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Economic value of a large marine ecosystem: Danajon double barrier reef, Philippines

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1. Introduction

The Danajon double barrier reef (Fig. 1) is the only double barrier reef in the Philippines formed over the last 6000 years and one of only three such sites in the Indo-Pacific region (Pichon, 1977). The double barrier developed as a result of unique tidal currents and/or resumption of subsidence after the outer barrier was formed (Grobe et al., 1985). It covers a total area of 272 km^2 (27,200 ha) with a total coastline of 699 km, spanning 17 municipalities in four provinces and two administrative regions. It accounts for over one percent (1%) of the total area of coral reefs of the Philippines which is estimated at 27,000 km^2 (Christie et al., 2006). This unique coastal environment is identified as a priority area for the conservation of reef fishes, corals, mangroves and molluscs (Green et al., 2004).

Located off northern Bohol Island, Danajon double barrier reef consists of three large reefs, clusters of small reefs and about 40 small islands. The outer barrier reefs and slopes contain the most prolific coral growth while the inner reefs and lagoons are more turbid and have less coral growth. In 2004, 211 hard coral species were recorded (Calumpong, 2004) and the presence of a variety of sharks and rays as well as a large population of seahorses were also reported (Christie et al., 2006). Danajon also hosts significant mangrove forest cover with over 2000 ha of *Rhizophora* sp. The area also serves as important feeding and roosting grounds of over 20 bird species during July to November, one of which is the IUCN-listed threatened species Chinese egret (*Egretta eulophotes)* (Perennou et al. 1994).

The condition of the coral reef reflects the extent of habitat degradation in Danajon as evidenced by low living coral cover despite high coral diversity in the area. Fish biomass is also very low suggesting that the general status of the area is degraded and overfished (Calumpong, 2005; Armada et al., 2009; Lucas, 2010). It is likewise considered a critical resource area especially for fishing, as it sustains the livelihood of around 5000 fishers in the commercial sector and over 125,000 full-time municipal small-scale fishers. The management of Danajon is difficult because of a generally large, poor population, which is highly reliant on fishery resources. Over 60% of coastal habitats in northwestern Bohol live below the poverty line of USD 120 per month (Green et al. 2004). Population densities on outlying islands are unusually high with most people heavily reliant on marine resources. The poverty and density of fisher population drives many fishers to use destructive, unsustainable and illegal fishing practices.

A number of coastal resource management projects have been initiated largely at the inner reefs of the Danajon double barrier reef either by local communities or government agencies such as the Department of Environment and Natural Resources (DENR) and the Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture (DA) in partnership with nongovernment organizations or special programs such as the Fisheries Improved for Sustainable Harvest (FISH), and Project Seahorse Foundation. There are more than 30 small marine protected areas (MPAs) including seven strict nature reserves and three protected seascapes (Green et al. 2002). A local initiative on mangrove reforestation in one of the islands has caught international attention for its size. As Amper (2004) discussed, the initiative of mangrove planting came from the residents themselves and was later supported by the DENR. The 487- hectare mangrove area has not only protected the island from storm waves and strong winds, and provided a spawning area for

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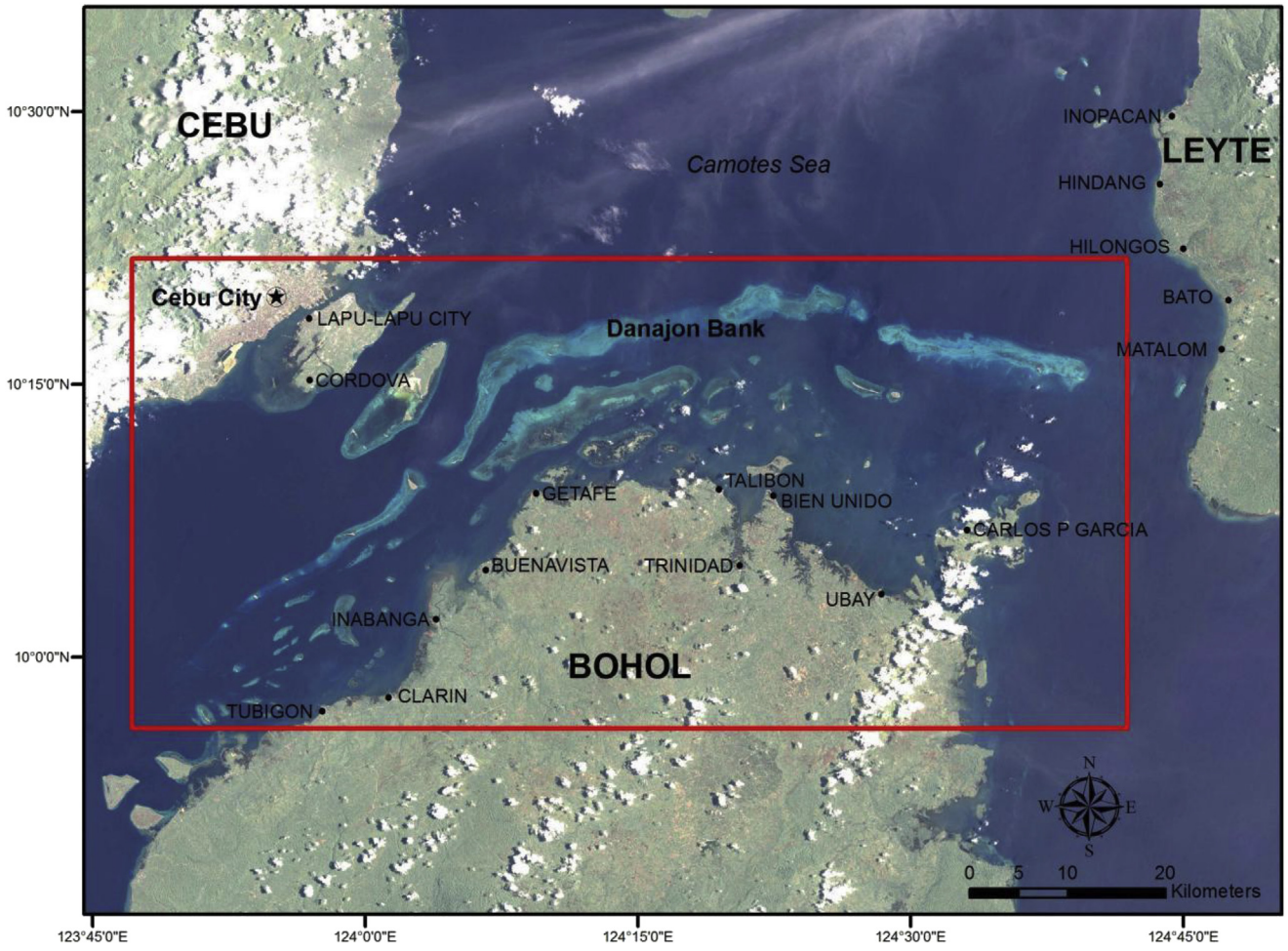

Fig. 1. Danajon Bank double barrier reef area.

fish and other marine creatures, but also brought eco-tourists.

