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Economic valuation of seagrass ecosystem in Maribojoc Bay, Bohol, Philippines

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Abstract. *Mascariňas HJC, Otadoy JB. 2023. Economic valuation of seagrass ecosystem in Maribojoc Bay, Bohol, Philippines. Biodiversitas 24: 4448-4456.* The seagrass ecosystem is one of the most productive and precious ecosystems. In the Philippines, however, more data on the economic valuation of all seagrass ecosystem services must be collected. The study estimated the total economic value of the seagrass ecosystem, including use and non-use values. Resource user groups include municipal fishers, gleaners, and tourism business operators. The sample size was determined based on the total number of resource users in Maribojoc Bay, Bohol, Philippines and using a confidence coefficient of 95% (P = 0.05). The total economic value of the seagrass ecosystem in Maribojoc Bay is PhP 52.8 million (US$ 1.1 million). Direct use values, or market benefits, are PhP 35.4 million (US$ 708 thousand), accounting for 67% of the total economic value. Indirect and non-use values, are PhP 17.3 million (US$ 346 thousand), accounting for 33% of the total economic value. On a per hectare basis, the economic value of the seagrass ecosystem in Maribojoc Bay is PhP 46,722 (US$ 934). The results of this valuation can be an input in decision-making to manage and conserve the seagrass ecosystem as well as maintain the economic security of Maribojoc Bay. The findings of this study are valuable for developing a comprehensive information management and decision-support system for the management and protection of the seagrass ecosystem. However, more research is required to evaluate the range of ecosystem services provided by seagrass ecosystems across the country, focusing on qualitative value attributions linked to the social-ecological dynamics of seagrass systems.

Keywords: Economic values, ecosystem services, Maribojoc Bay, seagrass valuations

INTRODUCTION

Seagrass ecosystems provide essential ecosystem services, including nutrient cycling, sediment stabilization, organic carbon production and export, biodiversity, and trophic transfers to neighboring habitats (Cullen-Unsworth and Unsworth 2013; Marco-Mendez et al. 2015). The seagrass ecosystem is one of the most valued ecosystems on earth, with a monetary value estimated at up to US$ 19,000 ha^{-1} $year^{-1}$ (Fourqurean et al. 2012). Despite their importance, seagrasses have experienced a large-scale decrease worldwide both directly and indirectly due to anthropogenic impacts (Turschwell et al. 2021). One significant factor contributing to their loss is that seagrasses receive very little attention compared to other coastal and estuary ecosystems (Unsworth et al. 2014a). Likewise, the nature of the benefits provided by seagrass is unfamiliar or less known to most people. Their values are not realized, thus they are usually forgotten, especially in decision-making processes (Unsworth et al. 2018). There have been many appeals for more vital management guidelines to preserve and restore existing seagrass beds. Unfortunately, the economic valuations of seagrass ecosystems have not been widely studied, and only a few studies have provided monetary estimates of the value of these systems. In addition, more data on the economic values of all seagrass ecosystem services needs to be collected. However, the precise ecological relationship between seagrasses and some of their advantages have recently been documented; as a result, efforts to translate some ecosystem services into economic values are still in their infancy (Dewsbury et al. 2016).

More effort needs to be made in terms of seagrass valuations. A stronger economic argument for preserving seagrass ecosystem needs to be established to raise awareness among the general public, government agencies, policymakers, and politicians of the need to protect seagrasses. Economic valuation is a step in strengthening people’s environmental consciousness and enhancing resource users’ knowledge in recognizing the importance of seagrass ecosystems. Giving ecosystem services monetary values may help influence policymakers and development project financiers on the importance of environmental conservation and the true meaning of ecologically sustainable economic development. Likewise, it demonstrates how human actions alter the ecosystem’s structure and function, and, consequently, their effect on ecological production in the form of goods and services that are beneficial for humans. Seagrass ecosystem values can be used to develop policy and justify investment in coastal management efforts (Fortes 2013).

In the Philippines, economic valuations of the seagrass ecosystem remain few, with the majority concentrating on the market value of commercial fisheries as the primary ecosystem service of importance. The economic value of the seagrass ecosystem is considerable and requires greater attention for its monitoring, management, and conservation. In Maribojoc Bay, Bohol, Philippines, more significant pressure is placed on seagrass ecosystems to meet local demands for food, space, transportation, and other resources as people inhabit coastal municipalities at an increasing rate. One of the most significant possible effects of growing populations on the seagrass ecosystem is the deterioration of water quality brought on by runoff, dredging, and other human activities. The negative economic repercussions of damaged seagrass beds fall on local communities because seagrasses have a variable capacity to ameliorate these effects. Compared to communities that benefit from various ecosystem services, well-being suffers disproportionately more where populations heavily rely on the ecosystem services that seagrasses supply (Nordlund et al. 2016). There is no existing economic valuation of the seagrass ecosystem at the study site, and consequently, this study needs to be done. In this study, the economic valuation of seagrass covers direct use, indirect use, and non-use valuations. The result of this valuation is crucial to management decisions and better planning policies to conserve the seagrass ecosystem while maintaining economic security in Maribojoc Bay, Bohol.

