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Are mangroves worth replanting? The direct economic benefits of a community-based reforestation project

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SUMMARY

Competition for coastal land use and overexploitation have reduced or degraded mangrove coverage throughout much of their distribution, especially in South-east Asia. Timber production was the initial motivation for early mangrove reforestation projects. More recently, benefits from protection against erosion and extreme weather events and direct improvements in livelihoods and food security are perceived as justifications for such restoration efforts. This study examines the socioeconomic impacts of a community-led reforestation project in the Philippines through a survey of the local fishers. Revenues from mangrove fisheries, tourism and timber result in an annual benefit to the community of US$ 315 ha^{-1} yr^{-1}. This figure is likely to be considerably more if the contribution of the mangrove to the coastal catch of mangrove-associated species is included. This estimate only includes direct benefits to the community from mangroves, and not intangible benefits such as coastal protection, which paradoxically is perceived by the community as one of the most important functions. More than 90% of all fishers, regardless of where they fished, thought the mangrove provided protection from storms and typhoons and acted as a nursery site and should be protected. Those fishing only in the mangrove perceived more benefits from the mangrove and were prepared to pay more to protect it than those fishing outside. This study concludes that replanting mangroves can have a significant economic impact on the lives of coastal communities. Acknowledgement of the value of replanted mangroves compared with other coastal activities and the benefits they bring to the more economically-vulnerable coastal dwellers should support better informed policy and decision-making with regard to coastal habitat restoration.

Keywords: carbon trading, fisheries, mangrove reforestation, socioeconomic analysis, timber, tourism

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INTRODUCTION

Although coastal communities and scientists have long realized the value of mangroves (Macnae 1968) policy makers have, until relatively recently, failed to recognize the range of services and products provided by intact mangrove forests (Farnsworth & Ellison 1997; Primavera *et al.* 2004; Barbier 2006). These attitudes have meant that competition for space with more 'profitable' concerns such as urbanization, agriculture and more recently aquaculture, as well as the overexploitation of forestry products and changes in water quality, have resulted in worldwide losses of approximately 33% by area in 50 years (Alongi 2002). Appreciation of the services and products provided by mangroves has been growing. Mangroves have been valued at US$ 9900 ha^{-1} yr^{-1} of which only 6.3% was from fisheries and raw materials (timber), with the majority of the assigned value being attributed to disturbance regulation and waste treatment functions (Costanza *et al.* 1997). Acknowledgement of the protective role of mangroves after the recent Asian tsunami has also increased governments' awareness of mangrove benefits (Dahdouh-Guebas *et al.* 2005; Danielsen *et al.* 2005; Kathiresan & Rajendran 2005; Barbier 2006).

Spurred by realization of their value and increasing environmental concerns, much effort has gone into rehabilitating degraded or deforested mangrove areas (Saenger & Siddiqi 1993; Field 1998; Kaly & Jones 1998; Alongi 2002). However, most replanting uses one or two mangrove species (Alongi 2002) and, in the Philippines, this has resulted in monogeneric stands of the economically valuable and easily-planted *Rhizophora* spp. (Walters 2000, 2004; Primavera *et al.* 2004). While there have been some studies of faunal recruitment into replanted mangroves (Al-Khayat & Jones 1999; Macintosh *et al.* 2002; Bosire *et al.* 2004; Crona & Ronnback 2005), it is not yet clear whether such reconstructed habitats fulfil the same ecological services as natural intact mangrove. The current study highlights the lack of information on the effectiveness of replanting mangroves in providing livelihoods to the surrounding populations. While other studies have focused on the benefits of timber products from replanted mangroves (Walters 2000, 2003, 2004, 2005*a*, *b*), the objective of the current study was to examine all economic benefits, including fishery landings, associated with a restored mangrove forest using a socioeconomic survey. To our knowledge, this is the first attempt to do so. A questionnaire-based technique was employed instead of direct use of landings statistics, as fishing at this site is nearly all by individuals and most of the catch is either not sold or goes unreported.

Study site

The present study site was selected as an example of successful mangrove reforestation and focused on a replanted mangrove situated at the mouth of the Aklan River, in the Aklan province of Western Visayas, Panay Island, Philippines. The mangrove is geographically isolated from other mangrove areas, the nearest being a 73-ha basin mangrove 20 km north-west of the study area, although there are some small patches of 1–5 ha approximately 10 km distant. The study area was well known to us through mud crab fisheries studies over the previous three years and good links were already developed with the community (Walton *et al.* 2006). The mangrove was replanted on mudflats once thickly forested with mangrove but where exploitation for firewood and building materials had left only a few isolated trees (DENR [Philippines Department of Environment and Natural Resources] Undated). The aim of the reforestation was to stabilize the shoreline, decrease sedimentation offshore and increase fish stocks and wood production.

