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People and mangroves in the Philippines: fifty years of coastal environmental change

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SUMMARY

Historical research has enhanced understanding of past human influences on forests and provides insights that can improve current conservation efforts. This paper presents one of the first detailed studies of mangrove forest history. Historical changes in mangroves and their use were examined in Bais Bay and Banacon Island, Philippines. Cutting to make space for fish ponds and residential settlement has dramatically reduced the distribution of mangroves in Bais, although forest has expanded rapidly near the mouth of the largest river where soils from nearby deforested hillsides have been deposited as sediments along the coast. Heavy cutting of mangroves for commercial sale of firewood occurred under minor forest product concessions in Bais and Banacon between the late 1930s and 1979. Cutting for domestic consumption of fuel and construction wood by local people has been widespread in both areas, although rates of cutting have varied in space and over time as a result of changing demographic pressures and in response to cutting restrictions imposed by firewood concessionaires, fish pond owners and government officials. People in both Bais and Banacon have responded to declining local forest availability by planting mangroves. Early motivations to plant reflected the desire to have a ready supply of posts for construction of fish weirs. Many have also planted to protect fishpond dykes and homes from storm damage, and increasing numbers now plant as a means to establish tenure claims over mangrove areas. However, planted stands have tended to be species monocultures and to bear only limited resemblance to natural mangrove forests. In contrast to many upland forests, opportunities for protection and restoration of mangroves are limited by virtue of a highly restricted natural distribution and by competing land uses that are likely to intensify in the future. Understanding historical patterns of change can be instructive to conservationists, but the future remains laden with uncertainties.

Keywords: mangroves, forest history, human ecology, induced intensification, community management, Philippines

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INTRODUCTION

Human actions worldwide are profoundly altering the distribution and character of the world's forests (Noble & Dirzo 1997). In fact, research in human ecology and the emerging field of forest history increasingly show that human influences have long been pervasive in many forests (Balee 1989; Thirgood 1989; Denevan 1992; Lepofsky *et al.* 1996; Roosevelt *et al.* 1996; Schneider 1996; Kirby & Watkins 1998; Agnoletti & Anderson 2000). By understanding present forest conditions in light of past human actions and by tracking forest succession over longer time periods, this research has generated findings that often pose challenges to conventional conservation thinking (Botkin 1990; Gomez-Pompa & Kaus 1992; Rudel 1998). Yet, research on historical use and alteration of forests can offer insights to guide forest restoration and management today (Botkin 1990; Redford & Padoch 1992; Walters 1997).

Mangroves are a unique type of forest that thrive in coastal intertidal environments throughout the tropics. Their ecological significance and economic importance are considered substantial (see Macnae, 1968; Christensen 1982; Hamilton *et al.* 1989; Lacerda 1993; FAO [Food and Agricultural Organization of the United Nations] 1994). However, mangroves have garnered little attention from researchers in human ecology and forest history.

It is known that mangroves have been cleared and degraded on a vast scale during the last century. In particular, cutting of mangroves for wood and to make space for brackish water aquaculture, residential settlement and infrastructure, have led to widespread decimation of forests in many countries, including the Philippines (Brown & Fischer 1918; Meltzoff & LiPuma 1986; Hamilton *et al.* 1989; Baconguis *et al.* 1990; Primavera 1993, 1995; Dewalt *et al.* 1996). In a few locations, researchers have also documented local people planting and managing mangroves in areas devoid of forest or degraded from previous use (Fong 1992; Smith & Berkes 1993; Weinstock 1994; Walters 1997, 2000*a*).

The conservation and restoration of mangroves have in recent years become a priority of many government and non-government organizations (Baconguis *et al.* 1990; FAO 1994; ITTO [International Tropical Timber Organization] 2002). Studies of mangrove forest history should be of interest to such organizations because actions aimed to curb ongoing destruction of mangroves will be likely to benefit from understanding past causes of such destruction. Likewise, understanding the historical origins and spread of such conservation-oriented practices as mangrove planting in the context of otherwise widespread forest clearing may be of value to those planning to promote such interventions elsewhere (Thorhaug 1990; Saenger & Siddiqi 1993; Melana *et al.* 2000). For both practical and theoretical reasons, it is worthwhile understanding how patterns of historical change in mangroves compare and contrast to changes in other types of forest.

This paper presents findings from one of the first historical studies of human influences on mangrove forests. It will focus specifically on historical changes in two distinct areas in the Philippines, namely Bais Bay and Banacon Island, selected by virtue of their regional ecological significance and the fact that local planting of mangroves had been documented in each (Cabahug *et al.* 1986; DENR [Department of Environment and Natural Resources] 1990; Yao 1987). Other papers on Bais Bay and Banacon Island have focused on development project experience and the detailed results of site-specific assessments. This study was a mostly-qualitative synthesis of changes to mangroves across both study areas (Walters 1997, 2000*a*; Walters *et al.* 1999). Specifically, the objectives of the paper are to (1) describe important changes in mangrove forest distribution and composition in each of these areas during the past 50 years, (2) explain how and why these changes have occurred over time as a result of various land and resource use practices, and (3) relate these findings to practical questions of mangrove conservation and the wider literature on forest history and human ecology.