MATERIALS AND METHODS

Study area

Maribojoc Bay is situated in the southwestern part of the island province of Bohol, Philippines (Figure 1.A). It has a total of 73.4 kilometers of coastline and covers an area of 145 square kilometers. The study was conducted from July to December 2020 in Maribojoc, Cortes, Tagbilaran City, Dauis, and Panglao coastal communities. Twenty-seven coastal barangays in the four towns and one city are situated along the periphery of the bay area. As of the 2015 census, Maribojoc Bay supported a population of 98,097 or 17,232 households.

Data collection

Maribojoc Bay has an estimated area of 1,129.55 hectares of seagrass beds (Figure 1.B). Updated data on resource users and operators of tourism-related businesses were acquired from the Municipal Local Government Units (MLGUs). Additional information was obtained from the barangay offices. Relevant information, such as major economic uses of seagrasses and environmental and socio-economic issues, was identified and verified through key informant interviews with various local government offices and provincial agencies. The total number of resource users in Maribojoc Bay is approximately 1,552, which comprises municipal fishers (65.9%), gleaners (32.6%), and tourism-related users (1.5%). Tourism-related users are operators of dive shops, boats, and cruises.

The sample size was determined based on the total number of resource users in Maribojoc Bay and using a confidence coefficient of 95% (P = 0.05). Using the formula, $n = N/1+Ne^2$, where N is the population size and e is the margin of error (Almeda et al. 2010). The resource users were sampled using systematic sampling with a random start-with replacement. The sampling method was used to ensure the sample would represent the population being studied. Moreover, the method was implemented to ensure that the selection of respondents was guided by probability methods (Laerd 2012). However, systematic random sampling would only be possible if the master list of respondents for the whole population was available. Respondents were interviewed for 5-10 minutes using a pre-tested survey questionnaire. A total of 473 resource users were interviewed, and the survey groups included municipal fishers, gleaners, and tourism business operators.

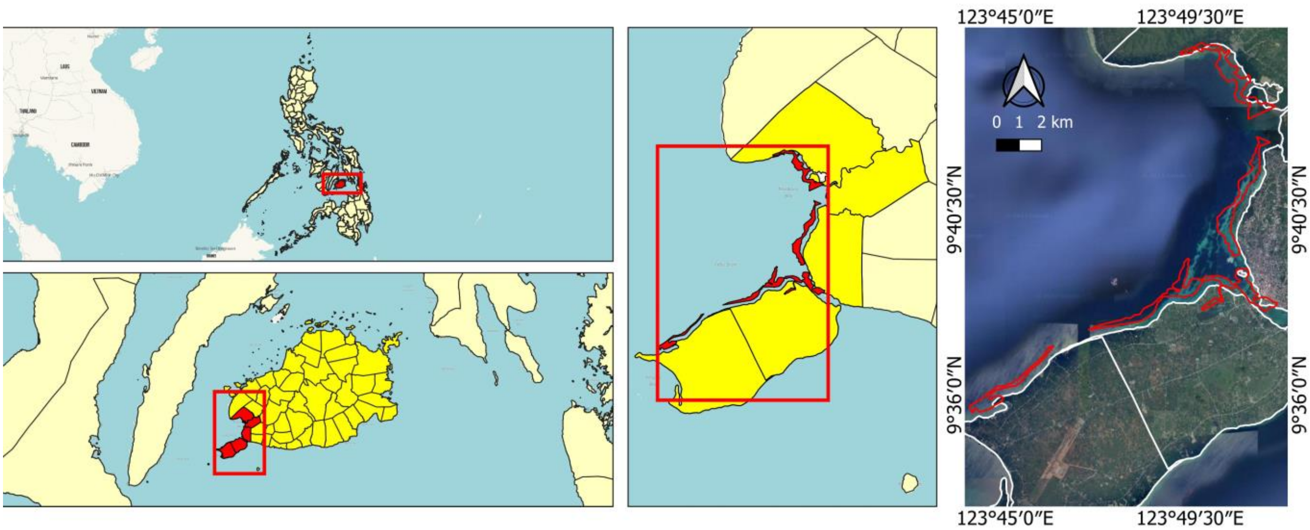

Figure 1. Map of Maribojoc Bay, Philippines with the towns and city (A), coastal communities and the estimated area of seagrass beds (B)

Seagrass ecosystem valuation

The annual net benefits generated from the seagrass ecosystem sum all net benefits from use and non-use values (Figure 2). The annual net benefits were computed using the Total Economic Value (TEV) framework (Spurgeon 1992) as follows:

TEV = use value + non-use value = (DUV + IUV + OV) + (XV + BV)

DUV = Direct Use Value, IUV = Indirect Use Value, OV = Option Value, XV = Existence Value, BV = Bequest Value.