The mudflat was initially planted in 1990 with 45 ha of *Rhizophora* spp. and 5 ha of *Nypa fruticans* by a cooperative of 28 local families (KASAMA [Kalibo Save the Mangrove Association]). An additional 20 ha of *Rhizophora* spp. was planted in 1993 (Primavera 2004). Pest damage to the plantation in 1997 was followed by infilling of naturally-recruited *Avicennia marina* and *Sonneratia alba*. Recent mapping of the mangrove forest suggested that although the area of *Rhizophora* spp. has decreased to 43 ha, natural recruitment had increased overall mangrove cover to 75.5 ha (Fig. 1). An ecotourism park constructed by the non-governmental organization USWAG (United Services Welfare Assistance Group) using Australian funding (AusAid) employs local staff to maintain a one kilometre walkway through the mangrove forest and to operate refreshment areas. Cooperation between KASAMA, USWAG and local government was instrumental in the success of the project. Also crucial was the awarding of land tenure rights in 1994 to KASAMA by the DENR, which has enabled protection of the resource. Recently the FAO (Food and Agriculture Organization of the United Nations) cited the Buswang mangrove as an example of excellence in forest management (Cadaweng & Aguirre 2005). At the time of the study, the mangrove had open-access fishing rights and was used by fishers from the five surrounding municipalities.

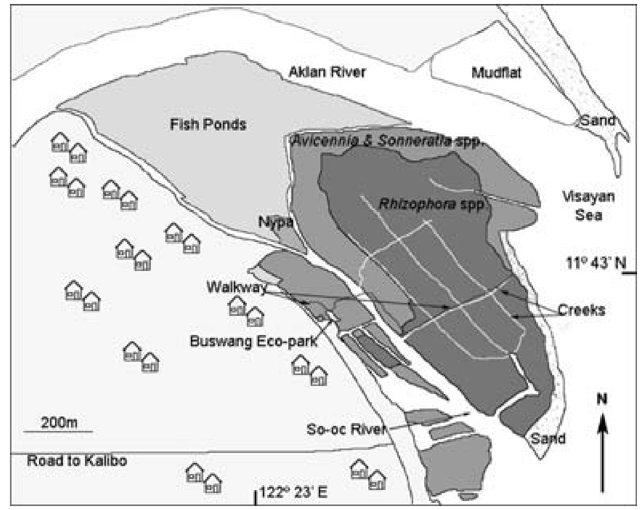

Figure 1 Map of the Buswang replanted mangrove forest in 2004 (houses represent part of the surveyed settlement area) situated at the mouth of the Aklan River, Panay, Philippines.

METHODS

A questionnaire was designed to assess the value of fisheries activities and the attitudes and socioeconomic background of the fishers. In Section 1, respondents were asked open-ended questions regarding the area fished, the gear used, the amount of fish and shellfish landed per trip, selling price per kg, boat ownership (if one was used) and sharing of catches. The second page asked in more detail about the average number of kg of each species landed per month. In Section 2, respondents were asked open-ended questions about the frequency, income and expense of their fishing/gleaning activities during the lean and peak months, as well as information on other income and how they earned it. Section 3 asked Yes/No questions on mangrove benefits and their willingness to pay (WTP) was assessed in three ways. The interviewees were presented with a choice of mangrove benefits and asked if the replanted mangroves needed to be protected and whether they would pay to protect the mangrove to prevent hypothetical encroachment from pond developers and, if not, why. They were asked in an open-ended scenario question whether the government should sell the mangrove for conversion to aquaculture ponds and, if so, for how much. They were also asked whether they themselves would sell the mangrove forest, if they owned it, and for how much. Section 4 of the questionnaire assessed the socioeconomic profile of the fishers.

A pilot study was conducted to help refine the questionnaire. After an initial training session, interviews by four enumerators were observed for one day to standardize interview technique. For the first two weeks, daily debriefing sessions were held with the enumerators to identify problems during the survey. Each face-to-face interview with the fisher and family was conducted over half an hour in the local Aklanon dialect. The respondents were assured of neutrality and complete anonymity. Initially, the local councillors from each *barangay* (village or municipality) introduced the enumerators to all the known fisherfolk in each of the five surveyed barangays that surround the mangrove. At the end of each interview, the respondents were asked to name six

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other people who fished or gleaned in the mangrove. Once the enumerators could no longer find new fishers to interview, they moved to the next barangay. In this way it was assumed that almost all fishers were covered in the sampling ($n = 241$).