METHODS AND STUDY AREA

Study area

This study was conducted between March and December 1997. Banacon is a small, remote island, located 5 km off the north-west corner of Bohol Province and about 30 km east of Cebu City (Fig. 1; Cabahug *et al.* 1986). It includes over 400 ha of mangrove forest, much of which is planted, and 15 ha of dryland on the eastern tip. There are currently 550 households in one village crowded onto the dryland portion of the island, 90% of which today derive their principal income from fishing and related activities.

Bais Bay is located on the eastern side of Negros Island, in the Central Philippines (Fig. 1). It occupies an area of *c.* 5400 ha divided into North and South Bays by Daco Island and a man-made causeway that connects Daco to the mainland (Fig. 2). North and South Bais Bay are bounded on the east by Tanon Strait, and on the west by a 1–4 km wide band of flat alluvial plain, which rises into steep hills and mountains that reach 950 m in elevation at their highest point in the adjacent watershed. A small fraction (about 4%) of the lands that drain eastward into Bais Bay are today forested, with most of the remainder in agriculture. In particular, the growing of sugar cane, most of it on large agricultural estates (*haciendas*) in the lowlands, and the production of sugar by local mills have been the principal engine of the local economy for over a century. In the hills

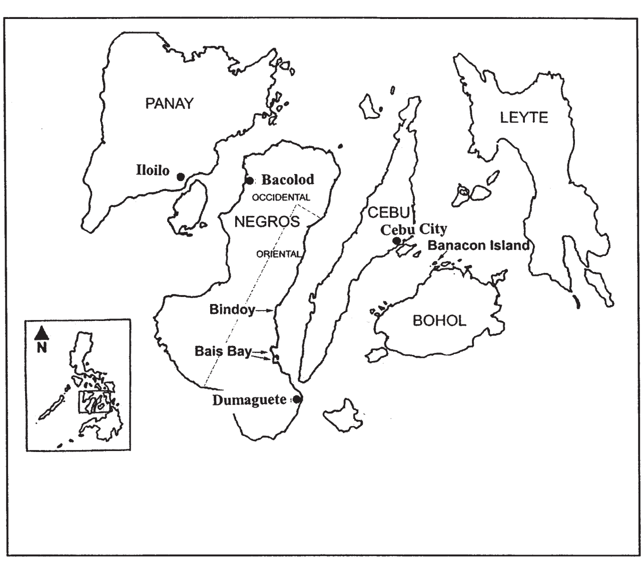

Figure 1 Location of Bais Bay and Banacon Island, Philippines.

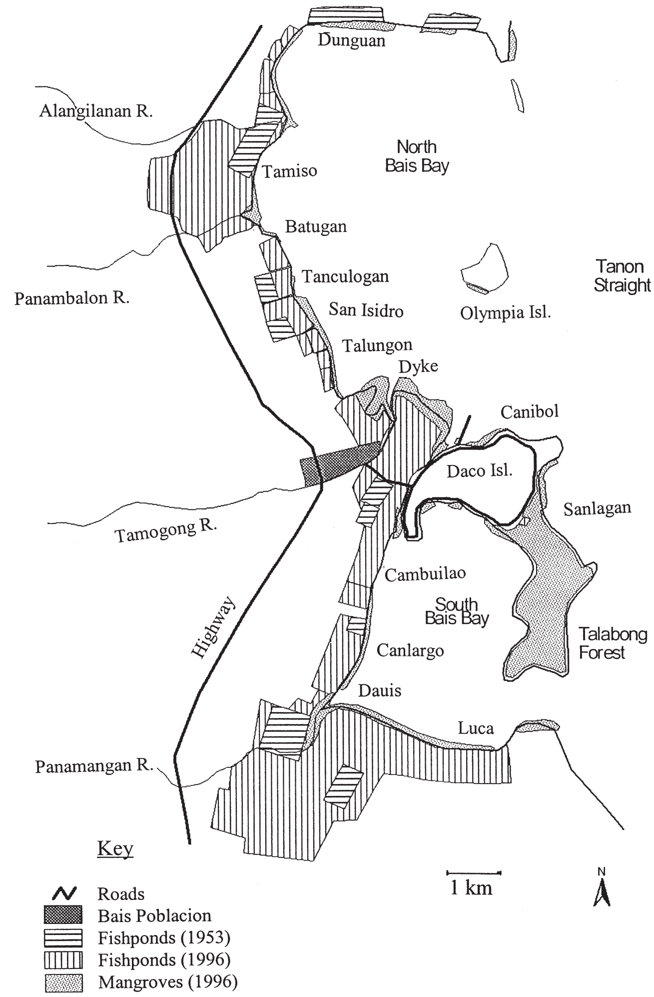

Figure 2 Distribution of fish ponds in North and South Bais Bay in 1953 and 1996.

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and mountains, sugar cane, corn, coconut and various other agricultural crops are grown on mostly small farms (Walters *et al*. 1999).

The coastal waters in and around North and South Bais Bay are ecologically diverse and productive, and support a variety of fishing activities from the 16 different villages that ring the two bays (Luchavez & Abrenica 1997). Extensive coastlands have also been developed into brackish water fish ponds and increasingly locals have farmed seaweeds and shellfish. Much of the perimeter of both North and South Bais Bay is today fringed by narrow bands of mangrove forest, ranging from several to over 50 m wide, some the result of deliberate planting and others apparently natural in origin, as will be discussed below. Larger stands of forest are found at the mouths of the two largest rivers, which drain into North and South Bais Bay, respectively. In addition, the largest stand of mangrove forest, called *Talabong*, extends as a peninsula across the seaward front of South Bais Bay (Fig. 2).