Direct use values

Use value measures the consumptive value or direct use values of tangible natural resources and the non-consumptive or indirect use values. Direct use values for seagrass ecosystems can be extractive, such as net revenues from the fishery, or non-extractive, such as tourism. The net revenue from the fishery was estimated using a market valuation. This method, market valuation, estimates the revenues according to the market price of the production produced by the seagrass ecosystem (Vassallo et al. 2013). On the other hand, tourism revenue was based on the economic contribution of seagrasses to non-consumptive activities such as snorkeling, diving, and boating. Education and research values were based on research expenditures in similar studies.

Furthermore, a producer surplus was computed. Producer surplus is the excess of revenue over costs received by resource users (i.e., fishers, gleaners, and tourism business operators). Costs represent the minimum amount a resource user would accept to maintain his current effort or operation level. Gross revenue includes the value of products (i.e., fish and shellfish) and services (i.e., tourism operations) generated from economic activity. The total cost consists of variable costs (i.e., fuel, supplies, repair, packing, and labor shares) and fixed costs (i.e., vessel depreciation, repair, and maintenance). Data on costs and revenues were obtained during the interviews with fishers, gleaners, and tourism entrepreneurs (Samonte-Tan et al. 2007).

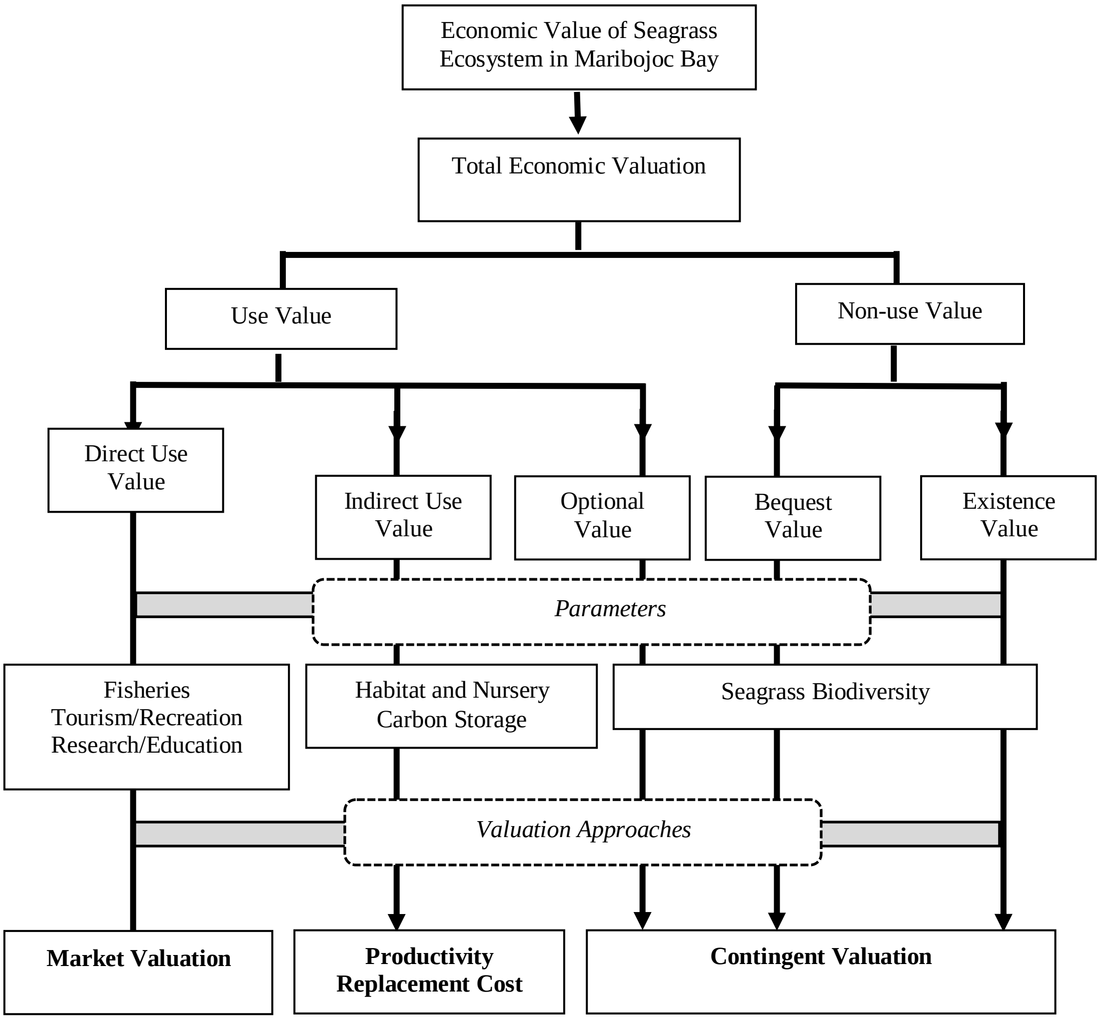

Figure 2. The economic valuation framework of seagrass ecosystem in Maribojoc Bay, Bohol, Philippines

The net revenue for the ith economic sector (R_i), Gross Revenue (GR), and Total Cost (TC) are calculated, respectively:

$$NR_i = GR - TC$$
$$GR_i = Q_i P_i$$
$$TC = VC + FC$$

Where: Q is the quantity produced, P is the ex-vessel or farm-gate price, VC is the total variable cost, and FC is fixed cost.