The fishers were classified into four groups: (1) mangrove only, those who only used the mangrove including the creeks ($n = 55$), (2) mangrove +, those who fished in the mangrove area and in other areas ($n = 52$), (3) shoreline, those who fished on the shore including the estuary, shoreline and shallow sub-tidal fishery up to 100 m beyond the mean low water spring tide level ($n = 38$), and (4) coastal, those who only fished just offshore, including all fishing more than 100 m beyond mean low water spring tide level ($n = 64$). Fishers who worked on other peoples' boats and were already included in the fishery survey and those that fished coastally and on the shoreline were excluded from further analysis ($n = 32$). The species caught were grouped taxonomically by phylum (molluscs) or by family (fish). Crustaceans were split into the swimming crabs excluding *Scylla* spp. (Portunidae), the mud crabs (*Scylla* spp.) and the prawns (Penaeidae).

The yes/no responses to the perceived mangrove benefits were binary coded and subjected to multivariate analysis using PRIMER (Clarke & Warwick 2001). Responses were first subjected to similarity analysis using the Bray-Curtis index. The resulting similarity matrix was used to produce a MDS (multi-dimensional scaling) plot. Differences in responses to the perceived mangrove benefits between the groups of fishers using the four a priori selected areas were analysed using a one-way analysis of similarity (ANOSIM) (Clarke & Green 1988) with fishing area as the factor in the similarity matrix, the R statistic giving a measure of differences in response among groups. A Bonferroni adjustment was made to control family-wise error rates.

A simple one-page survey asked 93 ecotourist visitors 13 open-ended questions in Tagalog and English, where they had travelled from, how many times they had visited and how large their group was. They were also asked how much they had spent on travelling there and on food, and how much extra they were willing to pay and if not why not. Their sex, age and education level were recorded. The survey took place during July–September, a period including public and school holidays. Information on annual visitor numbers was obtained from the operator's record books as all eco-park visitors are required to sign in. As mangrove thinning had only recently been initiated, harvest rates were extrapolated from test cutting of sample areas of mangrove (*c*. 1 ha) conducted by KASAMA to estimate market value. All income from timber sales was paid to KASAMA, who paid their own members to harvest the wood. Thus, all income was accrued by KASAMA members. Timber and propagule revenues were obtained from KASAMA.

RESULTS

Of the 4550 households in the five barangays, 241 families were identified as fishing or gleaning. Of those, 113 people fished or gleaned within the mangrove to supplement income or food supply supporting 465 family members.

Table 1 Summary of net annual fisheries revenues and expenses (US$) and catch (kg) from the mangrove, shore and coastal fishing locations.

Fishing area	*Net revenue (US$)*	*Expenditure (US$)*	*Annual catch (kg)*
Mangrove	16 057	835	21 555
Shore	104 219	34 444	98 585
Coastal	205 368	103 300	232 563
Total	326 187	138 579	352 702

The respondents identified 91 species that were fished or gleaned in the mangroves, on the adjacent shoreline or coastally. The catches from the coastal fisheries formed the greatest proportion of the total annual catches landed in the surveyed sectors both by weight (66%) and by value (63%) (Table 1). Shoreline catches formed 28% by weight and 32% by value and the mangrove fisheries formed 6% of the catches by weight and 5% by value. Although the dominant taxonomic families by weight were Scombridae and Clupeidae (Fig. 2), the Scombridae and Carangidae were of greater economic importance, composing 42% of the landings by value, the majority of which were caught in the coastal fisheries.

Within the mangroves, the gleaning of molluscs formed the greatest percentage by weight of the landings (111 kg ha^{-1} yr^{-1}) but the high-value *Scylla* spp. returned the greatest income of US\$ 99.8 ha^{-1} yr^{-1} (US\$ 1 = 54.66 PhP or Philippine Pesos). Some animal taxa were found exclusively in the mangrove forest including the Grapsoidea and Sergestidae, as were some species of Mollusca, including *Polymesoda erosa* and *Terebralia sulcata* (Fig. 3). Other animal taxa, including *Scylla* spp. and the penaeids (including *Penaeus monodon*), were caught mostly in the mangroves and on the shoreline. The total landings from the 75.5 ha mangrove forest represent a harvested biomass of 294 kg ha^{-1} yr^{-1}, a net value of US\$ 213 ha^{-1} yr^{-1} and an annual income for these districts of US\$ 16 057. However, only 50% of that was sold, the rest being consumed. There was no correlation between the percentage consumed of each species and its market price (Pearson's correlation coefficient $= -0.189$, $p = 0.317$). Only 5% of the gross return from gleaning was expended on consumables including bait and materials (Table 1). The mean time spent gleaning per trip (±SE) was 3.5 ± 0.4 hours with a mean number of visits of 44.2 ± 5.4 yr^{-1}. Expenses in coastal and shoreline fisheries were much higher at 50.3% and 33.1%, respectively (Table 1).