Methods

Information was gathered using a variety of social and natural science methods. Specifically, I conducted 215 semi-structured interviews with residents living in 18 different coastal villages in the two study areas. In the interviews, people were asked about the history of mangrove changes and patterns of resource use, as well as their motivations at different times to cut, plant and protect mangroves. Thirty-two key informants (i.e., government officials, mangrove scientists, etc.) were also interviewed to understand relevant changes in policy and to seek expert opinion on such topics as the causes of mangrove deforestation and reforestation. A variety of secondary sources of information were consulted, including maps, property surveys, unpublished government statistics, policy and legal documents, published and unpublished technical reports, and historical records. In particular, I carefully reviewed all official notes of the City Council of Bais from 1950–1990, inclusive. Information specific to land-use history in the uplands of Bais was, in part, also derived from semi-structured interviews of 20 elderly residents living in the uplands, conducted in 1992 by myself and colleagues (Walters *et al*. 1999).

Information from interviews and secondary sources was integrated with data collected from ecological assessments of mangrove forests and their environments. In general, efforts were made to confirm empirical claims made about mangroves by interviewees by visiting specific sites with them. I also measured the spatial dimensions and planted-tree densities of 123 mangrove plantations in nine different villages. To study more systematically the influence of human actions on mangrove forest composition, structure and regeneration, I made replicated measures across a range of sites and forest types using a standardized 10 m × 10 m census plot (Cintron & Schaeffer Novelli 1984). A total of 19 plots in natural mangrove forest and 33 in plantations ranging from five to 60 years of age were surveyed in this manner. A stratified random sampling approach was used to select plot sites. Approximately equal numbers of plots in both cut and uncut forest stands from each forest type were sampled to evaluate the effects of cutting. Every mangrove tree and seedling within each plot was recorded by species and size (diameter at breast height [dbh] and height), with evidence of cutting recorded. Data on nearly 6000 trees and 2000 seedlings were recorded. Species identification was based on Calumpong and Menez (1997). Finally, I systematically sampled water salinity, soil depth and particle size, tidal inundation, and shell infestation rates across different sites.

I employed a version of causal historical analysis, called event ecology, as the analytical methodology for evaluating causal links between historical events and integrating relevant biophysical and socio-economic information (Vayda 1996; Vayda & Walters 1999; Walters 2000*b*). With event ecology, research is guided by open-ended questions about why specific environmental changes of interest (events) have occurred. It then seeks to explain such changes by making causal connections to prior events, in so doing constructing causal chains outward in space and backward in time. Avoiding as much as possible a priori assumptions about which events are likely to do the explaining, socio-economic and biophysical information are sought as evidence where the researcher anticipates their having relevance to answering specific questions of interest. Counterfactual reasoning is then applied to evaluate the plausibility of specific causal relationships (Hawthorn 1991; Tetlock & Belkin 1996).

RESULTS

Human influences on Banacon Island mangroves

Banacon Island had about 20 fishing households before 1939. Residents cut wood freely from the local mangroves, but impacts were surely slight given the small population and extensive forest (*c*. 400 ha; Cabahug *et al.* 1986). In fact, older residents described the mangrove trees then as being much larger than today and supporting much more wildlife, including monkeys and migrating cranes.

A minor forest product lease (MFPL) was allocated to the mangroves of Banacon in the early 1950s. For over two decades after, wood from Banacon mangroves was cut and transported 40 km by boat to Cebu City, where it was sold as firewood to bakeries and other industries. Banacon residents contested this concession because they were discouraged from cutting wood under threat of fine from the concessionaire. This had the effect of creating artificial conditions of local wood scarcity.

People responded to this scarcity by planting mangroves. A resident who apparently learned the technique from a visitor to the island initiated planting in 1957. Planting eliminated ambiguity over claims to mangroves because local tradition imbues ownership of trees to those who plant them, regardless of underlying rights to land. He planted initially along the shore near his home. Other members of the community soon took notice and began to imitate the novel practice.

Subsequent planters claimed and planted areas closest to the settlement on a first-come, first-served basis in small parcels, resulting in a cumulative, steady expansion of planted mangroves outward, away from the village. All plantations were managed intensively for one species only, called *bakau* (*Rhizophora stylosa*), which was easy to plant and highly valued for posts used in the construction of fish weirs, houses and fences. Trees of other species were never planted and, in fact, were often deliberately cut back to make additional space for planting bakau.

This led to a progressive expansion of plantations into what was formerly natural mangrove forest. This process was hastened by cancellation in 1979 of the MFPL, the result of growing political momentum at the national level to protect mangroves. Specifically, efforts of the National Mangrove Committee (NMC), an inter-agency task force created in 1976 with the job of reviewing mangrove policy, led to the passage of legislation mandating establishment of wilderness areas over critical mangrove forests (NMC 1986). Island mangroves like those on Banacon and the Talabong forest in Bais Bay (see below) were recognized as particularly important ecologically. Banacon Island received wilderness area designation in 1979 under Presidential Proclamation No. 2151 (DENR 1990).

Most residents on Banacon had by this time come to appreciate the benefits of owning their own mangrove plantations and so continued to plant vigorously even after the island was designated a protected area. In fact, the government has since permitted continued planting and harvesting because, even though it violates the spirit of wilderness area designation, Banacon has become a national showcase for community-based mangrove reforestation and management.

Nonetheless, the cumulative effect of two decades of commercial cutting followed by intensive plantation silviculture is striking. As of 1997, virtually all natural trees (*Sonneratia* spp., *Avicennia* spp. and *Rhizophora* spp.) have been cut within 2–3 km of the village. In their place are approximately 300 ha of monoculture *R. stylosa* plantations. Plantation parcels are tightly clustered, forming a contiguous mosaic of forest patches of differing ages, divided only by walking paths and several wide (10–15 m) boat paths. Virtually all wood being cut comes from these plantations. Harvesting is done selectively or in small clear-cuts with cut areas replanted in more *R. stylosa*. Planted parcels are even bought and sold among residents with live trees still standing. Planting has also expanded the distribution of mangroves in places beyond their historic, natural range into nearby seagrass beds and mudflats. Thus, while the forest species diversity and structural complexity are far lower today, the actual forest area is probably greater.

Table 1 Key historical events with consequences for mangroves in Bais Bay.

Estimated date	*Historical event*
1870	First sugar cane estate (hacienda) established
1919	First of two industrial sugar mills built
1920	Brackish water salt panning in mangroves introduced (converted later to fish ponds)
1920	Mangrove planting introduced among fisherfolk on Daco Island
1935	Mangrove planting introduced among fish pond owners on the mainland
1935	Minor forest product lease allocated to harvest mangroves from Talabong
1950–1980	Extensive mangrove deforestation for fish pond development
1950	Causeway to Daco Island built facilitating settlement along the coast
1960	Perimeter roads built around Daco and Olympia Islands facilitating settlement and mangrove clearing along the shore
1960–1990	Forest clearing and settlement in mountains causes sedimentation along the coast
1965	Mangroves cleared for residential development of San Jose
1969/71	Typhoons devastate property and mangroves along coast
1975	Mangroves cleared for residential development of Obrero
1979	Minor Forest Product Lease for Talabong cancelled
1985	Talabong Marine and Wildlife Sanctuary established
1986-90	Certificates of Mangrove Stewardship allocated by DENR
1989	Bantay dagaat marine conservation patrol established
1991	Election of activist, pro-conservation mayor
1993	Mangrove reforestation and ecotourism project initiated

Human influences on Bais Bay mangroves

Spaniards first settled in the area of Bais in 1820 (Bais City 1994). Sugar cane growing began in Bais around 1850 and in 1870 the first 500 ha plantation was established on fertile lowland adjacent to the Bay (Table 1). Spanish immigrants and *mestizo* elites (of mixed Spanish-Filipino descent) continued to claim and develop lands, usually closest to the Bay first because sugar was at this time shipped directly by sea from Bais Bay to Iloilo City, Panay, from where it was then freighted to overseas markets (McCoy 1982; Bais City 1994). By 1892 sugar was already the largest export from the

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province of Negros Oriental and Bais was the source of 75% of this (Bais City 1994). Sugar exports continued to grow after the turn of the century following passage of the USA Payne-Aldritch Act, which established tariff-free imports for Philippine sugar (Billig 1993). The first of two industrial sugar mills was built in Bais in 1919. These events consolidated the hacienda plantation system, which remains to this day the backbone of the local political economy.

Terrestrial forests were cleared near the coast first, but haciendas cleared few mangroves in the early years because cane growing is impossible on saline soils. Some mangrove wood was no doubt cut for firewood or construction materials, but amounts were probably not large because production of sugar has historically relied much on the burning of *bagasse* (cane wastes) for fuel, and I found little evidence of mangrove wood use in the construction of older homes on the haciendas.

Mangrove cutting to make space for fish ponds

The first fish ponds in Bais were developed in the late 1920s or early 1930s, adjacent to hacienda lands in Alangilanan and San Isidro in North Bais Bay, and Canlargo in South Bais Bay (Fig. 2). These first ponds were built for salt making, but were later converted to fish farms. Early pond developers were either hacienda owners who claimed mangroves adjacent to their properties or local entrepreneurs resourceful enough to finesse the relevant permits and invest the needed labour and capital. Extensive mangroves in North and South Bais Bay were cleared for fish ponds between 1945 and 1970. Subsequent changes have involved making improvements to existing fish ponds or expanding in increments into remaining foreshore mangroves.

An exception to this pattern was the more recent development of fish ponds in mangroves at the mouth of the Tamogong River, near the Bais *poblacion* (town centre) (Fig. 3). The Tamogong is the largest river entering Bais Bay and drains most of the nearby mountains. Commercial logging in the mountains was especially active in the 1950s and 1960s. Swidden farmers (*kaingeros*) followed logging roads and cleared lands after the best timber had been extracted and the forest concessions retired. Agricultural settlement accelerated and shifted to monoculture of sugar cane in the 1970s and 1980s because the City built more roads that penetrated deeper into the mountains, thereby linking extensive upland areas with commercial cane markets in the lowlands. Substantial soil erosion ensued, much of it washing downstream and being deposited as sediment near the mouth of the Tamogong River, especially following heavy rainfall events when as much as 0.3 m of sediment was known to have been deposited in places. This led to a swift expansion of new land near the mouth of the river as mangroves, especially *Avicennia marina*, colonized accreting soils.