Indirect and non-use values

Indirect use values are the functional benefits of seagrasses, such as habitat, nursery, and carbon storage (Greiner et al. 2013; Jackson et al. 2015). Two approaches were used to estimate the net revenues for indirect use values: productivity and replacement cost methods. The productivity method was used to estimate the net revenue of the seagrass ecosystem as habitat and nursery. The net value of seagrass areas as habitation, breeding site, and nurseries is estimated at 20% of the net landings (Unsworth et al. 2014b, 2018). Meanwhile, the replacement cost method was used to estimate the net revenue for carbon storage (Lavery et al. 2013). The monetary value of seagrass's ability to store carbon was estimated using a carbon market price, such as the price per ton of carbon. Data on carbon storage in seagrass biomass was obtained from the IUCN report on blue carbon. In the said report, the amount of carbon held in seagrass living biomass is 11t CO_2e per hectare, and the price of CO_2 in 2020 is US$ 15t^{-1} (Luckow et al. 2015).

On the other hand, non-use values consist of option values, bequest values and existence values. The option value is the potential direct and indirect use of the ecosystem and resources. This value reflects the value of natural resources for future generations. Besides, the option value is the Willingness to Pay (WTP) for using or consuming the resources in the future. Also, option value represents the Willingness to Pay (WTP) for future use of undiscovered qualities such as medicinal plants or marine organisms. Bequest value is the value of leaving or endowing a natural resource to the next generation. Existence value is also known as preservation value. It is the value a person puts on the resource knowing that it exists and is being protected. However, the existence value is frequently defined as a bequest or option value. One ultimate goal of this study is to conserve the seagrass biodiversity for sustainability. Since seagrass conservation is a non-market good, its non-use values were measured using the contingent valuation method. The Contingent Valuation Method (CVM) is a widely used to determine the public's Willingness to Pay (WTP) for environmental resources and, consequently, the non-use values of resources. The CVM is employed by constructing hypothetical markets for a resource with no prevailing market. Through the hypothetical market, the respondent can express their willingness to pay for specific changes in the quantity or quality of the resource under the specified contingencies (Bundal et al. 2018).

In this study, the seagrass biodiversity was based on the average Willingness to Pay (WTP) values of respondents. The maximum WTP for the seagrass biodiversity conservation for each resource user was elicited through the contingent valuation question in the format known as "payment card" (Arin and Kramer 2002). During face-to-face interviews, seagrasses' biology and ecological functions were conveyed to the respondents by showing colored pictures of seagrass species and the goods and services they provide. The question eliciting information on resource users' WTP for seagrass conservation is stated as follows: ''Would you be Willing to Pay (WTP) a yearly contribution to the conservation fund to conserve and protect the seagrass biodiversity in Maribojoc Bay? If YES, how much? PhP 100, PhP 200, PhP 300, PhP 400, PhP 500''.

RESULTS AND DISCUSSION

The seagrass ecosystem has provided direct and indirect benefits (Table 1). Hence, it is economically and ecologically important to the coastal communities. A total of 473 resource users were interviewed, which comprised municipal fishers (250), gleaners (200), and tourism business operators (23). Table 2 provides the socio-economic profile of the respondents.

Resource users are mostly in their forties. The fishers and gleaners have been residents of the barangays since birth, or an average of at least 35 years. Males predominantly engage in by males (98%), while females engage in gleaning (72%). The average household size is five. Resource users, particularly fishers (92%), rely mainly on marine-based livelihoods. At least 50% of fishers are members of local organizations. Most of the gleaners (87%) are not members of any community organizations. In general, resource users have completed high school. Moreover, some resource users have land-based occupations to supplement their income. Minor occupations include carpentry, labor, vending, driving, processing fish products, employees, and other small businesses.

The knowledge and awareness of resource users about seagrasses were determined. Fishers (97%) and gleaners (100%) recognized and encountered seagrass, locally known as *lusay* in Maribojoc Bay, Bohol, Philippines. Through photos and descriptions, the seagrass species commonly encountered by gleaners and fishers were *Enhalus acoroides* (41%), *Thalassia hemprichii* (34%), *Halophila ovalis* (15%), *Cymodocea rotundata* (5%), and *Syringodium isoetifolium* (5%).