Most fishers (95% on average) thought that the mangrove acted as a barrier against typhoons and storms and similar numbers thought that mangrove forests act as nurseries for juvenile fish and crustaceans and molluscs (Table 2). However, only 73% on average thought that mangroves directly increased fisheries catches. Generally the group that fished only in the mangrove (Group1) perceived more benefits

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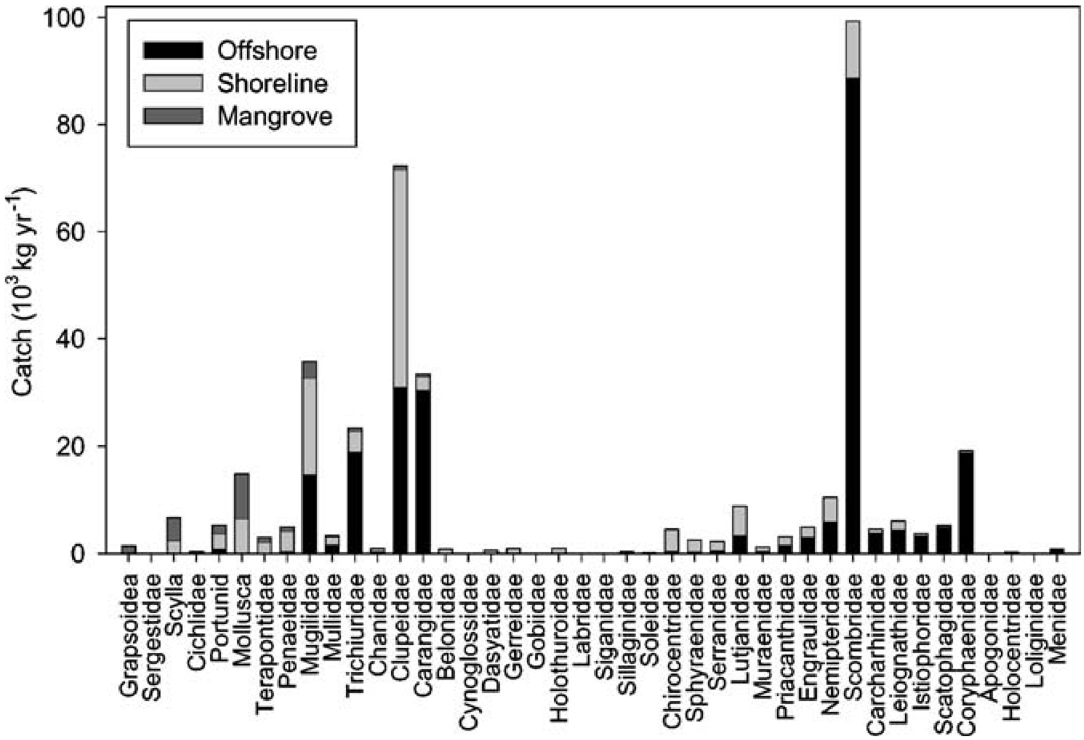

Figure 2 Catch (kg yr^{-1}) by taxon caught at each location. The locations include catches within the mangrove, on the shoreline (including catches from outside the mangroves but within 100 m offshore of mean low water springs) and coastal offshore catches (greater than 100 m offshore of mean low water springs).