These newly formed mangrove lands were soon after claimed by local entrepreneurs as prospective fish pond sites. In some cases, claimants planted mangroves to enhance their claims, only later converting the area to fish ponds. This process of claiming, planting and later clearing areas for fish

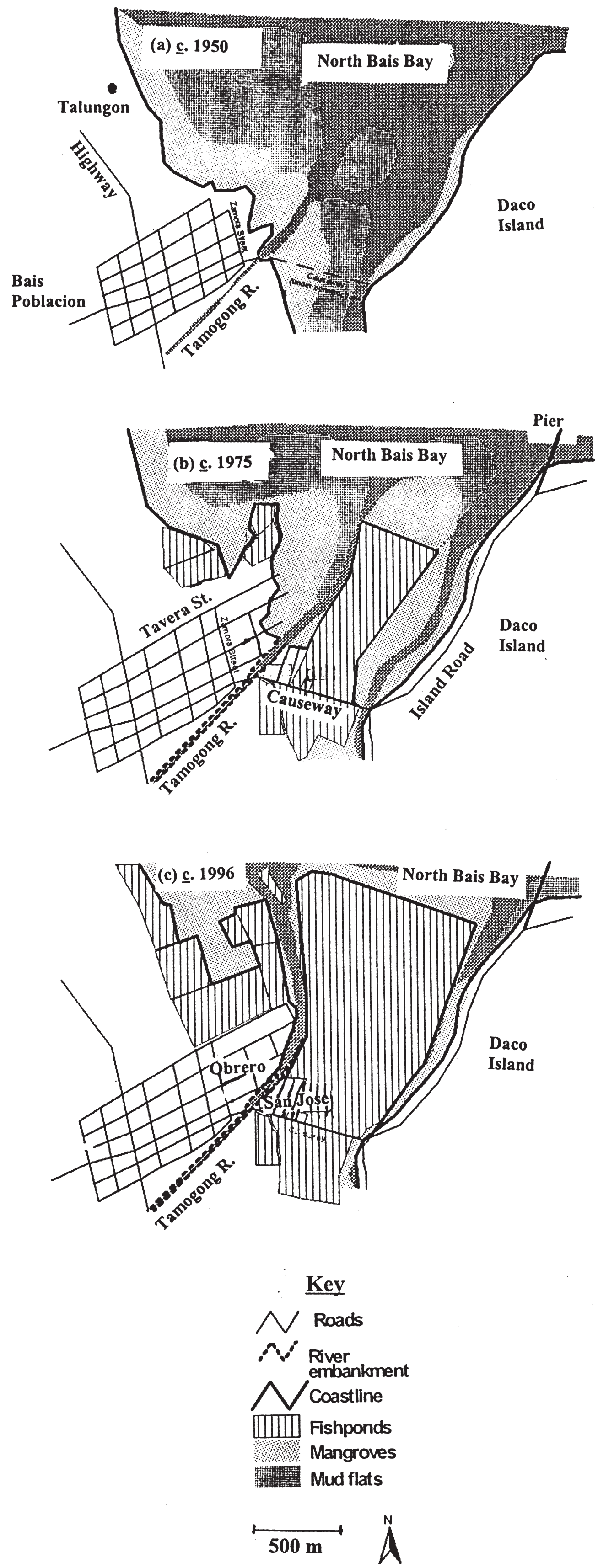

Figure 3 Changing mangrove forest distribution and land use at the mouth of the Tamogong River, North Bais Bay, comparing (*a*) 1950, (*b*) 1975 and (*c*) 1996.

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Table 2 Summary of fish pond statistics for North and South Bais Bay. (Source of information: the Municipal Planning office, Manjuyod, City Assessor's office, Bais, and Municipal Office of the Department of Agriculture, Tanjay.)

Municipality	*Number of fish pond holdings*	*Mean size and range of pond holdings (ha)*	*Total area of fish ponds (ha)*
North Bais Bay			
Manjuyod	17	11.1 (0.7–40.0)	189.5
Bais City	39	9.5 (0.2–91.0)	371.0
Sub-total	56	10.0 (0.2–91.0)	560.5
South Bais Bay			
Bais City	42	7.9 (0.1–40.0)	332.4
Tanjay	46	7.1 (0.2–34.0)	326.2
Sub-total	88	7.48 (0.1–40.0)	658.6
Total	144	8.47 (0.1–91.0)	1219.1

Table 3 Total population size from 1940 to 1995 for Daco and Olympia Islands, Bais Bay. * Estimates derived from interviews of older residents; ** Bais City Office for Planning and Development, unpublished data.

Island	*Year of census*						
	*1940**	*1950**	*1960**	*1970***	*1980***	*1990***	*1995***
Daco	450	900	1900	3851	5137	5678	6639
Olympia	100	250	350	520	605	724	788

ponds continued into the 1980s as the Tomogong delta expanded seaward. The construction of pond dykes and river control embankments in the 1970s probably accelerated the expansion by channelling river flows and silt deposition more directly offshore (Fig. 3).

Efforts to curtail fish pond development gained momentum in the late 1980s, the combined result of increasing local opposition from competing resource users (fisherfolk, gleaners) and pro-conservation policies emanating from the local and national government. There are currently 1219 ha of fishponds in Bais Bay (Table 2) and 80–90% of these were developed in mangrove areas. Extensive riverine/basin forests formerly found in the deltas of the Panambalon and Panamangan Rivers have been cleared and developed into vast pond complexes (Fig. 2). Fringing mangroves formerly found in wide bands along much of the bay shore have been narrowed or eliminated. Because pond development has almost always occurred from the landward-side, many of the upper elevation mangrove species that are likely once to have been common in Bais, including *Bruguiera*, *Ceriops* and *Xylocarpus* spp., have since become locally rare or been extirpated.

Mangrove cutting to make space for residential settlement in Bais Bay

Residential settlement in mangroves has been concentrated on Daco and Olympia Islands and at the mouth of the Tamogong River. Early residents on Daco and Olympia were fisherfolk that settled between 1900 and 1920. They built homes close to the shore, but few established formal title to these lands. The Bureau of Lands initiated legal release of private titles in Bais beginning in the 1920s under the auspices of the National Cadastral Survey. The lands on Daco and Olympia were subsequently titled to some of the local residents and to some entrepreneurs from the mainland. Many residents, their descendants and subsequent migrants to the islands remained landless.

The government built a causeway to Daco Island in 1950 and then built perimeter roads around each island in the 1950s and 1960s, hastening further in-migration. Local populations exploded (Table 3), and what unclaimed shoreline remained was settled. The concentration of homes along the shore prompted mangrove cutting there, but also created incentives to protect remnant trees and plant new mangroves for storm protection, tenure security, and to provide ready supplies of wood. Backyard planting became widespread in the 1970s, but plantation expansion was often later offset by the further cutting of mangroves from the landward side, done in most cases by older children who married and, wanting to establish a residence of their own, and had little option but to cut trees and build further out into the mangrove because adjacent drylands were owned by others.

On the mainland at the mouth of the Tamogong River, landless residents began to encroach into the mangrove immediately east of the poblacion in the early 1950s, in what is today called San Jose (Fig. 3). These people included municipal employees and middle-class entrepreneurs and so had clout. Responding to political pressure and the realization that fish pond speculators were claiming mangrove lands, the local government initiated two successive reclamation projects adjacent to the poblacion, converting 30 ha of mangrove to residential housing lots between 1960 and 1980 (Fig. 3).

Mangrove cutting for firewood and construction materials in Bais Bay

Mangroves throughout North and South Bais Bay have been cut for fuel and construction wood (Table 4). Early residents

Table 4 Summary of current mangrove wood uses in Bais Bay. Figures = % of respondents out of total number asked (n) that indicated that they used mangrove wood for said purpose. * Miracle hole or *amatong*, which uses mangrove branches piled around an excavated pit to attract and trap fish in the pit at low tide.

Village	*Mangrove wood uses*						
	Bunsod posts	*Fuelwood*	*House construction*	*Fence/pen construction*	*Nipa roofing*	*Miracle hole**	*Christmas trees*
Sanlagan, Daco (n = 37)	27	74	11	16	42	6	3
Canibol, Daco (n = 63)	6	5	3	2	29	0	18
Olympia Island (n = 21)	48	29	5	0	64	14	14
Mainland Bais (n = 37)	54	32	8	30	17	4	0

of Daco and Olympia Islands harvested for fuel and posts used in *bunsod* (fish weir) construction. In the 1930s, the extensive mangroves of the Talabong came under a MFPL to harvest firewood, although bunsod posts were eventually also cut and sold under the lease. By the 1960s, the concession employed 10 full-time cutters and guards and was the regular supplier of 10 bakeries in the region. Local people were permitted limited access under the lease to harvest firewood from designated areas, but some fisherfolk cut bunsod posts illicitly. Local demand for wood grew in the 1970s as populations expanded (Table 3). As had occurred on Banacon, the Talabong MFPL was cancelled in 1979 by national order. With the concession guards now gone, a dramatic surge in cutting ensued by locals from coastal communities around North and South Bais Bay. For the next 10 years, the level of cutting in the Talabong may well have surpassed that which occurred under the lease.

Marine scientists from nearby Silliman University had been researching Bais Bay since the early 1970s (Alcala & Ortega 1976). They convinced the local government to block fish pond applications that were pending following cancellation of the MFPL. They then influenced proposals that led in 1985 to the designation of the Talabong mangrove as a marine and wildlife sanctuary, managed jointly by the municipal and national government. Designation initially did little to curtail mangrove cutting, but this began to change in 1989 with the creation of a local *Bantay Dagaat* unit, a squad of local fisherfolk deputized to police illegal activities like mangrove cutting. Cutting restrictions were strongly enforced following the election in 1991 of a mayor who made conservation of mangroves a priority.

Cutting of natural forests has substantially declined in recent years, but the cumulative impact of past cutting has been substantial (Table 5). A cursory examination of most forest stands in Bais Bay reveals evidence of cutting on almost every tree (B.B. Walters, personal observation 1997). Sites closest to settlements had grossly stunted trees with profuse coppicing as a result of repeated cutting of main stems and branches. Cutting for firewood is unselective so all mangrove tree species have been heavily impacted (Table 5), but especially those less resilient to cutting disturbance (*R. mucronata, Bruguiera* spp. and *Ceriops* spp.).

Table 5 Cutting rates (% of total number of stems cut) by species for natural and plantation mangrove forests. Figures represent percentages of the total number of stems (sample sizes in brackets).

Species	*Percentage of stems cut*	
	Natural forests	*Plantation forests*
Rhizophora mucronta	30.9 (42)	24.6 (4238)
Rhizophora apiculata	44.7 (103)	19.2 (26)
Avicennia marina	37.3 (552)	22.2 (446)
Sonneratia spp.	72.4 (326)	50.0 (14)
Ceriops decandra	13.2 (68)	38.1 (21)
Bruguiera spp.	14.3 (7)	7.7 (26)
Mean	46.5 (1098)	24.4 (4771)

Mangrove planting in Bais Bay

Early mangrove planting dates from the 1920s on Daco Island and was motivated by the desire to have a ready source of posts for bunsod construction. Fisherfolk still plant for bunsod posts, but others are motivated differently. The surge in settlement along the shores of Daco and Olympia Islands that occurred in the 1960s and 1970s led to extensive mangrove clearing. This coincided with typhoons in 1969 and 1971 that inflicted much property damage. Such events have encouraged many coastal home owners to plant backyard mangroves for storm protection.

Concerns over land tenure also emerged in the 1970s and became an important motivation to plant mangroves. This reflected population pressures and competition for space: many planted simply to claim areas before others did. But it also reflected a growing political awareness among landless residents that was influenced by wider political sentiments in the country. In fact, local demands for property rights and tenure conflicts over mangroves have prompted government intervention on many occasions. For example, between 1986 and 1990 the Department of Environment and Natural Resources allocated 300 Certificates of Mangrove Stewardship under the auspices of the National Integrated Social Forestry Program. These certificates gave homeowners 25-year usufruct leases along the shore, but ultimately had little effect on mangroves since most suitable areas were already either developed or planted with mangroves when the certificates were allocated.

The commercial firewood concessionaire in Bais Bay paid his employees to replant areas following cutting. Only bakau

Table 6 Summary of the number and percentage of planters in Bais who claimed to have planted the different mangrove species.

Species planted	*Number of planters (n = 158)*	*Percentage of planters*
Rhizophora mucronata	156	98.7
Rhizophora apiculata	9	5.7
Avicennia marina	7	4.4
Nipa fruticans	7	4.4
Sonneratia spp.	3	1.9
Bruguiera cylindrica	2	1.3
Ceriops decandra	2	1.3

was planted because it was easy and could be sold both for firewood and as construction posts. Millions of seedlings were planted and it is likely that this planting in large part accounts for the ubiquity of bakau in the Talabong mangrove sanctuary today (B.B. Walters, personal observation 1997).

It has also become common practice in Bais Bay to plant mangroves outside fish pond dykes to protect against wave damage. Such planting has resulted in the creation of a band of mangroves around much of the perimeter of North and South Bais Bay where fish ponds exist. As with the backyard plantations, *R. mucronata* was most commonly planted, although *Avicennia marina, Nipa fruticans, Ceriops decandra* and *Sonneratia alba* were planted by some (Table 6).

DISCUSSION

People have profoundly and in myriad ways influenced the mangroves in Bais Bay and Banacon Island during the past 50 years. Much of the original forest in Bais Bay has been eliminated, and virtually every remaining stand of mangrove in both Bais and Banacon has been substantially altered in its composition, structure and distribution (Walters 2000*a*, *b*). Even the most apparently 'natural' mangroves owe much of their current character to direct anthropogenic influences, a point often overlooked by researchers studying these sites (see De Leon *et al.* 1991; Calumpong 1992). At the same time, an historical perspective has illuminated a dynamic interplay between forest loss and forest gain over time. Such a perspective poses challenges to the certainties often sought after in long-term conservation planning.

Brackish water aquaculture is a widely documented cause of mangrove deforestation (Meltzoff & LiPuma 1986; Dewalt *et al.* 1996; Naylor *et al.* 1998; Stevenson *et al.* 1999). In Bais Bay as in other regions of the Philippines, no other factor has had so drastic an impact on mangroves. From the late 1940s through the 1960s, fish ponds were promoted by the national government through the provision of concessional loans, financed in part by the International Bank for Reconstruction and Development (Villaluz 1979; Primavera 1995). Between 1950 and 1960, brackish water ponds in the Philippines nearly doubled in extent to 123 000 ha (Primavera 1995). With the exception of the 1980s 'prawn boom', pond development slowed thereafter, the combined effects of reduced government incentives, increased costs of clearing less optimal sites, and increasingly pro-conservation policies (Primavera 1995; but see Primavera 1993, p. 168).

Findings from Bais Bay are generally consistent with the wider trends, but also highlight things thus far not documented. For example, other studies of forest loss due to aquaculture have focused on distribution only, whereas findings from Bais show that forest clearing for fish ponds has impacted mangrove species differently. Mangroves tend to be characterized by broad zonation patterns, with some species found only in the landward, less frequently flooded portions of the forest. These drier sites were usually targeted first for fish pond development. Drier-zone mangroves like *C. tagal*, *Bruguiera* and *Xylocarpus* spp. were once fairly common in Bais, as they still are in nearby areas not impacted by fishponds (B.B. Walters, personal observation 1997; Walters 2000*b*). Today they are mostly rare and some have been locally extirpated.

Ecologists have long appreciated that mangroves contract and expand over time in relation to changes in hydrology and sedimentation (Thom 1967; Saintilan & Williams 1999; Hogarth 2001). Seaward expansion is more likely in deltaic environments where inputs of terrigenous sediments are large (Thom 1967; Woodroffe 1982; Saenger & Siddiqi 1993). In Bais, explaining forest change along the coast likewise requires understanding land use change in the nearby mountains. While the causes of upland deforestation in Bais are similar to those in other parts of the country (Boado 1988; Bautista 1990), I am unaware of other studies that have shown an explicit link between these upland changes and rapid expansion of mangroves along the coast.

This study also shows striking cumulative effects of small-scale tree cutting and planting on mangroves. Most natural mangrove trees demonstrate evidence of prior cutting (B.B. Walters, personal observation 1997). Data presented in Table 5 are slightly misleading in this regard because they fail to account for the many individual trees that have multiple stems. Cutting rates per tree are thus much higher than indicated. In fact, selective cutting appears to have caused over 90% of stem mortality in existing forests (Walters 2000*b*).

But human influences on mangroves are often ambiguous (Barnes 2001). While they have cut many mangroves, people living in Bais and Banacon have also planted millions of mangrove trees under their own initiative during the last 50 years. As a result, both areas are now showcased as national success stories in community-based mangrove management by governments who have recently modelled reforestation programmes after them (see Yao 1987; Melana *et al.* 2000). Local planting and management of the *nypa* palm, *N. fruticans,* is commonplace in South-east Asia (Fong 1992), but there have been few documented cases of local planting of mangrove trees (Brown & Fischer 1918; Weinstock 1994), although local planting and management of other tropical forest types has been well documented (Hyman 1983; Balee 1989; Romm 1989; Gomez-Pompa & Kaus 1990; Redford & Padoch 1992; Fairhead & Leach 1996; Poffenberger *et al.* 1996; Pasicolan *et al.* 1997; Walters 1997). Reforestation and/or afforestation following land abandonment may eventually counteract the effects of deforestation in some regions (Thirgood 1989; Schneider 1996; Moffat 1998; Rudel 1998). In fact, mangrove planting is now widely promoted by governments and non-government organizations as a means to counteract forest loss (Thorhaug 1990; Saenger & Siddiqi 1993; ITTO 2002). In this regard, what insights might be gleaned from the experiences of Bais and Banacon Island?

Mangrove planting and management in Bais and Banacon today are being done for different reasons, but these practices emerged and have spread in response to growing resource scarcities, notably of construction wood, but also of land and firewood. As such, the emergence and spread of planting and management in both Bais and Banacon appear to conform, in general, to the induced intensification model of agrarian change, whereby resource scarcities stimulate social and technical innovations that improve production efficiency (Boserup 1965; Ruttan & Hayami 1984; Netting 1993; Cuffaro 1997).

Dramatic productivity improvements (in terms of bunsod post production) are obtained from plantations. Some planters indicated that they have more incentive to plant now because government cutting restrictions are pushing the price of bakau wood higher. Scarcity of mangrove resources is likely to continue growing in the future given population increases and the likelihood that regulations against cutting continue to be enforced or are strengthened. In contrast to many upland forests, however, environmental conditions greatly limit where people can plant mangroves and most of these sites have already been occupied. Unless new areas are created, for example, by reclaiming fish ponds as sites for restoration (Stevenson *et al.* 1999), it seems likely that increasing demands for bunsod posts can only lead to further intensification of existing plantations, not the creation of new ones.

However, further intensification of wood production from existing plantations is not inevitable. Bakeries were formerly the major commercial consumers of mangrove firewood, yet were quick to switch to alternative fuels when commercial firewood consumption and the concessions supplying this were banned in 1979. Today, most bakeries in the region use natural gas, and the few that still burn wood use upland tree species.

Resource substitution has similarly occurred among domestic firewood consumers in Bais. Most people living on Daco and Olympia Islands formerly cut firewood from the Talabong forest, but far fewer do so today due to government restrictions imposed in the early 1990s. Such cutting restrictions might have resulted in greater firewood harvesting from plantations. But instead, most households have responded to the restrictions by shifting to alternative fuels altogether, especially *ipil ipil* (*Leucaena leucephala*) and *palwa* (coconut tree fronds), which are readily available and relatively inexpensive. People who have plantations often prune branches, roots and dead stems for firewood, but they typically will not cut live stems for this purpose because it is viewed as wasteful, the live trees having greater value as construction wood or for storm protection. The greater market value of bakau posts makes it more likely that planters will increase their harvesting from plantations for this purpose, but the price of bakau is high now and still many plantation owners will not cut wood for sale out of fear that it might undermine the value of their plantations for storm protection. Inexpensive, albeit lower quality alternatives to bakau also exist for bunsod construction and many now buy these instead of paying high prices to mangrove plantation owners. Should cutting restrictions continue to drive the price of bakau wood higher, it is likely that most bunsod owners will shift to non-mangrove alternatives.

There is a possibility that the emergence and spread of private mangrove plantations as a form of intensive, intertidal land use is, itself, a transient phenomenon in Bais and Banacon, and one that will gradually be replaced by other more capital-intensive land uses. For example, the once extensive mangrove plantations found in Manila Bay in the early 1900s were subsequently replaced by fish ponds, settlements and port infrastructure (Brown & Fischer 1918; Cabahug *et al.* 1986). In Bais, many plantations have already been cut and converted to fish ponds or home sites, although this has not yet occurred on Banacon Island.

Many upland forests cover vast expanses of land that is often marginal for other uses and so is readily available for afforestation or restoration (Rudel 1998). By contrast, mangroves are highly constrained in distribution and competing land uses are only likely to grow in intensity along many coasts where mangroves are found. It is thus difficult to predict whether the various efforts to promote planting and protection of mangroves will ultimately win over pressures that lead to their cutting and clearing. And even if forests are sustained, findings from this study and results presented elsewhere (Walters 2000*a*) show that intensively managed mangroves are very different from natural forests. As such, measures of forest distribution done without regard to changes in species composition and structural complexity tell only part of the story.

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