Table 1. Major uses of seagrass ecosystem in Maribojoc Bay, Bohol, Philippines

Direct Value	Indirect Value
Commercial fish	Habitat and nursery
Mollusks/ echinoderms	Carbon storage
Tourism	
Research	

Table 2. Socio-economic profile of resource users in Maribojoc Bay, Bohol, Philippines

		Fishers n = 250	Gleaners n = 200	Tourism operators n = 23
Gender	% Male	98%	28%	70%
	% Female	2%	72%	30%
Age	Minimum	19	24	28
	Maximum	79	75	54
	Average	46	44	36
Civil Status	%Single	9%	10%	0%
	% Married	91%	90%	100%
	%Others	0%	0%	0%
Number of years living in barangay	Minimum	2	3	1
	Maximum	58	65	42
	Average	26	40	12
Number of people living in a household	Minimum	1	1	1
	Maximum	12	9	8
	Average	5	5	5
Fulltime occupation in marine-based activities	% Yes	92%	64%	78%
	% No	8%	36%	22%
Member of organization	% Yes	51%	13%	74%
	% No	49%	87%	26%
Education	% No Education	0%	0%	0%
	% Elementary level	7%	15%	0%
	% Elementary graduate	10%	10%	0%
	% High School Level	37%	34%	0%
	% High School Graduate	42%	36%	13%
	% Vocational	0%	0%	0%
	% Vocational graduate	0%	0%	9%
	% College level	3%	2%	26%
	% College graduate	2%	3%	52%

As cited by the resource users, the importance of seagrass ecosystems is habitat and nursery ground for fisheries (37%), gleaning area for mollusks and echinoderms (26%), fishing area (17%), supporting coastal ecosystems and biodiversity (7%), providing shoreline protection (7%), an avenue for tourism and recreation activities (6%), and essential for research and education (2%).

When resource users were asked to compare their catch and harvest about 10 years ago, the majority noticed a change, such as decreasing yields (56%), and decreasing species caught (44%). The main issues and problems identified by resource users were the increasing number of resource users (35%), illegal fishing methods (18%), overharvesting (17%), habitat destruction (13%), water pollution (10%), and declining seagrass beds (8%). Solutions suggested by resource users to improve and increase their catch were alternative livelihoods and financial assistance (20%), habitat rehabilitation and protection of coastal ecosystems (16%), establishment of marine sanctuary (15%), bay areas exclusive to municipal fishers and gleaners (14%), strict enforcement of existing laws (13%), proper waste disposal (12%), regulating fishing and gleaning activities, and controlling the number of resource users (9%). Nevertheless, 98% of the resource users are aware of the existing Marine Protected Areas (MPAs) in the bay area. When asked if they had heard about the seagrass sanctuary, most of the resource users (96%) said they had not heard or had any idea about the seagrass sanctuary in the bay area.

Resource users were also asked if they would support a policy or ordinance to establish a seagrass sanctuary in Maribojoc Bay. The majority answered "yes," and the reasons why they wanted to establish a seagrass sanctuary were: they want to catch more fish and harvest more mollusks and echinoderms (21%); it provides habitat and nursery areas for fish and other marine organisms (20%); it helps maintain a healthy ecosystem and coastal biodiversity (20%); it helps conserve seagrass ecosystems for future generations (18%); there are fish and aquatic resources that depend on seagrasses (11%); and it provides recreation for tourism (10%). Issues, problems, and solutions regarding fisheries were identified by resource users (Table 3).

Revenue from seagrass ecosystem

Fishers operate on a range of 3-6 days per week. They only break or decelerate from fishing during bad weather (72%), lean seasons (23%), health issues, and personal engagements (5%). Based on the data gathered, peak fishing months are from March to July (5 months), and lean months are from August to February (7 months). Of the 250 fishers surveyed, about 67% also catch fish in the seagrass area. A total of 45 fish species belonging to 25 families were identified and caught by fishers in the seagrass area of Maribojoc Bay. Some of the most common fish caught in the seagrass area were rabbitfish *danggit* (32%), mullets *babakan* (12%), ponyfish *lawayan* (8%), potpot (6%), parrotfish *molmol* (6%), catfish *hito* (6%), and wrasses *labayan* (4%). Standard fishing gears used were nets (50%), hook and line (48%), spears (1%) and traps (1%). The average fish yield ranged from 2.3-6.1 kg/trip during peak months and as low as 0.5-1.8 kg/trip during lean months. On average, the annual net revenue per fisherman ranged from PhP 1,833 (US$ 37) to PhP 8,522 (US$ 170). For each municipality, the annual net revenue per fisher was multiplied by the total number of fishers (Table 4). The annual net revenue from fisheries in the seagrass ecosystem is PhP 10,593,410.00 (US$ 211,868).

Gleaners operate approximately five days per week. Peak gleaning months are from March to July (5 months). A total of 35 mollusks belonging to 20 families and 3 species of echinoderms belonging to 3 families are found in Maribojoc Bay. The most common species, ranked by the number of gleaners who harvest them, are plicate conch *aninikad* (28%), spider conch *saang* (17%), blood clam *litob* (16%), sea urchin *swaki* (15%), and wing shell *tagmanok* (6%). Prices depend on the species of mollusks and echinoderms; the price per kilo ranges from PhP 30.00 (US$ 0.60) to PhP 100.00 (US$ 2). Sea urchin *swake* is sold at PhP 100.00 (US$ 2) -PhP 150.00 (US$ 3) per bottle. According to data from 200 gleaners surveyed, the quantity gleaned ranged from 2.2-5.2 kg per day during peak seasons and as low as 0.7-1.8 kg per trip during lean months. On average, the annual net revenue per gleaners ranged from PhP 1,867(US$ 37) to PhP 4,344 (US$ 87). For each municipality, the annual net revenue per gleaner was multiplied by the total number of gleaners (Table 4). The annual net revenue from gleaning in the seagrass ecosystem is PhP 3,111,868.00 (US$ 62,237).

Table 3. Issues and problems identified by resource users for decreasing catch or harvest and their suggested solutions for improving catch or harvest

Issues and problems	Fishers N=250	Gleaners N=200	Solutions	Fishers N=250	Gleaners N=200
An increasing number of resource users	34%	36%	Regulate fishing/ gleaning activities and controlling the number of resource users	9%	10%
			Provide alternative livelihood and financial assistance	20%	22%
Illegal fishing/ destructive methods (e.g. cyanide, gill/ fine mesh nets)	21%	10%	Strict enforcement of existing laws. (Imposing penalties and imprisonment)	15%	7%
Overharvesting due to open access (intrusion of fishers/gleaners from other towns)	16%	19%	Bay area exclusive only to municipal fishers and gleaners	14%	15%
Water pollution	11%	7%	Proper waste disposal for municipal and various establishments.	13%	9%
Habitat destruction	12%	16%	Rehabilitate and protect the coastal ecosystems	16%	17%
Declining seagrass beds	6%	12%	Establishment of seagrass sanctuary	14%	20%

Table 4. Annual net revenue from seagrass ecosystem of Maribojoc Bay, Bohol, Philippines

Category	Annual Net Revenue (PhP/Year)					
	Maribojoc	Cortes	Tagbilaran	Dauis	Panglao	Total
Fishing	2,205,666	1,832,877	1,781,101	2,982,309	1,791,456	PhP 10,593,410.00 (US$ 211,868)
Gleaning	739,146	322,988	465,848	807,471	776,414	PhP 3,111,868.00 (US$ 62,237)
Tourism	1,649,200	268,200	1,917,400	5,349,900	14,494,600	PhP 23,679,300.00 (US$ 473,586)

Note: *US$ 1.00 = PhP 50.00 (2020)

Bohol is one of the tourist destinations in the Philippines. Tourist arrivals in Bohol have increased from 2015 to 2019. Tourism establishments and recreational facilities along the bay area are visited both by local and foreign visitors. Tourism has contributed to the local economies of Maribojoc, Cortes, Tagbilaran City, Dauis, and Panglao regarding sales, income, employment, and tax revenues. The main tourism activities in the bay area include snorkeling, diving, boating, and cruise operations. Thus, this study values seagrass ecosystems for their economic contribution to non-consumptive activities. As of 2019, there were 29 boat operators in Maribojoc Bay. Ferry boats, bay cruises, and floating cottages are offered at PhP 1,500.00 (US$ 30)-PhP 2,500.00 (US$ 50) daily. A boat operator can cater to an average of eight trips per month. A dive shop in Panglao can accommodate an average of 324-1,093 divers per month. A dive shop charges PhP 2,400.00 (US$ 48)-PhP 3,200.00 (US$ 64) per dive, including taxes and equipment rentals. The average annual net tourism revenues were PhP 19,790,400 (US$ 395,808) for dive shops and PhP 3,888,900 (US$ 77,778) for boat operations. The net benefits from tourism are computed from the annual net revenue per entrepreneur and the number of entrepreneurs in the municipality (Table 4). The annual net benefit from tourism in Maribojoc Bay is PhP 23,679,300.00 (US$ 473,586).

Research and education value

Seagrass ecosystems are excellent for education and scientific studies. The research value was based on marine research expenditures such as field work, data gathering, transportation, boat rental, dive equipment, and other supplies (Samonte-Tan et al. 2007). The project cost was estimated based on the financial data of some research projects conducted by academic institutions and NGOs. There will be one research project taking place each year within Maribojoc Bay. The research value is approximately PhP 1,500,000.00 (US$ 30,000) per research study per year.

Indirect use and non-use values

For seagrass ecosystems, the non-market values include (a) the provision of feeding, nursery, and breeding areas for fisheries; (b) carbon storage; and (c) seagrass biodiversity. Maribojoc Bay has a total estimated area of 1,129.55 hectares of seagrass beds. The net value of seagrass areas as habitation, breeding site, and nurseries is estimated at 20% of the net landings. The seagrass area was estimated to absorb 12,425 tons of CO_2. The net revenue is based on the price of CO_2 in 2020 at US$ $15t^{-1}$. The seagrass biodiversity was based on the average Willingness to Pay (WTP) values of respondents. The Willingness to Pay (WTP) of resource users was participated by 200 gleaners. The WTP result shows that 100% of the study participants answered "yes" to the Willingness to Pay (WTP) question. However, the result showed a decreasing trend in the number of participants who answered "yes" to the WTP question as the bid price increased (Table 5). The contribution was once a year, and for the mode of collection, the results suggest that the majority prefers yearly (88%), followed by quarterly (7%) and semi-annually (5%). As for the payment vehicle, the majority wanted that it would be billed through community tax (60%); other respondents chose to pay directly to the LGU in charge of the program (21%); and a non-government organization (18%). The resulting mean WTP for conserving the seagrass biodiversity of Maribojoc Bay was PhP 181.9 (US$ 3.6). Hence, biodiversity value was computed using resource users' willingness -to -pay at PhP 200.00/year (US$ 4) for seagrass biodiversity conservation in Maribojoc Bay. The net revenue for seagrass biodiversity was computed based on the number of resource users in the municipality. The annual net benefits from the indirect and non-use value in Maribojoc Bay is PhP 17,326,449 (US$ 346,529) (Table 6).

Total economic value of seagrass ecosystem in Maribojoc Bay

The total economic value of the seagrass ecosystem in Maribojoc Bay is PhP 52.8 million, or US$ 1.1 million (Table 7). The total direct use value is PHP 35.4 million, or US$ 708 thousand. Tourism is the major economic sector, generating use values of PhP 23.6 million, followed by fisheries (PhP 10.2 million) and research (PhP 1.5 million), respectively. On the other hand, total indirect and non-use values are PhP 17.3 million or US$ 346 thousand. Carbon storage (PhP 9.3 million), habitat or nursery functions (PhP 7.8 million), and seagrass biodiversity (PhP 204 thousand) are the non-market values contributing significantly to the total economic value of the seagrass ecosystem in Maribojoc Bay. On a per-hectare basis, the economic value of the seagrass ecosystem in Maribojoc Bay is PhP 46,722 or US$ 934.

The monetary value of seagrass meadows has been estimated at up to US$ 19,000 per hectare per year (Short et al. 2008). In East Bintan, Indonesia, seagrass is worth US$ 3.5 million to the local communities, as Dirhamsyah (2007) estimated. In the Philippines, the total annual production of the goods and services of seagrass from the few study sites was worth only US$ 809,766 (UNEP 2007). This is because only the data from fishing production was considered reliable, so seagrass goods had a total value of only US$ 34.84. On the other hand, seagrass services had no value since none of the data submitted was considered reliable. In addition, during the valuation process, people who are less informed of the true worth of the seagrass will attach to it at a much lower price. The low values attached to seagrass ecosystem services are one principal reason for their continued loss (Fortes 2013).

The net revenues obtained in this study are compared to other related studies (Table 8). Regarding fisheries production, the annual net revenue per hectare is US$ 127 for commercial fish and US$ 63 for mollusks and echinoderms. The values are higher compared to the study conducted by Samonte-Tan et al. (2007), which used market valuation, and McArthur and Boland (2006), which used the productivity method. However, the value for provision (fisheries, tourism, and research) is US$ 628, much lower than to the provisioned value of US$ 2,287 by Dirhamsyah (2007), which used market valuation, travel cost, and cost-benefit methods. In this study, the annual net revenue for tourism is US$ 419, whereas research is US$ 27. Meanwhile, the annual net revenues for habitat and nursery roles (US$ 138) and carbon storage (US$ 165) are lower compared to the other studies. The annual net revenue for seagrass biodiversity is US$ 4.

Table 5. Bid values and percentage of respondents willing to pay the proposed bids

Bid prices	Gleaners N = 200
100	98%
200	82%
300	48%
400	4%
500	0%
Average WTP (PhP)	181.9
Standard deviation (PhP)	81.7
Median (PhP)	200 (US$ 4)

Table 7. Total economic valuation of seagrass ecosystem in Maribojoc Bay, Bohol, Philippines

Resource Use	Total Economic Valuation PhP	US$
Direct		
Fisheries	10,269,513	205,390
Commercial fish	7,157,645	143,153
Mollusks/Echinoderms	3,111,868	62,237
Tourism	23,679,300	473,586
Research	1,500,000	30,000
Subtotal	35,448,813	708,976
Indirect & non-use		
Habitat and nursery role	7,803,061	156,061
Carbon storage	9,318,788	186,376
Seagrass Biodiversity	204,600	4,092
Subtotal	17,326,449	346,529
Total Economic Value (TEV)	52,775,262	1,055,505
TEV per ha per year	46,722	934

Note: *US$ 1.00 = PhP 50.00 (2020)

Table 6. Benefits from indirect and non-use values of seagrass ecosystem in Maribojoc Bay, Bohol, Philippines

	Estimated benefits from indirect and non-use values (PhP/Year)					
Ecological function	Maribojoc (216.17)	Cortes (none)	Tagbilaran (259.95)	Dauis (230.36)	Panglao (423.07)	Total (1129.55)
[a]Habitat and nursery	1,493,327	-	1,795,764	1,591,353	2,922,616	7,803,061
[b]Carbon storage	1,783,403	(none)	2,144,588	1,900,470	3,490,328	9,318,788
[c]Biodiversity	42,600	35,400	34,400	57,600	34,600	204,600
Total	3,319,330	35,400	3,974,752	3,549,423	6,447,544	17,326,449
	US$ 66,387	US$ 708	US$ 79,495	US$ 70,988	US$ 128,951	US$ 346,529

Note: [a]Habitat and nursery role estimated at 20% of fish landing in seagrasses (Unsworth et al. 2014, 2018). [b]Carbon storage estimated at 11tons CO_2/ha in seagrasses biomass (Murray et al. 2011). [c]Biodiversity value computed using resource user's Willingness to Pay (WTP) at PhP 200/yr (US$ 4) for conservation of seagrass ecosystem in Maribojoc Bay, Philippines

Table 8. Comparison of annual net reveneue from the seagrass ecosystem in Maribojoc Bay, Philippines with other studies

Resource use	This study Annual Net Revenue PhP/ha (US$)	Other studies Annual Net Revenue (US$/ha/yr)	Valuation method	Author/ location
Commercial fish	127	63	Market valuation (Seagrass-DUV)	Samonte-Tan et al. (2007), BMT, Philippines
		133	Productivity (fish commercial value)	McArthur and Boland (2006), South Australia
Mollusk/ echinoderms	55	13	Market valuation (Seagrass-DUV)	Samonte-Tan et al. (2007), BMT, Philippines
Tourism	419	None		
Research	27	None		
Provisioning (fisheries, tourism and research)	628	2,287	Market valuation, travel cost, cost-benefit)	Dirhamsyah (2007), East Bintan, Indonesia
Habitat and nursery role	138	47-109	Market valuation (fisheries standing stocks e.g. fish and invertebrates)	Unsworth et al. (2010), Wakotabi, Indonesia
		28-120	Productivity (fish habitat)	Unsworth et al. (2014), Indonesia
		83	Productivity (fish habitat)	Stuip et al. (2000), Philippines
Carbon storage	165	386	Carbon storage calculation	Lavery et al. (2013), Australia
		28	Carbon storage calculation	Duarte and Chiscano (1999)
Seagrasss biodiversity	4	None		

Note: *For comparison from other studies, the annual net revenue in Philippine Peso (PhP) was converted to US$. US$ 1.00 = PhP 50.00 (2020)

The pressures on the seagrass ecosystem in Maribojoc Bay were identified during interviews with resource users. Key issues included: (i) increasing number of fishers and gleaners resulting in a decrease in harvest; (ii) use of illegal fishing methods; (iii) overfishing due to open access, intrusion of fishers from other towns and provinces, and encroachment of commercial fishers; (iv) habitat destruction due to unregulated expansion of coastal development for tourism; and (v) water pollution and decreasing seagrass beds. Thus, the intensity and diversity of demands placed on the seagrass ecosystem will continue to increase as the population grows.

Seagrass resources are thought to be invaluable, which is why their monetary value should be addressed. If the resource has intangible value, people are less willing to conserve it, and the loss of this resource may be perceived as inconsequential or unavoidable. Therefore, providing economic value to the seagrass ecosystem can be based on the different services and benefits it can provide (Bundal et al. 2018). The value of the seagrass ecosystem in Maribojoc Bay is essential in policy-making, as this information can be used to set charges and conduct benefit-cost evaluations of management interventions, initiatives, and investments that would directly impact the health of this ecosystem. Understanding the value of the seagrass ecosystem in Maribojoc Bay is crucial. By assigning a value to seagrass resources, users and stakeholders are informed that using the resources has opportunity costs involved. Resource valuation informs decision-makers about how to allocate resources and formulate user fees that consider the environmental costs associated with the activities of users (Fortes 2013; Wawo et al. 2014).

Managing the seagrass ecosystem will impact the local economy and benefit Maribojoc, Cortes, Tagbilaran, Dauis, and Panglao coastal communities. However, the seagrass ecosystem's current net benefits depend on its quality. Conservation efforts must be made to ensure that the seagrass ecosystem continues to provide these benefits. The tricky part is ensuring that these advantages are maximized now and in the future. Achieving necessities and enhancing the standard of living in coastal communities depend on stakeholders managing the seagrass environment sustainably.

In conclusion, the economic valuation results of the seagrass ecosystem in Maribojoc Bay should be incorporated into the conservation and management programs of the local governments. The importance and benefits derived from the seagrass ecosystem may be emphasized during Information, Education, and Communication (IEC) activities, to inform the local stakeholders to appreciate the economic value generated from the seagrass ecosystem. Outreach initiatives should be carried out to increase public awareness about the intangible benefits of seagrass ecosystems and their importance for ecosystem sustainability. Likewise, the local government units may consider the outcomes of this study in their management planning decisions and as a basis for formulating environmental user fees at the municipal level. Similarly, it is crucial for better-informed decision-making against unsustainable livelihood practices. Consequently, the application of conducting economic valuations of seagrass ecosystems as a tool for policy and planning should be replicated in the province and other coastal areas. Overall, there is a need for comprehensive local studies that evaluate the range of ecosystem services offered by seagrass ecosystems across the country, emphasizing on qualitative value attributions related to the social-ecological dynamics of seagrass systems.

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