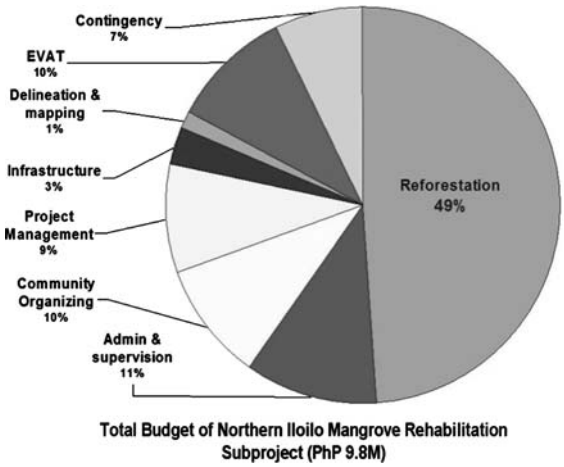

Fig. 2 Breakdown of Northern Iloilo Mangrove Subproject budget (PhP9.78 million) by planting (reforestation) and non-planting activities (Anon 2000)

Emphasizing natural resource management as an approach to governance, the Project funded a total of 90 subprojects in 82 low-income rural municipalities. The subprojects included Coastal and Nearshore Fisheries, specifically the rehabilitation of 5,302 ha of degraded mangrove forest and protection of 2,074 ha of productive forest, among others. The rehabilitation subproject covered only half the area of protected forest (average 97.2 vs. 188.5 ha), but had 4.4 times the total cost (PhP1497,328 vs. PhP342,328) and 13.3 times the unit cost (PhP15,251 vs. P1,145/ha).

An internal report as of December 2005 (CBRMP, unpub.) gave survival rates (range: over 20–98%) for majority of the planting sites. Data were not scientifically convincing, however, because survival rates were reported as rounded-off numbers or as a single figure for the whole municipality and basis for computation was not explained. Nevertheless, four

Table 3 Summary of planting and monitoring costs (US$/ha) in various mangrove rehabilitation projects in the Philippines

Base year/site	Costs (US$/ha)			References
	Plantation (spacing)	Monitoring	Total cost	
1983 : Banacon	$66–78 (0.5 × 0.5 m)	None		Cabahug et al. (1986)
	59–68 (1.0 × 1.0 m)	None		
1983: Jolo	125 (1.0 × 1.0 m)	None		
1986 : CVRP	80 (0.5 × 0.5 m)	None		
	40 (1.0 × 1.0 m)	None		
1986–1992: CVRP	60–140			De Leon and White (1999)
~1990: Philippines	$337 (PhP8,206)			Agaloos (1994)
~1990: Region 7[a]	$205–552 (PhP4,981–13,428)			
~1990: Region 4	$228 (PhP5,540)			
1993: 4 FSP-JBIC Provinces	$435-538/PhP11,800–14,600 (varied spacing)	$26–37/PhP700–1,000	$472–575/ PhP12,800–15,500	NFDO–DENR (2003)
Palawan	$218/PhP5,900 (varied spacing)	$24/PhP650	$242/PhP6,500	
2004: Surigao del Sur	$51 (PhP2,500) for propagules, excluding labor	None		E. Enderez, CERD (Pers. Communication)

[a] Varying distance of seed source

municipalities (with 33 sites) had survival rates reported to two decimal places—taking the mean for these towns gave an average survival of 35.2%.

To focus on a single municipality, Magallanes in Agusan del Norte, Northern Mindanao will illustrate the case of CBRMP. Magallanes planted only 53.8 ha (of a target 80 ha), and recorded a seedling survival rate of 59.1% (32 ha) in December 2005. Over a year later in January 2007, hardly five hectares (or even one hectare) of planted mangroves could be seen remaining (J. H. Primavera, pers. observation). According to local officials and fisherfolk, the seedlings had been washed away by strong flood waters originating from Agusan del Sur and Davao, or damaged by the onrushing clumps of water hyacinth and debris brought by the flood. The very costly lesson of Magallanes (total planting cost of PhP2.28 million) shows that mangroves should have been planted outside the creeks away from floodwaters, and that planting should have been inside adjacent fishponds.