The outer Danajon reef is largely outside any active management effort. Previous efforts at integrating the initiatives of different provinces and municipalities/cities surrounding Danajon have not succeeded. The Cebu-Leyte-Bohol-Southern Leyte Management Council initiatives in 2002 and 2009 have not progressed beyond the signing of the Memorandum of Agreement.

Historically in the Danajon Bank area, each municipality operated quite autonomously and not in a coordinated manner with the neighboring municipalities. Given the number of fishers and mobility of fishers, without coordination among all the local governments covering the Danajon area, the potential for managing the fishing effort and curbing the illegal and destructive fishing was very poor. As governance interventions were refined and improved in the area, it was realized that the entire area needed to be treated as a common management unit and that the primary municipalities needed to form a management cluster and adopt common management guidelines and policies. They also needed to coordinate their efforts to stop illegal fishing because of fisher mobility. This cluster approach also involved engaging large numbers of local stakeholders in order to raise awareness and to get the buy-in of the communities towards a common cause of protecting and restoring the Danajon Bank coral reef and fisheries. This process has also made it possible to set aside more marine protected areas to help restore the coral reef habitat with active community support.

In 2011, the Danajon Bank Marine Park Project, was initiated as the first collaborative large-scale marine protected area in the Philippines. The Danajon Bank Marine Park Project aimed to accomplish the following outputs: i) establish a Danajon Bank Marine Park Governance Framework; ii) establish the Bien Unido Double Barrier Marine Park, a large-scale marine protected area within the outer reef of the Danajon Bank to restore marine habitats and address overexploitation of fish stocks; and iii) enhance livelihood options through secure food sources, and tourism-related economic opportunities.

As a first step towards accomplishing these goals, the project sought to compile and analyze baseline information on biophysical, socio-economic, institutional, policy and governance conditions of Danajon. This was aimed at contributing towards the formulation of the Governance Framework Plan for Danajon double barrier reef.

This study will estimate the economic values of the marine ecosystems comprising the Danajon reef (Fig. 1) area under present conditions and the future values of economic benefits and costs among stakeholders in the fishing and tourism industry. The objectives of this study are:

1. To calculate the use values attributed to the direct utilization of ecosystem services provided by the Danajon reefs; and
2. To estimate an appropriate diver visitation fee based on a willingness-to-pay valuation.

The Danajon reef area is a capital good acquiring value to the

extent that the services it provides are valued by the people. These services are determined by the reefs' attributes, which are determined by the characteristics of the marine ecosystem and by the activities of the people.

Economic valuation is a tool for decision-making as the estimates will help stakeholders to understand the contribution of the Danajon reefs to the local communities. The strength of economic valuation is identifying mutually-compatible ecosystem services provided and the values of their corresponding economic activities. Although most of the direct and indirect values of ecosystems can be measured accurately and reliably using valuation techniques, the main constraint is often the availability of relevant biophysical data rather than economic data. Economic valuation is straightforward when relationships between human-controlled inputs and the production of ecosystem services are efficiently priced in the market. The global estimate of the total value of an average hectare of coral reefs ranges between 490Int$/year for the total bundle of ecosystem services that can potentially be provided to almost 350,000Int$/year (De Groot et al., 2012). For many beneficial impacts, there are no direct markets, hence the use of the contingent valuation method (CVM) which generally derives values via respondents' willingness-to-pay to prevent damages to natural resources. Although there is concern on quality of CVM-generated value data (i.e., individuals may behave strategically, misreporting their true value in order to influence outcome), this is addressed with clarity in a well-designed contingent market.

Knowing that the Danajon reefs and adjacent ecosystems are valuable to the local economy is of little use if it does not lead to real investments in conservation. This valuation can help identify the beneficiaries of conservation and the magnitude of the benefits they receive, and thus help develop mechanisms to capture some of these benefits and make them available for conservation. The economic valuation provides an estimate of the stream of benefits and opportunities over time. The present value is an estimate of all benefits (including future benefits) that would be lost in the absence of conservation.

2. Methods

2.1. Economic framework

The study determined the economic value of coastal and marine resources of Danajon reefs based on the Total Economic Value framework as shown in Fig. 2. This analysis focused on three ecosystem services important for coastal communities in the Philippines: (1) fisheries - key provisioning service of coral reefs, important for subsistence and livelihood; (2) ecotourism - has high economic potential for the local economy; and, (3) shoreline protection – important ecosystem service for typhoon-prone areas. Use value measures the consumptive value (direct use values) of tangible natural resources such as fish and shellfish, as well as non-consumptive (indirect use values) ecological and recreational uses. Use value consists of direct, which can be classified as —goods‖ and indirect use values, which can be classified as —services‖. Direct use values associated with major economic sectors will be estimated using the equation,

$$NPV = \left(\sum_{t=0}^{T} B_i - \sum_{t=0}^{T} C_i\right)/(1+r)^t \quad (1)$$

where *NPV* = net present value, *B* = benefits of each sector, *C* = costs of each sector, *i* = sector, *t* is the year, and *r* is the social discount rate. Local values were converted to US dollar using 1 USD = 42.79 PHP (2011).

A variety of economic valuation techniques were used to estimate monetary values for as many goods and services as possible. Both market and non-market values were measured. Net revenues were obtained, as these represent ecosystem —rents‖ after deducting the costs of bringing ecosystem goods and services to market. Table 1 lists goods and services that typically dominate the overall valuation of a marine habitat, and shows the valuation method applied. All costs and revenues were calculated using empirical data collected using survey instruments.

Annual revenues were calculated by multiplying average monthly revenues during peak and lean months with the average reported number of peak and lean months, respectively. For shoreline protection, the benefits transfer method is used based on USD 1,320 annually or USD 473/km^2 (Hargreaves-Allen, 2004) indirect benefit of coastal protection from coral reefs in Indonesia.

The results are a static estimate of ecosystem values at the time data are collected and projections of future values over a 20-year time horizon. The valuation estimates will reflect, at the minimum, the magnitude of potential losses due to improper management of coastal and marine resources.