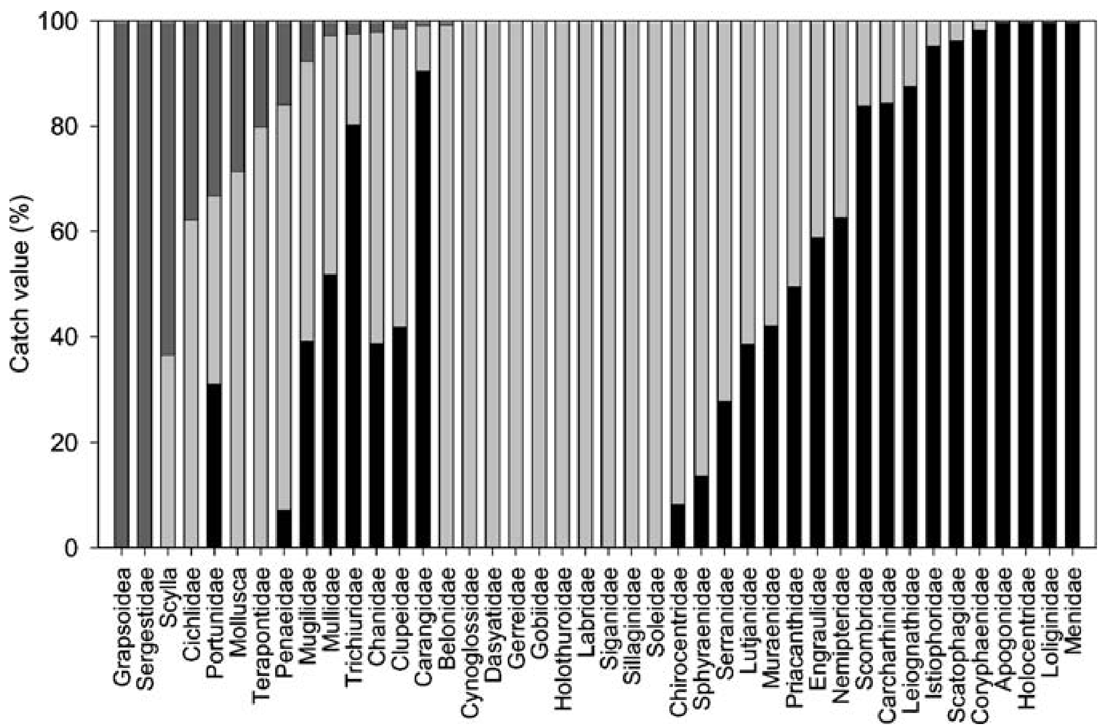

Figure 3 The percentage net value by taxon caught at each location. The locations include catches within the mangrove (dark grey fill), on the shoreline, including catches from outside the mangroves but within 100 m offshore of mean low water spring tide level (light grey fill), and coastal catches from greater than 100 m offshore of mean low water springs (black fill).

Table 2 Perceived benefits (% of positive responses), willingness to protect the mangrove (%), willingness to pay for mangrove protection and average income (US$) for the four groups of fishers. Mangrove = those that fish in the mangrove only, Mangrove+ = those that fish the mangrove in conjunction with other habitats, Shore = those that fish the shoreline only, and Coastal = those that fish coastal areas only.

	Mangrove	*Mangrove+*	*Shore*	*Coastal*	*All*
Perceived benefits (%)					
Increases fishing	81	82	79	56	73
Nursery site	97	94	86	88	91
Acts as a barrier against storm damage	100	97	93	90	95
Increases biodiversity	84	85	79	63	77
Acts as sediment trap	84	82	86	61	77
Willingness to pay and protect and income					
% who want to protect the mangrove	100	100	97	95	98
Annual mean donation offered (US$)	7.92	4.01	2.27	2.38	4.00
Annual mean income (US$)	1090	1446	1789	1346	1427

from the mangrove and were prepared to pay higher sums to protect it, even though the mean salary of this group was the lowest. Multivariate analysis was used to examine differences in the perceived mangrove benefits to the four user groups. MDS plots based on similarities produced by cluster analysis using the Bray-Curtis index of similarity (Fig. 4) and a subsequent ANOSIM test suggested significant differences in perceived benefits ($R = 0.497$, $p < 0.001$). Significant differences between all groups were revealed in adjusted pairwise comparisons ($p < 0.006$). Fishers that only gathered food in the mangroves (Group 1) earned significantly less than those fishing on the shoreline (Group 3) but not significantly less than those fishing coastally (Group 4) or those fishing both in the mangroves and elsewhere (Group 2) (Kruskal-Wallis $H = 10.48$, $df = 2$, $p = 0.005$) (Table 2). Tellingly, the amount offered to protect the mangrove by Group 1 (mangrove only) was 0.7% of their estimated annual earnings, compared with 0.13% and 0.15% offered by Group 3 (shoreline only) or Group 4 (coastal only), respectively. Analysis of variance suggested there was no difference ($p > 0.5$) between the mean numbers of fishers in each group that would either oppose the government if it wanted to sell the mangrove for pond development (93.5%) or not sell the mangrove for profit for pond development if they were hypothetical owners (92.4%). Of those 6.5% who thought the government should sell the mangrove, the median valuation was US$ 12 806 ha^{-1}, compared to US$ 18 295 ha^{-1} by the 7.6% of fishers who would sell it themselves.

In 2004, *c.* 17 000 people visited the 75.5 ha Buswang Ecopark, each paying US$ 0.18, generating a total income of US$ 3059 or US$ 41 ha^{-1} yr^{-1}. A total of 93 respondents completed the Ecopark questionnaires. Of those only 53 were from separate groups. Foreigners made up 10.5% of the visitors. The mean return travel cost to the Ecopark was US$ 0.62. The mean expenditure was US$ 0.11 $visitor^{-1}$. Sixty-six per cent of visitors were prepared to pay more than the current entrance fee, 80% of these were prepared to pay $ 0.36 US. Only 4% of visitors indicated their reluctance to pay more.

Income generated through mangrove propagule sales depended on demand but was generally very small. In 2003, only 1900 propagules were sold, raising US$ 20.87. In January 2004, 1580 propagules were sold. Until recently, harvesting of timber was not permitted owing to laws that prevented mangrove cutting (Primavera *et al.* 2004). However, thinning has now begun and test cutting (*c.* 1 ha) suggests timber harvest rates of 200 m^3 ha^{-1}, selling at US$ 4.47 m^{-3}. This represents a gross income of US$ 894 ha^{-1} for KASAMA as the thinning is carried out by KASAMA members under contract for KASAMA. The mangrove was planted in 1990, thereby giving an average annual income over the 15 years from timber sales of US$ 60 ha^{-1} yr^{-1}.

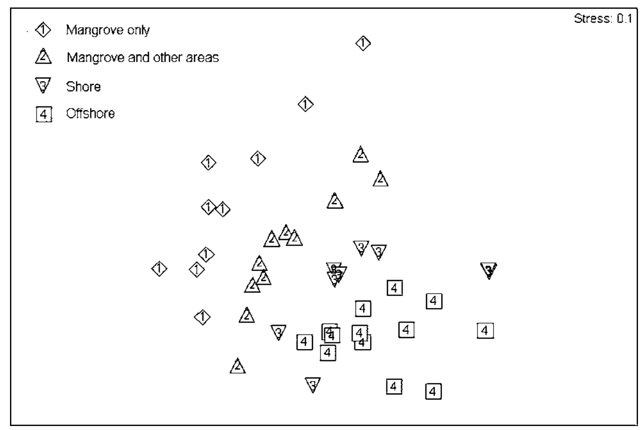

Figure 4 Multidimensional scaling (MDS) plot of the positive responses to the different perceived benefits of the mangrove (increases fishing, acts as a nursery site, acts as a barrier against storm damage, increases biodiversity, acts as a sediment trap) to the four user groups.

DISCUSSION

The exact contribution of mangroves to fisheries landings is notoriously hard to estimate. Previous studies have suggested the value of mangrove to fisheries to be between US$ 70 ha^{-1} (Ron & Padilla 1999) and US$ 13 223 ha^{-1} (Ronnback 1999) adjusted to 2005 values using the USA consumer price index (Costanza *et al.* 1997). There are various reasons for the discrepancies between studies, including differences in productivity of different mangrove systems, difficulties in

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assessing the proportion of coastal fisheries that rely on presence of mangroves, and difficulties in monitoring the landings in coastal and mangrove fisheries. The current study approaches the problem from a different perspective by using interviews with fishers. This approach may be open to different sources of error, such as inaccurate reporting. However, for one data subset (catches of *Scylla* spp.) comparison with quantified landings was possible (Walton *et al.* 2006) and indicated that questioning tended to underestimate actual catches by only 12–14%. Fisheries studies have suggested there was a decline in relative abundance of mud crabs, possibly indicating short-term impacts of overexploitation or recruitment limitation (Walton *et al.* 2006). However, recently mud crab catches have recovered (M. Walton, unpublished data 2005).

In estimating the value of fisheries that are dependent on the mangrove, the most reliable data are for those species that are not caught outside the mangrove. These are valued at this study site at US$ 24 ha^{-1} yr^{-1}, of which 76% is from molluscs (197 kg ha^{-1} yr^{-1}). This compares favourably with the standing stock of various species of edible molluscs in the natural mangroves of Bais Bay (Negros Oriental), which was estimated at 70–1400 kg ha^{-1} wet weight (Alcala & Alcazar 1984). Inclusion of all species caught within the replanted mangrove increases the valuation to US$ 213 ha^{-1} yr^{-1}, of which landings of mud crabs and penaeid prawns contributed 50%.

Mangroves are widely thought to contribute to coastal fisheries production either by acting as a food source (directly or indirectly) or as a nursery owing to their high productivity and complex structure (see reviews by Hogarth 1999; Kathiresan & Bingham 2001). Beck *et al.* (2001) suggested that nursery habitats should contribute more to the adult population than other areas through enhanced densities, growth and survivorship of juveniles and disproportionate recruitment into the adult population. Several studies have demonstrated increased densities of juveniles in mangroves compared to other habitats (Chong *et al.* 1990; Robertson & Duke 1990; Vance *et al.* 1990; Nagelkerken & van der Velde 2002; Lugendo *et al.* 2005). Others have demonstrated improved survival of juvenile fish and prawns in natural and experimental mangrove habitats (Robertson & Duke 1990; Laegdsgaard & Johnson 1995; Macia *et al.* 2003). Mangroves are also thought to improve feeding rates of small fish (Laegdsgaard & Johnson 1995) and increase growth rates (Robertson & Duke 1990), and have been shown to contribute to stocks of fish in coral reefs (Mumby *et al.* 2004). Some caution is needed in quantifying the significance of such contributions to coastal fisheries as mangrove area may be co-correlated with a number of other variables such as length of coast line, rainfall, intertidal area and tidal amplitude (Lee 2004) or confounding factors like non-standardized fishing effort (which varies with fishing gear and fish species) and mismatch between catching and landing sites.

The contribution of mangroves to subsistence fisheries has been estimated to be 10–90% (Nickerson 1999; Ronnback 1999). Using the most cautious estimate of a 10% contribution by fish families that are associated with mangroves (Ronnback 1999) gives an estimated annual value of the replanted mangrove to the shoreline and coastal fisherfolk of US$ 250 ha^{-1} in the present study. However, Singh *et al.* (1994) (cited in Ronnback 1999) estimate that for ASEAN (Association of South-east Asian Nations) countries the mangrove contribution to mangrove-associated species caught in coastal fisheries is 30% for fish (= US$ 703 ha^{-1} in the current study) and 100% for penaeid prawns (=US$ 100 ha^{-1} in the current study). Recent studies have shown the dependence of juvenile stages of *Scylla olivacea* on the replanted mangrove (Walton *et al.* 2006), so that the value of coastal fisheries for this species (US$ 57 ha^{-1}) should also be included. Thus, the replanted mangrove is worth US$ 860 ha^{-1} to the fisheries outside the mangrove area and 1207 kg ha^{-1} yr^{-1} to total fisheries production, a value of US$ 1073 ha^{-1} both within and outside its boundaries using aforementioned percentage contributions.

It is not unreasonable to assume that the contribution of the Buswang mangrove to adjacent coastal fisheries is considerable, as it represents the only significant area of mangrove within 20 km. In the Philippines, up to 80% of the coastal catches of all mangrove-associated species are thought to be dependent on mangroves (Nickerson 1999). Applying this estimate would increase the proportion of the shoreline and coastal fisheries production attributable to the Buswang mangroves to 2204 kg ha^{-1} yr^{-1} or US$ 2002 ha^{-1} yr^{-1}. Figures from the Philippines Bureau of Fisheries and Aquatic Resources in 2003 suggest that mean production from brackish-water ponds in the Philippines is 244 999t yr^{-1} from approximately 230 000 ha of ponds (Primavera 2005) resulting in a productivity of 1065 kg ha^{-1} yr^{-1}. This suggests that the productivity attributable to mangroves can be equivalent to that of brackish-water ponds.

Revenues from the Buswang Ecopark averaged US$ 41 ha^{-1}, although more than half the visitors were prepared to pay twice as much in entry fees and only 4% objected to price increases. Propagule collection is worth very little per hectare but is probably financially important to those engaged in the collecting. The timber exploitation rate in Buswang (13.3 t ha^{-1} yr^{-1} with a value of US$ 59.6 ha^{-1}) is similar to that of the Matang mangrove in Malaysia where 17.4 t ha^{-1} yr^{-1} of mangrove wood are harvested sustainably (Gan 1995 cited in Tipper 2002).

The survey suggests a total value of US$ 564–2316 ha^{-1} is entering the local community from the mangrove each year. This may be an underestimate, as occasional and non-resident users of the mangrove that glean for molluscs, such as oysters and clams, are likely to be under-represented. The value of food security to the population is difficult to assess, but may be especially significant to the more vulnerable, poorer sections of the community. Estimations of frequency for gleaning often included comments such as 'when we have no food' or 'when I have no work' suggested the mangrove was used as an important emergency food store for much of the population.

In Mexico, some farmers have sold credits for sequestered carbon resulting from a reforestation project to the International Federation of Automobiles (USA), for US\$ 10–12 t^{-1} carbon (Eong 1993). *Rhizophora* plantations are known to sequester up to 15 t ha^{-1} yr^{-1} carbon annually, another 1.5 t ha^{-1} yr^{-1} carbon being trapped in the soil (Hogarth 1999; Kathiresan & Bingham 2001; Alongi 2002). Thus, in the future sale of carbon credits for a reforestation project such as Buswang may be valued at US\$ 163–198 ha^{-1} yr^{-1}.

The mangrove replanting was done purely on a volunteer basis, however there is currently further replanting being performed that can enable an estimation of the cost of planting a hectare of *Rhizophora* spp. In the new reforestation area, workers were paid 1 PhP per propagule for planting, propagules cost 1 PhP each and the stake which supports the propagule cost 0.6 PhP. The density of planting was 4444 propagules per hectare, resulting in a cost of 11 554 PhP ha^{-1} or US\$ 211 ha^{-1}.

The interviewed fishers' attitudes to the mangroves were closely related to their dependence on the forest. Those who fished exclusively in the mangrove perceived greater benefits than the shoreline and coastal fishers, and were prepared to pay more toward protection. Moreover, more than 90% of this group would not sell the mangroves if they owned them and slightly more would not want the government to sell them. The price (US\$ 18 295 ha^{-1}) offered by those that wanted to sell was at the lower end of the scale of agricultural land in the Philippines (US\$ 9000–90 000 ha^{-1}). This low price highlights the low value that many people place on mangroves because of lack of education. However, this cannot be taken as the willingness to accept value (WTA), as the majority would not sell, suggesting an attachment that was worth more than money.

The economic evaluation of the Buswang mangrove shows that the services rendered are at least equivalent and frequently greater than those cited for natural mangroves (Costanza *et al.* 1997). This suggests that mangrove replanting can be successful in replacing at least some of the services of natural mangroves. These have been valued up to US\$ 13 320 ha^{-1} yr^{-1} including US\$ 8928 ha^{-1} yr^{-1} for waste water treatment and US\$ 2452 ha^{-1} yr^{-1} for disturbance regulation, adjusted to 2005 values using the USA consumer price index (Costanza *et al.* 1997). However these higher valuations should be treated with caution in the context of Philippine mangroves, as these valuations may simply reflect differences in the cost of living and land prices. The 2004 Asian tsunami has emphasized the protective value of mangroves (Dahdouh-Guebas *et al.* 2005; Danielsen *et al.* 2005; Kathiresan & Rajendran 2005; UNEP [United Nations Environmental Programme] 2005), although there is some debate on the protection function of coastal vegetation from large tsunamis (Kathiresan & Rajendran 2006; Kerr *et al.* 2006). A study in Orissa (India), demonstrated that mangroves also protect against typhoons, a more frequently occurring phenomenon; households protected by mangroves suffered 78% lower costs associated with typhoon damage than unprotected households and 24% less than those protected by a dyke (Badola & Hussain 2005). Studies elsewhere in the Philippines have shown that villagers have long recognized the protective value of mangroves and often replant mangroves to protect coastlines (Walters 2003, 2004). The protection function of mangroves appears now to be fully appreciated by policy makers, as several governments have revealed plans for extensive mangrove reforestation since the Asian tsunami in 2004 (Barbier 2006).

CONCLUSIONS

The current study only includes goods and services that directly benefit the local community economically. Undervaluation of mangroves is one of the primary reasons driving the conversion of mangroves to other land uses. This study suggests that fish production related to replanted mangrove was 578–2568 kg ha^{-1} yr^{-1} (US\$ 463–2215 ha^{-1} yr^{-1}), which can equal that of brackish-water aquaculture ponds. The replanted mangrove also supplied additional services providing an income from tourism of US\$ 41 ha^{-1} yr^{-1} and from sustainably-harvested timber of US\$ 60 ha^{-1} yr^{-1}. Therefore the total direct economic benefits from the replanted mangroves was US\$ 564–2316 ha^{-1} yr^{-1} depending on what percentage of the coastal and shoreline catches of mangrove-associated species were attributable to the replanted mangrove (10–80%). The initial planting costs were estimated at US\$ 211 ha^{-1}. This is a relatively small cost compared to the returns, especially if depreciated over the project lifetime (US\$ 211 over 15 yrs = US\$ 14 yr^{-1}). However, it represents a significant capital cost in the context of average household income in the community, illustrating the need for some initial external funding for such initiatives. The most widely recognized benefits of this replanted mangrove were coastal protection and the nursery function, which may account for the high percentage (98%) of the interviewees who wanted to protect the mangrove and the small percentage that wanted to sell. After the 2004 tsunami, the current study provides timely support for arguments in favour of reforestation by demonstrating that replanted mangroves can be as productive as natural mangrove and can have seafood production equivalent to the brackish water ponds, thus having an important role in ensuring food security. These additional services make mangroves the best of the coastal reforestation options rather than less effective sand-binding vegetation such as *Casuarina* or coconut plantations.

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