The more successful projects reported well-equipped community organizers and environmental specialists who trained the local officials and POs. The latter benefited from regular monitoring and field visits (Roldan 2004). Sustainability approaches included structural arrangements in LGUs (such as creation of a municipal environment and natural resource management office or MENRO); realignment of LGU personnel duties, allocation of budget for subprojects), enhancing sustainability plans of LGUs (through municipal ordinances, and NRM and self-sustaining income projects), strengthening institutional arrangements (networking with other LGUs/POs), and issuance of tenurial instruments (e.g., CBFMA) to willing families.

Pew Projects in Iloilo 2006 to Present—Under the Pew Grant for Mangrove Conservation of the senior author, two mangrove greenbelt projects were initiated in the province of Iloilo along short stretches of the Iloilo River and 5 ha of coastline in Dumangas municipality. The two projects shared common features of consultation with local communities and other stakeholders, signing of a Memorandum of Agreement with LGUs, and use of nursery-reared *A. marina* (rather than the favored *Rhizophora* species).

For the Iloilo River project, more than 400 *A. marina* seedlings were planted in rows along the riverbank by the same biology students who reared them in the nursery. Seedling survival was ~50% at 6 months and <10% after 1.5 years with most of the surviving plants located in the upper row. Mortality was mainly due to frequent tidal flooding; other factors were anthropogenic—garbage (plastics, twigs,

Fig. 3 Ermita, Dumangas, 2006: *Avicennia marina* plants healthy at 3 weeks (**a**) but dead 3 months after planting (**b**), with rotting stems (**c**) due to frequent inundation. Planting was in the subtidal zone with visible seagrass beds (**e**). Plants also had problems with algae, sediments (**d**) and barnacles (**f**). Photos by S. R. Novilla and J. H. Primavera

old shoes/clothes, other junk), digging up of substrate and trampling by fishers.

Similarly, the ~20,000 mangrove seedlings (90% *A. marina* + 10% *Sonneratia alba, Rhizophora* spp.) planted in Ermita, Dumangas died within 3 months (Fig. 3a, b). During the earlier consultation, beach resort operators required a No Planting zone up to 50 m from the beach so resort guests could swim. Hence the seedlings were planted in the lower intertidal to subtidal flats with seagrass patches (Fig. 3e), where they suffered mainly from inundation as evidenced by rotting stems (Fig. 3c) and only secondarily from damage by barnacles, filamentous algae and sediments (Fig. 3d, f). Moreover, *S. alba* could survive the 'strangling' presence of filamentous algae in sandy, marine habitats unlike *A. marina*.

Discussion

Few of the mangrove project documents cite seedling survival, and this may be related to weak monitoring instruments in the original proposals. The few reported survival rates do not give sufficient details (e.g., Roldan 2004) whether figures were based on eyeballing (in the case of rounded off numbers) or actual counts of plants in sample plots, sizes of sample plots (area in sq m or ha), dates of sampling, etc. The CBRMP Monitoring and Evaluation Report of December 2005 illustrates this point. Only four of 16 towns for which data sets were available had figures reported to two decimal places. The other 12 towns reported either rounded off-figures (e.g. 60, 90% for Town A) or a single figure for multiple sites (e.g., 75% for Towns X, Y, and Z).

Although Roldan (2004) reports a trend of high survival for 1,900 ha of FSP and FRMP sites, the other projects probably have low survival rates, based on 17–19% for CVRP sites surveyed 10 years after planting (Calumpong 1996). Another example is the CBRMP 53.8 ha planted site in Magallanes, Agusan del Norte which had no more than 5 ha remaining in January 2007. Seedling survival at 2 years has been suggested as a reliable indicator of longterm success (Roldan 2004). However, biological success is defined as reproduction or the production of flowers and viable fruits. For many mangrove species, this starts at 3–5 years. Recommended monitoring for survival and growth of mangrove plants should therefore be at 3, 6 months, 1, 3 and 5 years—more frequent at the start and extending beyond the usual 1 year.

Surprisingly, exceptions to the generally poor track record of mangrove planting in the Philippines have been the low-budget initiatives: Pagangan and Banacon in Bohol ($80\ha), Buswang, Kalibo in Aklan (initial loan of $23,100 or PhP561,705) and Bani, Pangasinan ($21,500 or PhP522,000). With very high ~90% survival rates, they are often described as success stories. Aside from modest funding, these projects have shared a number of features—regular maintenance (by residents who live right next to the plantations) and co-management with local governments. Perhaps community-initiated efforts borne out of a shared need (e.g., for coastal protection) have greater assurance of success than heavily funded and donor-driven international development assistance projects in millions of dollars. Factors that affect survival are: (a) biological—mangrove species, and pests (algae, barnacles, insect larvae), (b) physical—tidal level and inundation, substrate, waves/typhoons, sedimentation, (c) human factors—gleaning, fishing gears, fishing boats, and (d) prospects of tenure.

The natural colonizers in most replanting sites are *A. marina* (Fig. 1c) and *S. alba* (Primavera et al. 2004; Roldan 2004; REECS 2006), but their relatively small seeds require a labor-intensive nursery period. In contrast, *Rhizophora* species have large propagules that are easy to collect and to plant (Samson and Rollon 2008), hence they are preferred by government agencies and NGOs alike (Fig. 4). But this is planting by convenience, not by ecology. Moreover, *Rhizophora* are suited to more protected zones such as behind the *S. alba-A. marina* zone of fringing mangroves, or along muddy tidal rivers and creeks, hence the high *Rhizophora* mortality rate in most planting sites (Fig. 1d). In 2003, the Philippine Association of Marine Science (PAMS) recommended the use of locally adapted and existing mangrove species such as *S. alba* and *A. marina* in seaward zones, and *Rhizophora* species in more sheltered areas.

The main source of planting guidelines favoring *bakhaw* has been the DENR, the government agency which oversees mangroves in the country. This preference for *Rhizophora* may also be traced to the weak ecological background of many forestry staff, and the influence of American ecology—*Rhizophora mangle* dominates the ~8 species of Neotropical mangroves—on Philippine forestry practices. In

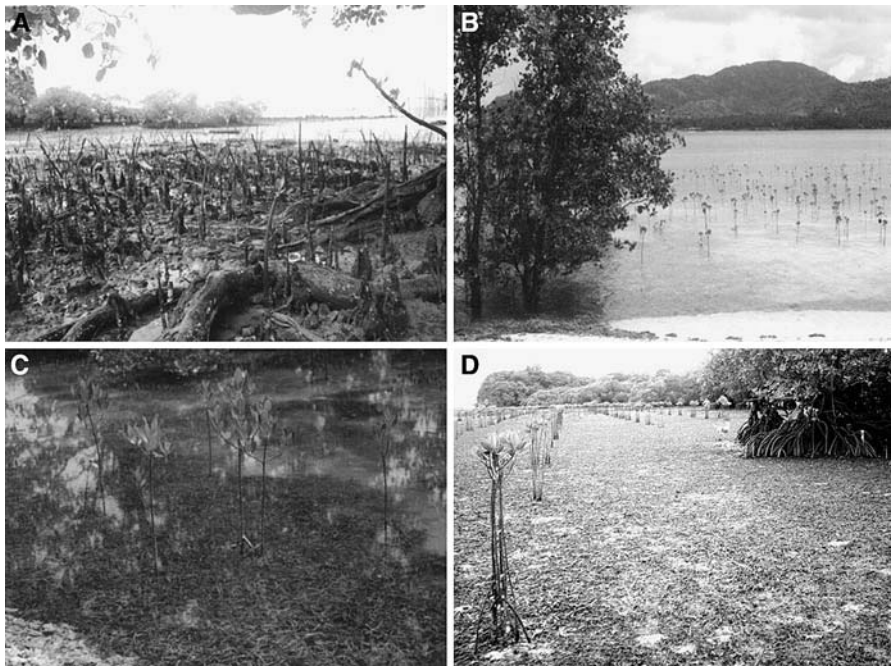

Fig. 4 Mangrove rehabilitation in wrong sites using wrong species, Visayas, Philippines: *Rhizophora* seedlings and saplings planted among roots of natural *Sonneratia alba* stands in Guimaras (**a**), on seagrass beds in Aniniy, Antique and Calatagan, Batangas (**c**, **d**) and adjacent to *S. alba* stands in Antique (**b**). Photos by J. H. Primavera

response to this, a few guides on mangrove replanting in the Philippines have been prepared, among them Sinohin et al. (1996), Melana et al. (2000) and Salmo and Juinio-Menez (2001). What becomes clear is the need for Philippine forestry technicians to expand their formal training to include basic ecological concepts, and for NGOs to undergo mangrove refresher courses and workshops before undertaking widescale mangrove reforestation projects.

Planting locations have mostly been seaward in the lower intertidal down to the subtidal zones that include tidal flats and seagrass habitats (Fig. 4a–d). These areas are open access and pose little or no threat of ownership conflicts for plantation managers (Samson and Rollon 2008). But they are not optimal for mangroves (Erftemeijer and Lewis 2000), hence the generally low survival and growth rates (REECS 2006; Samson and Rollon 2008). Ironically, the few cases where plants manage to survive means that seagrass and mudflat habitats (with their fish and bird fauna) are transformed to mangroves.

In contrast, the upper to middle intertidal sites that are ideal for mangroves are mostly occupied by culture ponds which theoretically are covered by a legal title if privately owned, or by a fishpond lease agreement (FLA) from the government. At present, a large proportion of these ponds (in the thousands of hectares) are underutilized or totally abandoned; a few have naturally reverted to mangroves (Fig. 1b). More significantly, at least 10% up to a third of government-leased ponds probably have no legal basis—either the FLA has expired or the FLA application has not been approved. Or terms of the FLA have been violated, e.g., the ponds have been subleased (Primavera 2000, 2005). According to the 1998 Fisheries Code, such violations constitute grounds for FLA cancellation (and pond reversion to mangroves), but this has not been enforced neither by the BFAR nor the DENR. Guidelines for pond-to-mangrove rehabilitation can be found in Stevenson et al. (1999) and Melana et al. (2000).

In 2005, the PAMS issued another Call to Action for the DENR, local governments and BFAR to:

(a) stop planting mangroves in the wrong sites, i.e., the seaward (or lower intertidal) zone, especially in seagrass beds,

(b) plant mangroves in the right sites, i.e., in the middle to upper intertidal zones, particularly in abandoned and FLA-expired ponds, which are their natural habitats,

(c) undertake an inventory of FLA status of government-leased ponds, and

(d) reserve some 50,000 ha of abandoned and FLA-expired ponds for mangrove planting in order to restore the balance of 180,000 ha of mangroves

and 180,000 ha of aquaculture ponds (for a minimum 1:1 ratio).

In the Philippines single families often own up to hundreds of hectares of pond area, although 20 ha or even less is the most that a pond operator can realistically manage by himself. This results in the underutilization or abandonment of many ponds, and low pond productivity 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 modest lease fee of ~$20 (PhP1000)/ha per year.

Theoretically and legally, coastal resources are state property, but weak law enforcement by the government has left a *de facto* open access situation (Janiola 1996). Tenurial security through 25-year instruments—the FLMA, MSA and CBFMA, in succession—has been important in imparting a sense of ownership and responsibility to the community. The earliest form of tenure granted to mangrove areas was the Certificate of Stewardship Contract (CSC) in the 1970s, replaced in the 1980s by the Integrated Social Forestry Program (ISFP) which provided incentives for co-management. A later formulation and more appropriate instrument was the Mangrove Stewardship Agreement (MSA), a renewable lease to small (~1 ha) areas of intertidal land. More recently, the Forest Land Management Agreement (FLMA) was issued as a production sharing contract between the government and individual families, communities, or corporations for the management of plantation areas previously established under the short-term contract reforestation program, on a 25 plus 25 year tenure basis. Under these various instruments, contract holders are entitled to harvest, process, utilize or sell the wood and other commodities produced from the plantation in exchange for protecting, maintaining and managing the forest.

In 1993, the DENR stopped its contract reforestation efforts and the next year endorsed the NGO-assisted Community-Based Mangrove Forest Management Approach. Executive Order No. 263 mandated community-based forest management as the national strategy to ensure the sustainable development of the country's forest resources, by consolidating tenure instruments into a Community-Based Forest Management Agreement (CBFMA) which is granted in place of the previous agreements.

Involving the community is a more sustainable approach to reforestation and maintenance of existing resources because participatory approaches empower local communities to contribute more effectively to forest management (Contreras 2003). However, tenure grants to community managers are more complex than they are on paper—since most forest resources are owned by the State, and such resources are common to multiple stakeholders (Contreras 2003), tension and contradictions arise. There is now a conflict between existing legislation that bans mangrove cutting (e.g., Pres. Decree 705, R.A. 7161) and the new policies that allow limited use by community stewards. Planters-contract holders of the Kalibo, Aklan plantation did not get DENR approval to selectively cut the overcrowded *Rhizophora* stands until the trees were 16 years old (A. Quimpo, KASAMA, personal communication).

Conclusion

Although commercial mangrove plantations for fuelwood and alcohol were recorded in the Philippines in 1918 (Brown and Fischer 1920), mangrove rehabilitation started only in the 1930s–1950s for community initiatives in Negros, Bohol and the Visayas. This was followed by government-initiated projects in the 1970s and international development assistance programs (in the form of loans through the Philippine Government) in the 1980s.

Over time and with the evolution from community-initiated to internationally-funded projects, planting costs have zoomed from <$100 to over $500/ha with up to 50% of the latter amount going to overhead costs such as administration, supervision and project management. Despite heavy funding in the hundreds of millions of dollars to rehabilitate thousands of hectares of mangroves over the last two decades, the longterm survival rates of mangroves—the most (and only) meaningful index of success for any planting project—are generally low at 10–20%.

Poor survival can be attributed mainly to two factors—inappropriate species and sites. The favored but unsuitable *Rhizophora*, are planted in sandy substrates of exposed coastlines instead of the natural colonizers *Avicennia* and *Sonneratia*. More significantly, planting sites are generally in the lower

intertidal to subtidal zones where mangroves do not thrive rather than the optimal middle to upper intertidal levels, for a simple reason. Such ideal sites have long been converted to brackishwater fishponds whereas the former are open access areas with no ownership problems. But as complex and difficult as the issue of pond ownership may be, such consideration should not outweigh ecological requirements—mangroves should be planted where they used to be and that is fishponds, and not on seagrass beds and tidal flats where they never existed. For starters, ponds facing open seas and along riverbanks should be reverted back to mangroves (or beach forest) to a width of 50–100 m and 20–50 m, respectively, in compliance with R.A. 8550, P.D. 705, P.D. 953, and other laws that mandate a coastal buffer zone or greenbelt.

If such ecologically sensitive sites are in privately titled ponds, then they may be reverted to the public domain by means of environmental buy back schemes such as offered by the Global Environment Facility. Additional areas for mangrove rehabilitation are ponds with legally problematic FLAs, i.e., licenses that should be cancelled because of Fisheries Code violations. The Bureau of Forestry and BFAR should consider cancelling such FLAs.

Legal protection of Philippine mangroves is not wanting, it is implementation that is generally weak, hampered by inadequate manpower and resources and lack of political will to enforce the laws. Mangrove rehabilitation programs would have better returns if they also addressed law enforcement problems and re-orientation of forestry extension workers.

To attain a more balanced mangrove: pond ratio than the present 0.5:1, the challenge for the Philippines is to muster enough political will to make abandoned, underdeveloped and otherwise illegal culture ponds available for mangrove rehabilitation, in compliance with the laws of the land. For mangrove rehabilitation efforts to succeed, funding appears to be of secondary importance. The essential requirements are suitable (high to mid-intertidal) sites, correct species, community involvement and commitment, and grant of tenure.

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