2.2. Data collection

Data collection methods included a review of secondary literature and reports, focus group discussions, survey instrument on socioeconomic activities, and a contingent valuation questionnaire. Data gathered from secondary sources included the scientific or peer reviewed literature for qualitative description of all goods and services derived from marine ecosystems contained in the Danajon outer reef, including seagrass and mangrove systems; and existing socio-economic profiles of the local communities and resource users of coastal and marine resources.

Prior to the field data gathering, each of the 17 Municipal Mayors in the Danajon reef area were formally informed of the upcoming activities in their respective coastal villages. The purpose of this important communication in this economic valuation process is to ensure that local leadership will appreciate the true economic value of their natural resource base and support the initiative to conduct a resource valuation study about this unique double barrier reef. Rowe and Frewer (2005) have emphasized public communication, consultation and participation as necessary processes for public engagement. Although, considerable human effort is required to set up the structured interviews and group discussions/meetings (Brown and Reed, 2009), participatory economic valuation included three focus group discussions conducted with different stakeholder groups, including tourists, fishermen, local government representatives and community members for this research. The purpose of the group discussions was to obtain information that only specific resource users or stakeholders are knowledgeable about and to help validate information from the field survey. The duration of each discussion was at least one hour with 12–20 participants per group. The participants in each focus group discussion varied based on the resource concern being discussed:

Focus group discussion on tourism, held on 13 July 2011 in Mactan, Cebu.

- mainly dive shop operators discussing local trends in their business during lean and peak months, and the potential benefits to their livelihood if the Danajon reefs will established as a marine park.

Focus group discussion on MPA enforcement, held on 15 July 2011 in Buenavista, Bohol.

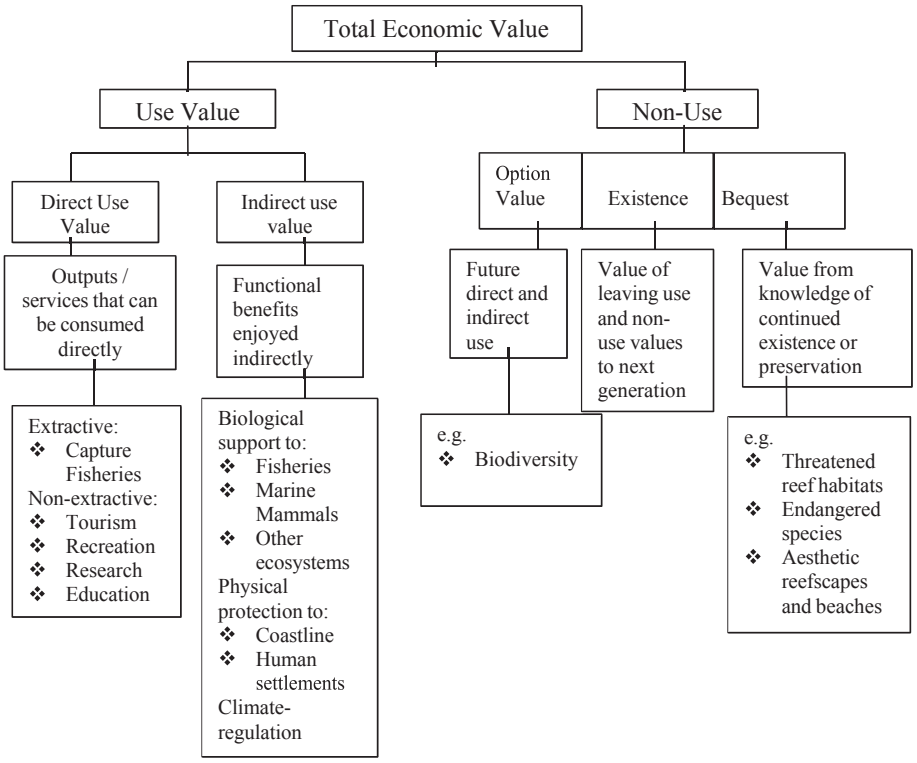

Fig. 2. Total economic valuation framework.

Table 1
Ecosystem service and valuation methods.

Good/service		Methodology	Variables
Fisheries	Municipal Subsistence	a) . Market value b) . Benefit Transfer c) . Additional data	a) . Catch data and estimate • . numbers and demographics of individuals involved with each fishery • . Landings (volume) by major species • . Proportion landings in/near marine park • . Costs associated with each gear type • . Catch per unit effort b) . Based on literature (get data from physical/ecological study); link to estimates of fishing effort from fishermen, c) . Fisher survey and/or household survey (link to socio-economic study)
Tourism	Direct: - . tourist trips - . accommodation - . employment - . other services Recreational and aesthetic benefits	• . Market value • . Multiplier effect • . Consumer surplus	Use number of tourists for Mactan and Panglao records. Then collected income and expenditure data from these using tour operator survey. Include employment numbers, wages etc. Establish within travel cost survey nights spent in Mactan/Cabilao and other expenses. Used previously collected hotel data and choose multiplier which is industry and regionally specific (from literature/government) User fee and visitor entry data. Plus tourist survey to combine with willingness-to-pay (Contingent valuation)
Shoreline protection values		• . Benefit transfer	Damage costs avoided or preventative expenditure.

– mainly wardens and Municipal Agricultural Officers in the area discussing illegal activities (e.g., poaching) in their respective areas and anticipated enforcement costs (e.g., surveillance, apprehension) if the Danajon reefs are established as a marine park.

Focus group discussion on seaweed farming, held on 18 July 2011 in Bien Unido, Bohol.

– mainly seaweed farmers discussing trends in their seaweed farming activities in the past five years, and potential benefits to the seaweed farming sector if the Danajon park is established.

Field data gathering started in July through September 2011 in 17 municipalities in four provinces within two administrative regions. The socioeconomic survey instrument was a structured questionnaire which included the number of coastal and marine resource users, household income from major occupation, fish landings and value, catch per unit effort, fishing costs per trip. This survey was administered to 691 randomly selected respondents from coastal villages.

For the contingent valuation method, data were collected from key informant interviews and a contingent valuation questionnaire. For the key informant interview, dive business owners and employees were selected as key informants for their expertise and

experience with dive tourism and their ability to provide detailed information about the dive potential of Danajon Bank, challenges and opportunities that may arise for expanding dive tourism to Danajon Bank, and potential dive business support to marine conservation efforts. Key informants were selected by identifying dive businesses within the region of Danajon Bank, for they are the most likely to access potential dive sites on the Bank. Dive businesses were identified on Mactan Island, Cabilao Island, and one in Bien Unido of Northern Bohol, in the Philippines. Dive businesses were identified and informants willing to participate were interviewed. Twenty-two face-to-face semi-structured key informant interviews were conducted, all in English, which most Filipino tourism brokers are fluent in. Written field notes were also recorded proceeding interviews, to make note of reactions, gestures, main conversational points, and things that may not be expressed in the voice recording. Data were collected during the months of July and August, 2011.

People are willing to pay for non-use, or passive use, environmental benefits. However, these benefits are usually treated as zero unless their monetary value is estimated. The key informant interviews were complemented through a contingent valuation survey, which is the most widely used method for estimating non-use values. The contingent valuation method is referred to as a

> —stated preference‖ method, because it asks people to directly state their values (i.e., assign monetary values) for non-use values of the environment—values that do not involve market purchases.

The contingent valuation method employed a hypothetical question to elicit respondents' maximum willingness to pay (WTP) for park entrance and/or diving in the Danajon reef area. The scenario provided: There is a current plan to establish a marine park that encompasses the Danajon Bank outer barrier reef. Environmental user fees may be collected and would help fund the management of the Park. A colored map of the Danajon reefs was provided showing various points of interest and potential dive sites and boat touring activities. Respondents were asked to state their maximum willingness to pay for the amenity to be valued. That is, ‗If you were traveling to Danajon Bank, what is the maximum amount that you would be willing to pay as a daily, per person entrance fee to the marine park?' The format of an open-ended question and the responses represent a direct expression of the aesthetic and recreational values of the reefs. The mode of questionnaire administration was self-administered. The contingent valuation survey was administered to 100 local and foreign tourists in six resorts on Mactan Island during the months of July to September 2011. The mean willingness to pay was calculated directly from the surveyed local and foreign respondents. Aggregation is obtained by multiplying the mean willingness to pay by the annual number of visits.

3. Results

For the economic valuation of the Danajon reef ecosystem services, the identification of relevant stakeholders was critical. Throughout this valuation, stakeholders were involved in order to identify the main relevant services and assess their values. The local stakeholders referred to here were persons or groups with concern in the way the Danajon reef ecosystem services are used, enjoyed, or managed. These stakeholders included the coastal communities adjacent to the Danajon reefs who are mostly comprised of local fishers, seaweed farmers and gleaners. Close to 80% of seaweed farmers and 40% of fishers directly use the coral reefs and marine waters, which serve as the primary location of their marine activities (Fig. 3). These stakeholder groups directly benefit from the Danajon reefs and its associated ecosystems.

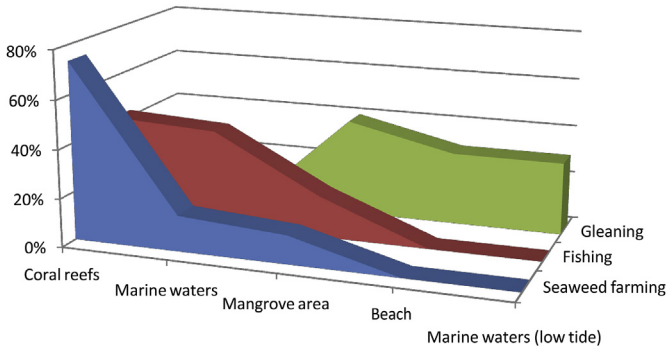

Fig. 3. Direct uses of the Danajon reefs and its associated ecosystems, n = 691.

3.1. Fishing

The local communities use the coastal resources for municipal fishing. Fishers are dependent on reefs, mangrove areas and marine waters for fish food (subsistence and commercial) and viable marine-based ventures. A majority of the fishers use the coral reefs (43%) and other marine areas, pelagic and open ocean (40%). The Coastal Conservation and Education Foundation, Inc. 2013a, reported that the most abundant fish species recorded were members of the Labrids (wrasse), observed at 234.1 ± 57.8 individuals/500 m^2. Caesionids (fusiliers) were the most abundant family (203.9 ± 87.9 individuals/500 m^2). Piscivores (ex. snapper, grouper), commercially important species, were recorded at very low levels (0.32 ± 0.28 individuals/500 m^2). Ex-vessel prices of these fishes ranged from USD0.60/kg to USD5.74/kg. The average fish catch ranged from 1.6 to 4.0 kg during lean months to 4.4–13.7 kg/fisher/day during peak months (Table 2). Only 3% of the fish catch is used for family consumption while 97% are sold. In general, November through April are considered peak fishing months. Lean months are from May to October.

Table 2
Net benefits from fishing.

Number of years fishing (mean)	22
Fishing location (% of fishers)	
Mangrove area	17
Coral reefs	43
Other (pelagic, open ocean)	40
Catch from fishing (kg)	Mean
Peak months – minimum	4.38
Peak months – maximum	13.70
Lean months – minimum	1.62
Lean months – maximum	4.09
Revenue from fishing (USD)	Mean
Peak – Min	11.51
Peak – Max	35.90
Lean – Min	4.73
Lean – Max	13.27
Cash and non-cash expenses (USD)	Mean
Daily expenses	
Fuel	7.14
Boat rental	1.25
Supplies	10.90
Hired labor	27.72
Family labor	
Monthly expenses	3.63
Annual expenses	11.86

3.2. Gleaning

Gleaning is a year round activity on Danajon reef ecosystems and on tidal flats in the ecosystem. Coastal residents, including women in fishing villages gather shellfish and invertebrates on daily basis from the shoreline to the level of the receding tide, using tools such as knives and plastic containers. While gleaning is usually conducted during low tide, small boats may be used for transport along the shoreline or to areas further from their residence. Gastropods and bivalves are major species gleaned from intertidal areas and seagrass beds. Echinoderms are harvested mainly for consumption while molluscs are sold at local markets. In the Philippines, most gleaned shellfish and invertebrates are not estimated because their catch is believed to be small, consisting of species of low value. The results from this survey document gleaned catch of 1.3–3.9 kg/day during peak months (Table 3). The relative catch from gleaning on Pamilacan Island, Philippines and what it was worth back in 1986 contributed 7.1 t/km^2/year or 40% of the total reef fish yield (Savina and White, 1986).

3.3. Seaweed farming

Bien Unido, Bohol is where a majority of the seaweed farms are located. Coastal residents in this area consider seaweed farming as a primary source of income and a main source of livelihood. Compared to five years ago, there is an increase in seaweed farmers from 100 to 300, the reason stated is that seaweed farming ensures more income compared to fishing and is considered a viable livelihood and a potential attraction for tourists. Most farms are one hectare and the usual farming method is the off-bottom which consists of approximately 2000 single lines per hectare. Seaweed is mostly for selling after it is dried (7:1 fresh-dry ratio). Peak months for seaweed farming are August–December (Table 4). On average, seaweed farmers invested USD67.65/month for of *Kappaphycus* sp. seedlings, bamboo and labor. During lean months, net revenues ranged from USD19 – 70 per month. During peak months, net revenues from seaweed farming ranged from USD58 – 140 per month. The coral reef area is where most seaweed farming is done.

Table 3
Net benefits from gleaning.

Number of years gleaning(mean)	13
Fishing location (% respondents)	
Mangrove area	40
Beach	30
Other	30
Catch from gleaning (kg)	Mean
Primary gear	
Peak – Min	1.33
Peak - Max	3.86
Lean - Min	0.83
Lean - Max	1.71
Secondary gear	
Peak - Min	0.00
Peak - Max	9.00
Lean - Min	50.00
Lean - Max	2.00
Revenue from gleaning (USD)	Mean
Primary gear	
Peak - Min	1.32
Peak - Max	17.13
Lean - Min	0.76
Lean - Max	3.77
Secondary gear	
Peak - Min	0.00
Peak - Max	7.36
Lean - Min	1.17
Lean - Max	1.75
Cash and non-cash expenses (USD)	Mean
Daily expenses	
Fuel	0.70
Boat rental	0.47
Supplies	10.52

Table 4
. Net benefits from seaweed farming.

General information	*Mean*
Number of years farming	9
Size of farm	453.65
Location	% respondents
Mangrove area	26
Coral reef area	74
Purpose of catch	% respondents
Personal consumption	0
Selling	100
Quantity harvested (kg dry)	Mean
Aug–Dec (1st crop)	
Min	3000
Max	4000
Jan–Jun (2nd crop)	
Min	1000
Max	2000
Expenses (USD)	Mean
Boat rental	
Supplies – bamboo	116.85
Supplies - rope/nylon	186.96
Seedlings/fingerlings	934.80
Hired labor	46.74
Annual permit	15.19

3.4. Tourism

Tourism contributes to the local economy of many coastal communities as a variety of tourist activities take place in the coastal areas of Mactan Island and northern Bohol. These activities are mainly SCUBA diving, swimming, snorkeling, beach combing, boating, sun bathing, some recreational fishing and visiting fishing villages. Bien Unido municipality in northern Bohol, as well as the Cordova municipality and Lapu–Lapu City on Mactan Island in Cebu, are endowed with historical places and scenic attractions such as white beaches and underwater cultural sites. With the variety of recreational activities in the Danajon reef area, there is potential for tourism development.

Tourism in Danajon Bank is reported by Kuklok (2012) with Bohol Island as a popular tourist and dive destination with 102,930 foreign tourists and 231,282 domestic tourists in 2010.

Foreign tourists comprise about 30% of the total visitors. Tourism revenues include direct revenues (e.g., diver fees and park entrance fees) and indirect (private sector) revenues (e.g., lodging and resort accommodation, dive operations and restaurants). Peak months for tourism are January–February and May through December. The average age of the surveyed tourist was 29 years old, traveling on average for 6 days with at least one companion. In terms of annual income, 70% of foreign visitors' income was at least USD60,000/year and 60% of local tourists' income was below USD20,000/year. The average tourist expenditure per day for foreign and local visitors was USD215 and USD35, respectively.

When asked the question, _If you were traveling to Danajon Bank, what is the maximum amount that you would be willing to pay as a daily, per person entrance fee to the marine park?', the entrance fee of respondents' interviewed ranged from USD 0.50–35.00 for local tourists and USD 2–40 for foreign tourists. The median entrance fee that tourists would be willing to pay is USD 4 and USD 14 for local tourists and foreign tourists, respectively. The value of coral reefs for recreation along the Danajon double barrier

Table 5
Economic values of coral reef ecosystems in the Philippines.

Location of coral reef ecosystem in the Philippines	Economic value results		Reference/author
	Annual net revenue (million USD)	Present value per unit area (USD/ha)	
Olango Island	1.53–2.54	383–634	White et al., 2009
Moalboal	0.15–0.22	233–359	White and Rosales, 2003
Bohol	1.26	805–3526	Samonte-Tan et al., 2007
Lingayen Gulf	4.7	600	Ahmed et al., 2006
Danajon reefs	6.4	227	This study

reefs has a potential net annual return to the local economy of USD3.06 million. This value demonstrates that specific economic activities are dependent on functioning Danajon reef ecosystems. The values generated for Danajon reefs fall within a spectrum of valuation for Philippine coral reefs (Table 5).

3.5. Shoreline protection

Surrounded by Region VIII (Eastern Visayas), Central Visayas does not get many typhoons but does occasionally receive strong storms as seen in the last 3 years. The Danajon coral reefs serve as natural barriers to storm surges that can cause destruction to coastlines and communities. This is an indirect use value for the control of coastal erosion or damage protection from storms, wave action and wind. The indirect benefit of coastal protection from Danajon double barrier reefs was estimated to be worth USD 557.01/km^2 (adjusted 2011 USD). This estimate was based on USD1,320 annually or USD473/km^2 (Hargreaves-Allen, 2004) indirect benefit of coastal protection from coral reefs in Indonesia. Losing the Danajon natural reef barrier may have significant physical and economic effects on the local communities who live in coastal areas near the coral reefs.

3.6. Total economic value

The economic value of the marine resources of Danajon reefs is estimated using Equation (1), based on the total economic value (TEV) framework. The TEV of the Danajon reef ecosystem consisted of use values, each of which were further disaggregated in several value components. Direct use value is generated from direct human use of reef ecosystem (consumptive or non-consumptive) and indirect use value is derived from the regulation services provided by reef ecosystem. Use values can be associated with private or quasi-private goods, for which market prices usually exist. Use values are sometimes divided further into two categories: (a) Direct use value, related to the benefits obtained from direct use of ecosystem service. Such use may be extractive, which entails consumption (for instance of fish and shellfish for food), or non-extractive use (e.g., aesthetic benefits from coral reefs). (b) Indirect use values are usually associated with regulating services, such as the physical protection to coastline or erosion prevention, which are public services generally not reflected in market transactions.

The use values, which measure the consumptive value or direct use values of tangible natural resources as well as non-consumptive or indirect use values of natural resources were estimated (Fig. 4). Net revenues ranged from USD56/month to USD210/month during peak months, which were in general from November to April. Although the marine activities occurred year round, net revenues were less during months where an individual's number of hours spent at sea per day was limited due to roughness of waves. The net revenues from gleaning and municipal fishing decreased the most by at least 70% during lean months. Overall, municipal fishers' net revenues were less than commercial fishers.[1]

The present value of the stream of net benefits derived from the marine resources of the Danajon bank over a 20-year period using a 10% discount rate, amounts to USD 59.6 million (Fig. 5). The total economic value of the marine resources is USD 6.27 mil/year. The tourism and fisheries sectors were the major economic sectors generating annual direct use values from the marine resources of USD 3 mil/year and USD 2 mil/year, respectively (Fig. 6). For shoreline protection, indirect use value is estimated at USD 150,393/year. Other values are gleaning and seaweed farming which account for 13% of the total economic value.

The Danajon bank double barrier reef, which covers an area of approximately 1% of the total coral reef of the Philippines estimated to be 27,000 km^2, are diverse and productive. Thus, the use values attributed to the direct utilization of ecosystem services provided by the Danajon reefs are significant. The importance of the Danajon coral reefs to the local economy contributes USD3.46 million or more than half (56%) of the economic revenues from fishing, dive tourism, seaweed farming and shoreline protection (erosion prevention) in the Danajon area (Table 6). The associated habitats which are also critical and included mangroves, beach and marine waters when combined, generated the remaining revenues of USD2.77 million from fishing, tourism, seaweed farming and gleaning.

4. Discussion

In the Philippines and in general, municipal fishers are considered the “poorest among the poor”.[2] In 2000, households whose heads were fishers had a significantly higher poverty incidence than households in general. Their daily income was roughly the retail value of 2 kg of fish. Low incomes can be attributed to declining fish catch, estimated to be about 2 kg per day, down from the 20 kg per day that was the average catch during the 1970s (Israel, 2004). After a decade, this situation has not changed much. In terms of the poverty incidence, one out of five Filipino families was estimated to be poor in 2012.[3] The poverty incidence among families in this region, where the Danajon reefs are central, is about 27%, which is higher than the national average of about 20%. It is essential to emphasize the importance of the Danajon reefs as a large marine ecosystem generating goods and services for the people in the region. The Danajon reefs are essential to the

[1] Municipal fisheries refer to fishing done in inland and coastal areas with or without the use of a fishing boat of up to three gross tons. Commercial fishing refers to fishing done in offshore waters using fishing vessels of more than three gross tons.

[2] http://www.greenpeace.org/seasia/ph/PageFiles/616503/Roadmap_to_Recovery_July_2013.pdf.

[3] A family of five will need around PhP 5513 (USD120) monthly income to buy their minimum basic food needs; and around PhP 7890 (USD172) monthly for their minimum basic food and nonfood needs (National Statistical Coordination Board (NSCB) http://www.nscb.gov.ph/poverty/2012/highlights_fullyear.asp.

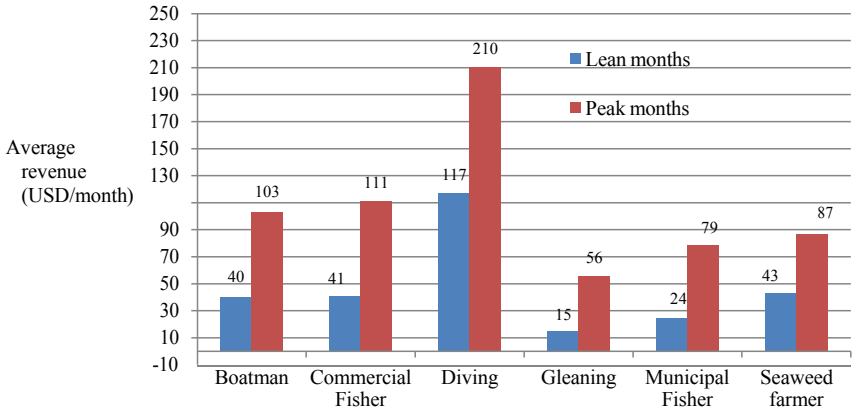

Fig. 4. Revenues obtained from marine related activities benefiting from the Danajon Reef area ecosystems, Philippines, 2011.

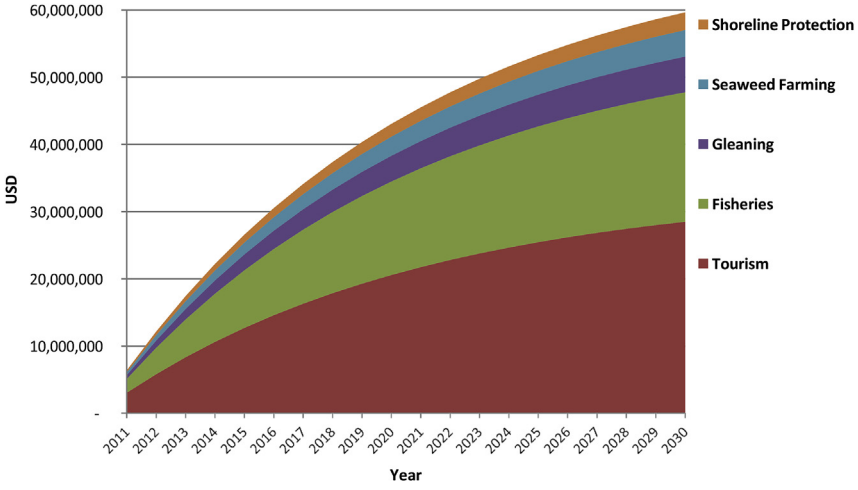

Fig. 5. . Cumulative economic value from Danajon reefs, Philippines, 2011.

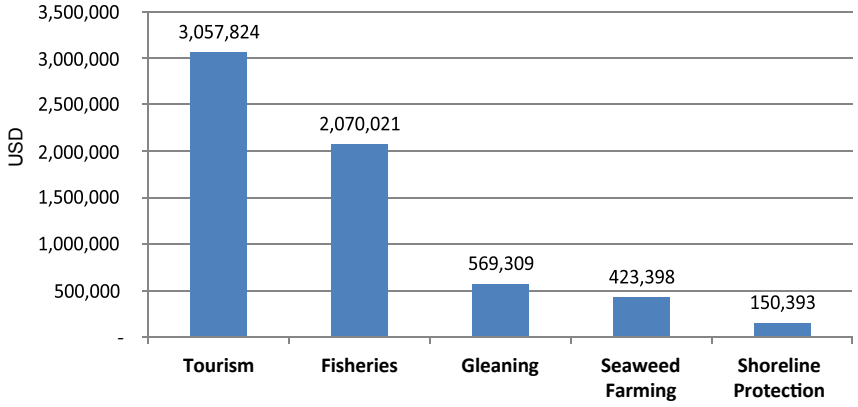

Fig. 6. Annual net benefits from Danajon reefs, Philippines, 2011.

livelihood of at least 771,570 people living in the 17 coastal municipalities within the three surrounding provinces (NSO, 2012). The loss of coral reefs impacts fisheries, thus limiting the livelihood options in low-income areas.

4.1. Inter-governmental cooperation

In January 2012, these economic valuation results (including other relevant studies), which were presented during the Danajon Bank Summit participated in by all Local Government Units 9 LGUs) encompassing the Danajon Reef, triggered an inter-local government cooperation under the principle of local autonomy enshrined by the 1987 Constitution and the Local Government Code.

After a series of consultations, a Danajon-wide management council was formed in May 2012. The partnership between and among the 19 municipal and/or city governments and 4 provinces

Table 6
Ecosystem values by habitat type.

Resource use	Net benefits (USD, 2011)			
	Coral reefs	Marine waters	Mangrove area	Beach
Tourism	2,130,023	–	304,289	608,578
Fishing	876,934	829,850	353,128	–
Gleaning	–	–	339,917	226,612
Seaweed farming	309,801	61,960	49,568	–
Shoreline protection	150,393	–	–	–
Total	3,467,151	891,810	1,046,902	835,190

in 2 administrative regions were forged through a Memorandum of Agreement (MOA) that formally created the Danajon Double Barrier Reef Management Council to enable collaborative management of this large marine ecosystem. The council is governed by a Governing Board consisting of 5 local chief executives from the provinces and one urbanized city.

The framework plan for the management of Danajon was completed in 2013 after consulting with key stakeholders. The governance framework identifies common management strategies and action plans that will harmonize policies and complement resource protection with other sustainable activities. The Danajon Double Barrier Reef Governance Framework plan (Coastal Conservation and Education Foundation Inc, 2013b) which was a result of a series of stakeholders' consultation is one of the key steps toward the realization of Danajon as a marine-managed area. This was participated in by selected representatives of all four provinces and 19 municipalities. It forms part of an intrinsic platform for the LGUs to collaborate and cooperate to achieve a common goal for Danajon Bank.

In addition, one policy that also paved the importance of Danajon bank in the national government agenda is the Memorandum Circular that was issued mandating all LGUs to attend regular meetings of the Danajon Double Barrier Reef Management Council (DDBRMC). The target participants of the Technical Working Group meetings thereafter were the representatives from the Local Government Units, primarily the City and/or Municipal Environment and Natural Resources Officers, Provincial Environment and Natural Resources Officers, City and or Municipal Agriculturist Officers and City and/or Municipal Planning and Development Coordinators.

The DDBRMC, consisting of all component municipal and city mayors, decided to focus their initiatives on five commonly-agreed focal programs. These are: fisheries and habitat management, coastal law enforcement, climate change adaptation and disaster risk management, ecotourism, and capacity building-education. These nascent efforts at inter-local government unit collaboration sought to address the needs for reef management, and also explore options for its sustainable financing.

4.2. Sustainable financing

Current financing of reef management is insufficient considering the threats of land- and marine-based activities that cause irreversible damages to the reefs. In a recent study, results showed that visitors to marine managed areas were generally willing to pay more to enter the park than they were required to pay, meaning that there are opportunities for increasing management funds (Samonte et al., 2010). Tourism is a growing economic sector. It is estimated that coral reefs alone contribute at least USD1.06 billion annually to the Philippine economy (Burke, et al., 2012). Particularly, dive tourism in the Philippines has only a few substantial international dive destinations such as the Tubbataha Natural Park and Apo Reef in Mindoro which are accessible only about 4 or 5 months a year due to rough seas. Danajon as a unique double barrier reef provides a viable alternative and is accessible year round. This study found that diver tourists were willing to pay a positive amount to enter the Danajon reef park. Based on the willingness-to-pay valuation, an appropriate diver visitation fee is estimated USD 14 for foreign tourists and the local tourist fee is USD 4 per person before they would enter the Danajon marine park for scuba diving. This suggests that the establishment of an entrance fee to cover park maintenance and management costs is a feasible option. With proper training, local residents could work as dive boatmen and provide services to park visitors.

In rural economies, sustainable mechanisms for funding livelihood activities of resource users are inadequate and mostly not institutionalized. The economic values generated can be used to establish sustainable funding mechanisms to finance ecotourism in the area and provide incentives to the MPA managers. One of the major economic drivers of growth in Central Visayas (Bohol, Bien Unido and Cebu) region in recent years has been tourism. In 2010, 712,400 foreign tourists and 1,059,834 domestic tourists traveled to Cebu, a 9.6 percent increase from 2009 (Department of Tourism Philippines, 2012). The establishment of a two-tier park fee is a feasible option as implied from the willingness-to-pay results. Foreign visitors are willing-to-pay 300 percent more at USD13.70 than local visitors at USD3.40 to enter the Danajon marine park. The potential park revenue is estimated at USD7,500 per year based on a conservative number of 1000 tourists (both foreign and local).

Danajon reefs generate revenue from more than one economic activity-fishing, tourism, seaweed farming. Efforts must be exerted to maintain the diversity and productivity of Danajon reefs to sustain the benefits. The challenge is to ensure that benefits derived from Danajon reefs sources are optimized now and in the future. All marine ecosystems of Danajon reefs contribute to the local economy in terms of use and non-use values. Non-use values from ecosystems are those values that do not involve direct or indirect uses of the Danajon reef ecosystem. They reflect satisfaction that individuals derive from the knowledge that ecosystem services and species are maintained and that other people have or will have access to them (Kolstad, 2000). In the first case, non-use values are usually referred to as existence values, while in the latter they are associated with altruist values (in relation to intra-generational equity concerns) or bequest values (when concerned with inter-generational equity). It should be noted that non-use values involve greater challenges for valuation and is beyond the scope of this study.

The benefits generated from marine resources include direct benefits from fisheries, seaweed farming, gleaning, and recreation/tourism; and indirect benefits as reflected from the shoreline protection. The marine resources generate direct and indirect values. Mangroves and coral reef areas yield a value at USD 6.4 million in annual benefits. This implies that in terms of management efforts, the protection and conservation of mangroves and coral reefs should be prioritized. With these corresponding values, appropriate financial and human resources should be allocated for the protection and conservation of these vital coastal resources.

The benefits of these coastal resources will continue over time if appropriate conservation efforts are undertaken. The present value of the stream of net benefits derived from the marine resources of Danajon over a 20-year period using a 10% discount rate,[4] amounts

[4] The National Economic Development Authority (NEDA) uses discount rate between 10% and 12%. The lower discount rate of 10% used in this study as a more conservative rate. The present value of gross revenue under the Danajon reef park management calculated using a 10% discount rate, is almost double that under business as usual.

to USD 59.6 million. This implies that the current net benefits are dependent on the quality of the coastal and marine resources for these benefits to continue into the future. Another way of viewing this is in terms of economic losses. If these coastal resources are not protected and destructive economic activities are allowed to continue, then present value economic losses equivalent to USD 6.4 million on an annualized basis will be incurred. The bottom-line is that we cannot value all the ecosystem service benefit. The global estimate of the total value of an average hectare of coral reefs ranges between USD490/year for the total bundle of ecosystem services that can potentially be provided to almost USD 350,000/year (De Groot et al., 2012). The values estimated for the Danajon reefs present the lower limits of potential the ecosystem service values, which will help to increase financial revenue to support conservation efforts. In the long run, sustained livelihood of people dependent on this large marine ecosystem can be achieved.

5. Conclusion

The Danajon reefs produce many ecosystem services that are often underestimated and even ignored in fundamental decision-making. An example of this gap in information is shoreline protection. As storms appear to be increasing in the area based on the last few years, the value of the reefs derived from water surge and waves generated by storms is increasing. The extent of the Danajon reefs protects a coastline of almost 700 km and 17 coastal towns/communities predominantly dependent on fishing for their livelihoods and main food source. By estimating the value of the Danajon reef ecosystems in monetary terms, the value of ecosystems services are made explicit to inform economic decision-making.

This study shows that the Danajon reef ecosystem supports several economic activities which are crucial for the economic development of the local community as well as the improvement in the quality of life of the coastal community. These values will be used as a basis to promote policies and livelihood options that reinforce the establishment of the Danajon‘s management council that seeks to collaboratively govern this large marine ecosystem. The results will also inform the regional, provincial and local government units and relevant government agencies about guidelines for the development of appropriate user fees that support the economic and environmental sustainability of local fishing and ecotourism industry in the provinces of Cebu, Bohol, Leyte and Southern Leyte.

The process of identifying local the stakeholders, engaging them in the economic valuation and characterizing their individual reasons for conserving different reef ecosystem services could facilitate the establishment of the Danajon reef large marine park and help support better policies. The local policy-makers and decision makers should recognize that there are huge economic benefits derived from coastal resources. Occupational-multiplicity is common for the fishermen located along the coastal areas adjacent to the Danajon reefs. The more marine-based occupations an individual or household is engaged in, the more dependent the individual or household is on the Danajon reefs. This further indicates that the marine resources of the region are very important to the community. Reducing stress on the marine resources will require recognition of other livelihood options. There is potential for ecotourism as a viable livelihood option that could address the problems of resource degradation. More than 75 percent of the coastal households are fishers, and with the establishment of the Danajon reefs as a marine park, it can be expected that there may be a gradual shift in communities‘ livelihood from extractive (fishing) to non-extractive uses (engaging in tourism-related livelihood). For example, the effectiveness of coastal resource management, which includes marine protected area establishment, relies on management programs that create opportunities or incentives that replace unsustainable fishing practices and catalyze local revenue generation. The net benefits of marine conservation are improved livelihood opportunities to local coastal communities and shared benefits across economic sectors (i.e., fisheries, tourism).

Finally, the local policy-makers and decision makers should recognize that there are huge economic benefits derived from marine resources. More importantly, the local policy-makers and decision-makers should not doubt that any economic activity which will adversely impact on reef habitats, mangroves, and seagrass in particular and on the marine water quality in general, will have corresponding severe effects on the environment as well as on the socio-economic well-being of the community.

The local government and concerned organizations must therefore maintain the diversity, health and productivity of marine ecosystems to sustain these benefits. The stakeholders of Danajon reefs should effectively regulate and manage their marine resources as these are the foundation towards obtaining basic needs and improving the quality of life of coastal communities.

Without any economic activity which may cause damage to Danajon reefs, and with appropriate conservation measures,[5] the present value net benefits from the marine resources will continue into the future. However, if unsustainable livelihood continues and degradation of the marine resources prevails, this will lead to a decline in the benefits derived from these resources. Unless unsustainable livelihood is mitigated or the Danajon reefs are managed (e.g., National marine park), the economic losses may continue to increase until such time that the coastal and marine resources will be unable to generate benefits to the community. This research contributes to the knowledge gap particularly on how governance and reef management may impact difficulty in the coastal areas by recognizing the current economic gains and the importance of conserving the Danajon reefs for future generations. This information is especially important for local decision makers who may lack a full understanding of how a coral reef ecosystem, such as Danajon, can generate real economic and human use values for people in their areas of jurisdiction.

The values generated demonstrate that the Danajon reefs provide mutually-compatible services as indicated by the stakeholders, both local foreign, use and stated values. The establishment of the Danajon marine park will require the cooperation among the Local Government Units in enforcing park boundaries to mitigate unsustainable fishing practices. Without this intervention, these ecosystem benefits cannot be sustained. This study identified the stakeholder groups that receive large benefit flows, from which funds could be extracted. The potential financing sources for conservation through the collection of park fees is worthwhile to help make conservation financially sustainable.

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[5] Conservation measures may range from direct measures such as establishment of marine protected areas to indirect economic incentives such as alternative livelihood.

participants in the Danajon Bank area who participated in the survey used to gather the information essential for this study.

References

Ahmed, M., Umali, G.M., Chong, C.K., Rull, M.F., Garci, M.C., 2006. Valuing recreational and conservation benefits of coral reefs: the case of Bolinao, Philippines. Ocean Coast. Manag. 50, 103–118.

Amper, Z.H.S., 2004. Indigenous development amid national development: the case of mangrove reforestation in Banacon Island, Getafe, Bohol. Philipp. Q. Cult. Soc. 32 (3/4), 237–258 (Cebu: San Carlos Publications).

Armada, N., White, A.T., Christie, P., 2009. Managing fisheries resources in Danajon Bank, Bohol, Philippines: an ecosystem-based approach. Coast. Manag. 37, 308–330.

Brown, G., Reed, P., 2009. Public participation GIS: a new method for use in national forest planning. For. Sci. 55, 166–182.

Burke, L., Selig, E., Spalding, M., 2012. Reefs at Risk in Southeast Asia. World Resources Institute, Washington D.C.

Calumpong, H.P. (Ed.), 2004. FISH Project—Baseline Assessment in Danajon Bank. Silliman University Marine Laboratory, Dumaguete City, Philippines, p. 169.

Calumpong, H.P., 2005. Baseline assessment of Danajon Bank, Bohol. