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NEWS AND VIEWS

Illuminating the need for ecological knowledge in economic valuation of mangroves under different management regimes — a critique

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Abstract

This is a commentary on a paper by Gilbert and Janssen (Gilbert, A.J., Janssen, R., 1998. Ecol. Econ. 25, 323–346) that deals with valuation of management alternatives for the Pagbilao mangroves, Philippines. Our main critique focuses on the undervaluation of fisheries as well as the inability to quantify the value of ecological services and internalize aquaculture's environmental costs. In addition, the sustainability criteria set up for the aquaculture management alternatives is open to debate. These weaknesses affect the result of Gilbert and Janssen's analysis so that the value of the unexploited mangrove forest is underestimated, and the value and sustainability of converting the forest into aquaculture ponds are overestimated. If applied to decision-making, the erroneous results from this partial cost–benefit analysis may have dire consequences for the mangroves and coastal communities of Pagbilao.

Keywords: Mangrove ecosystems; Economic valuation; Fisheries; Ecological services; Sustainable aquaculture

1. Introduction

Mangrove areas in the Philippines have declined from about 500 000 ha in the early 1900s (Brown and Fischer, 1918) to 117 700 ha in 1995 (Anonymous, 1998). This decline has been caused by overexploitation for fuelwood and conversion to agriculture, salt beds, settlements and industry. But the major factor is aquaculture, accounting for half the loss of 279 000 ha of Philippine mangroves from 1951 to 1988 (Primavera, 1995).

The socio-economic impacts of the massive destruction of Philippine mangroves (Primavera 1993, 1995; Nickerson, 1999) highlight the importance of valuation studies such as those by Gilbert and Janssen (1998) — 'Use of environmental

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functions to communicate the values of a mangrove ecosystem under different management regimes'. The paper aims to demonstrate the integration of physical performance of the mangrove ecosystem with its economic efficiency. Although Gilbert and Janssen thoroughly describe the environmental functions of mangroves, they base their valuation of management alternatives for the mangroves (i.e. the principal component in their analysis) on incomplete ecological knowledge. This becomes obvious in their valuation of fisheries, aquaculture and ecosystem services. Furthermore, the sustainability criteria used for the aquaculture management alternatives are questionable. These weaknesses affect their analysis so that some management alternatives are significantly underestimated and others overestimated. Consequently, the economic value of preserving the Pagbilao mangroves is low compared to the policy alternatives with the highest economic values, i.e. semi-intensive milkfish and intensive shrimp aquaculture. We cannot support this result for reasons described in this commentary (see also Table 1). In our critique we have minimized reference to the unpublished background reports, but need to cite them directly in some cases, simply because that nowhere in its 24 pages can the reader check the accuracy of Gilbert and Janssen's calculations.

Table 1
Main critique and suggestions for improvement (in italics) to a paper by Gilbert and Janssen (1998) that deals with valuation of management alternatives for the Pagbilao mangroves, Philippines[a]

Fisheries
Productivity estimates do not include stock assessment and are based on incomplete field samples.
Very high harvesting cost (87.75%) assumed for all fisheries. *Use 0–10% cost for onsite fisheries. Revised net value for onsite fisheries is P10 800–12 000 per ha mangrove.*
Offshore fisheries, coastal seascape interactions, shrimp trawl bycatch and onsite mollusc gathering are not recognized nor valued. *Use previous valuation efforts or estimate new context-specific values. The annual gross value of, e.g., offshore shrimp and finfish fishery supported by one ha mangrove can be estimated to P37 800–87 300.*
Ecological Services
Ecological services are not valued and consequently the opportunity cost of lost services is ignored in the case of mangrove conversion. *Use previous valuation efforts or estimate new context-specific values.*
Erroneous assumption that the mangrove waste disposal service cannot be attributed a value because water pollution is not a problem at present.
Aquaculture
The external costs to society of the wastes released by aquaculture are not accounted for. *Apply the polluter-pays principle and let the aquaculture operations bear their external costs.*
The risk of self-pollution and subsequent collapse of aquaculture systems is not acknowledged. *Reduce the overcrowding of ponds by performing major revisions of the mangrove forest area that can be converted to sustainable aquaculture*

[a] US$1 = P25.

We agree with Gilbert and Janssen that ecologists sometimes communicate their knowledge inadequately and that further research is needed on approaches for valuing ecosystem services. We oppose, however, that based on insufficient ecological information and erroneous assumptions Gilbert and Janssen refrain from valuing many goods and services. Since they account for the foregone benefits of not converting mangroves into, for example, aquaculture ponds, but only partially cover the foregone benefits of not preserving the mangroves, their analysis becomes biased. Unfortunately, Gilbert and Janssen chose not to address this shortcoming, which otherwise could have triggered an interesting debate on resource valuation as the basis for management plans and policy decisions. For instance, we must expand the concept of economic valuation to also include sustainability aspects and fairness of revenue distribution (only briefly discussed by Gilbert and Janssen), and not focus entirely on economic efficiency (Costanza and Folke, 1998). We invite Gilbert and Janssen to elaborate on these aspect in a potential response to this commentary.

2. Capture fisheries

For fisheries valuation our main critique focuses on the very high harvesting cost assumed for all fisheries and the exclusion of some

fisheries. We also criticize the methodology used to estimate fish and shellfish productivity. Fishery surveys did not include stock assessment, and calculations for mangrove fish number and biomass were based on samples lacking in temporal and spatial replication. Therefore, extrapolation in time (from only two sampling dates to 1 year) and space (from one waterway to the whole forest area) is not valid.

2.1. Onsite fisheries

Mangrove onsite fisheries (mainly mudcrabs) comprise 98.8% of total fisheries revenues (Ong and Padilla, 1997). Gilbert and Janssen (p. 337) assume that 87.75% of the landed price of fish covers the harvesting costs and 12.25% represents the in situ value. This harvesting cost is based on the 1996 National Statistical Coordinating Board report on Philippine marine fishery resources, which in turn used data from the 1989 Annual Survey of Establishments (National Statistics Office, 1992). Of the total 207 fishery establishments surveyed in the latter report, the majority (47.3%) were fish farms (aquaculture), 40.1% combined ocean (commercial), coastal (municipal/artisanal) and inland (freshwater) fisheries, and 12.6% other fishery activities. The following deductions (from the gross value of fishery products) that comprise most of the 87.75% 'harvesting costs' are applicable to aquaculture or commercial fisheries, but not to mangrove onsite fisheries: 27.5% materials and supplies, 23.2% fuel, and 22.2% employee compensation. The harvesting cost in mangrove onsite fisheries probably ranges from close to zero (Naylor and Drew, 1998) to not more than 10% of landed value. Based on a 0–10% harvesting cost the revised computation of the annual value of mangrove onsite fisheries is P10 800–12 000/ha mangrove under the preservation alternative.

2.2. Offshore fisheries

Gilbert and Janssen fail to recognize the mangrove support to offshore fisheries by describing it as 'minimal' (p. 336). Positive correlations between offshore fisheries yield and amount of mangroves in the nursery area have been demonstrated throughout the tropics (Pauly and Ingles, 1986; Camacho and Bagarinao, 1987; see also a review by Rönnbäck (1999)) although the effects of open access conditions and level of fisheries exploitation have often been overlooked. Barbier and Strand (1998) calculated that the deforestation of each hectare of mangrove resulted in an annual loss of US$1400 in revenue from Mexican penaeid shrimp fisheries alone. In the Philippines one hectare of mangrove has been estimated to support a shrimp fishery production of 130–350 kg/year (Pauly and Ingles, 1986). The yearly production of finfish supported by each hectare of mangrove has been estimated at 550 kg (Gedney et al., 1982) and 900 kg (Rönnbäck, 1999). Although the mechanisms behind such correlations remain unclear, ecologists are shifting focus from detrital and nutrient export to the nursery function of mangroves in providing food and shelter to juvenile fish and shrimp (e.g. Primavera, 1996, 1997; Rönnbäck et al., 1999). Rather than negate the existence of the mangrove–fisheries connection, the paucity of ecological data demonstrates the need to apply the precautionary principle.

Assuming a harvesting cost of 87.75% (National Statistical Coordination Board, 1996) and market price of P185/kg for shrimps (Gilbert and Janssen, 1998) and P25/kg for fish, the annual value of mangrove offsite fisheries ranges from P4600 to P10 700/ha under the preservation alternative. The revised annual combined value of onsite and offshore fisheries — P15 430 to P22 700/ha mangrove — under the preservation alternative is 10–15 times the value (P1490) estimated by Gilbert and Janssen (Table 3, p. 338). Nickerson (1999), who also worked with trade-off analysis in the Philippines, estimated an even higher fisheries value for the mangroves in Lingayen Gulf. Even assuming Gilbert and Janssen's high harvesting cost of 87.75% for all fisheries, the net fisheries value still amounts to P65 540/ha mangrove in Nickerson's study. Her recognition of the significant fisheries value of mangroves explains why total net benefits from semi-intensive shrimp aquaculture were less than 3% of those from fishery and forestry products under the undeveloped management alternative.

2.3. Other fisheries

It should be emphasized that our calculations above (and those of Gilbert and Janssen) do not include estimates of the productivity and value of molluscs, although their harvest constitutes an important in situ mangrove fishery (Macintosh, 1982; Matthes and Kapetsky, 1988). Neither are the biophysical interactions between mangroves and other coastal ecosystems like seagrass beds and coral reefs (Ogden, 1997; Rönnbäck, 1999) covered in this analysis. Furthermore, because penaeid shrimp sales generate most of the revenues from mechanized trawling in developing countries, shrimps (and indirectly mangroves) effectively subsidise commercial fish harvesting efforts by these vessels (Turner, 1977; Bennett and Reynolds, 1993), including fish species that do not utilize mangroves as habitat. Excluding these fisheries from the valuation effort highlights the significant underestimation of the fisheries value presented by Gilbert and Janssen (1998).

3. Ecological services

The total economic value of ecological services like disturbance regulation (storm protection, erosion control, flood regulation), waste treatment, nutrient cycling and biodiversity is related to forest size, implying that the preserved forest cannot be placed on a par with, for example, the buffer zones retained under the aquaculture alternatives. Although previous valuation efforts have demonstrated that ecological services constitute the major value of unexploited mangrove systems (e.g. Lal (1990), Costanza et al. (1997)), Gilbert and Janssen make no effort to quantify their value. Consequently, the value of the unexploited Pagbilao mangroves is significantly underestimated, whereas the value of management alternatives converting the forest is overestimated because the opportunity cost of lost ecological services is ignored.

If Gilbert and Janssen believe previous studies are incorrect or represent context-specific marginal values not transferable between regions and over time, they could have estimated values for Pagbilao ecological services themselves. The annual value of mangrove waste disposal service has, for instance, been estimated at US$5820/ha in Fiji (Lal, 1990) and US$1193/ha in Mexico (Cabrera et al., 1998), based on the cost of constructing a sewage treatment plant. However, Gilbert and Janssen assumed that this value could not be attributed to waste disposal because 'water pollution is not a problem in Pagbilao' (p. 339). This statement lacks both substance and explanation. Although Pagbilao may have no acute water problem today, future loadings of nutrients and pollutants from human activities coupled with an extensive removal of existing mangroves could lead to serious environmental problems. Therefore, the precautionary principle should be applied, i.e. assuming the need to build a sewage treatment plant using the above estimates.

4. Sustainable aquaculture

Gilbert and Janssen claim that all management alternatives they present are sustainable. Under the aquaculture alternatives, 'wastes released by the ponds into the nearby environment do not overload the system's capacity for self-purification and so good water quality is maintained' (p. 334). Because they neither outline nor discuss such capacity for self-purification, their statement has no basis and their sustainability criteria for aquaculture remain doubtful. The aquaculture alternatives outlined by Gilbert and Janssen are so-called throughput systems (Daly and Cobb, 1989). This means that resources, collected over large areas, are introduced and used in the aquaculture production site and released back into the environment in concentrated forms as nutrients and pollutants, causing various environmental problems (Folke and Kautsky, 1991, 1992). By applying the polluter-pays principle and internalizing environmental costs, the aquaculture alternatives would have to pay society the external costs of the impact of wastes released.

In Pagbilao, extensive milkfish culture has been sustainable since the 1950s because of low stocking densities of 3000 juveniles/ha (Padilla and Tanael, 1997). In contrast, Gilbert and Janssen

propose higher densities of 6000 juveniles/ha for semi-intensive milkfish culture, i.e. the management alternative ranked first. The sustainability of this recent culture system (initiated during the last 10 years with the introduction of commercial milkfish feeds in the Philippines) remains to be seen. The annual feed utilisation of this management alternative is 859 200 kg, based on a milkfish production of 537 000 kg/year (Table 2, p. 336) and a feed conversion ratio of 1.6 (Sumagaysay and Borlongan, 1995). Only 20% of supplemented feed is converted into harvested milkfish, and the remaining 80% (687 400 kg/year) is either excreted or never ingested by the fish (Nunes and Parsons, 1998). The enormous amount of feeds released into the environment has great potential to cause pollution and collapses in milkfish production (through negative feedback).

The ecological and socio-economic unsustainability of intensive shrimp aquaculture, which is ranked second by Gilbert and Janssen, is well-documented. The uncontrolled expansion and intensification of shrimp aquaculture has led to self-pollution and disease problems, and the life span of most intensive shrimp ponds seldom exceeds 5–10 years in Thailand (Flaherty and Karnjanakesorn, 1995; Dierberg and Kiattisimkul, 1996) and other countries.

Self-pollution and subsequent collapse of aquaculture systems can be reduced if pond design and operation allow nutrient effluent assimilation by surrounding mangroves. Robertson and Phillips (1995) estimated that 22 ha of mangrove forest would be required to filter the nitrogen and phosphorus loads from a 1 ha intensive shrimp pond. The sustainability of this effluent loading depends on hydrodynamic conditions, other pollution sources and harvesting rate of accumulated mass. Gilbert and Janssen need to revise their estimate of converted forest area to satisfy their own sustainability criteria for aquaculture activities in Pagbilao. For intensive shrimp culture, this means that only a small proportion of the forest can be converted into ponds, instead of the 86% proposed by Gilbert and Janssen. Major revisions of all management alternatives involving aquaculture activities also imply a corresponding reduction in the economic value for these alternatives, which is beyond the scope of this commentary. Under this reformulated scenario the economic value of the aquaculture alternatives will be greatly reduced especially for the more intensive systems.

5. Conclusion

The study by Gilbert and Janssen has underestimated the value of mangroves in supporting fisheries production by: (1) assuming an inaccurately high harvesting cost for the onsite fishery, (2) not recognizing the commercially important penaeid shrimp fishery, and (3) excluding other fisheries supported directly or indirectly by mangroves. The value of ecological services was not quantified, although it constitutes the major value of unexploited mangrove forests. As a consequence, the opportunity cost of losing these services is not internalized in the valuation of the management alternatives that lead to conversion of the forest. The aquaculture alternatives should also bear their costs to society of waste emissions into the environment. Furthermore, the sustainability of the aquaculture alternatives is open to debate because the high concentration of ponds and the high stocking density in ponds increases the risk of self-pollution.

In conclusion, the analysis by Gilbert and Janssen significantly underestimates the value of the unexploited mangrove forest, and overestimates the value and sustainability of management alternatives for forest conversion. This has altered the outcome and conclusions of the study, and ultimately may have dire consequences for the mangroves and coastal communities of Pagbilao.

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REPLY TO RÖNNBÄCH AND PRIMAVERA

Use of environmental functions to communicate the values of a mangrove ecosystem under different management regimes. Response to a critique

1. Introduction

Many studies existed to demonstrate that mangroves have a high value. A number of those studies have been quoted in the G + J article (Gilbert and Janssen, 1998). The basic reason to start such studies is usually the assumption that if we would only know the true value of mangroves we could use this information to prove that conservation is the best option. The G + J article is about communication of values, use of valuation in a decision context and the limitations of valuation to prove that mangroves should be preserved. The article is not about whether mangroves are worth preserving.

One of the purposes of the G + J article is to show the need for ecological information as basis for valuation. This information, such as data to assess production functions, are typically not available. It is to be expected that this applies to many other situations since adequate time series are hard to find. Further, site-specific conditions often prevent the possibilities for benefit transfer. In short, the problems encountered in the G + J study go beyond the detailed discussion of the input data and would address the more fundamental problem of lack of sufficient ecological data.

All data collected and all calculations are included in a summary report (Janssen and Padilla, 1997). This 247-page document has been available since 1997 from IVM, Amsterdam and IIED London.

2. Capture fisheries

Absence of stock assessment is a shortcoming of G + J as they admit on p. 335. Nonetheless, the limited sampling was cross-referenced with other, completed studies. R + P (Rönnbäck and Primavera, this issue) use 'benefits-transfer' in their attempt to correct or complement estimates in G + J. For this to be valid, the complex interconnectivities of the various ecosystems presented in the area, e.g. mangroves, seagrasses, and coral reefs need to be documented. Only additional empirical studies in the area can throw light on this issue.

A second problem lies with attribution. How much of the shrimp landings may be attributed to the mangroves given that seagrasses and perhaps coral and other habitats also provide nursery functions?

R + P question the assumption that 87.75% of the value of landed fish resulting from off-site fisheries covers the cost of harvesting. R + P suggest a range of 0–10%. The evidence of G + J on harvesting costs is rather weak (based on a national survey), so this seems to be a legitimate critique. However, even a ten-fold increase in the in situ price of fish would not make a difference to the ranking of the alternatives. R + P question the assumption that the effects of mangroves on off-site (transient) fisheries are minimal. The relationship between mangrove loss and fisheries is complicated. The best economic study up-to-date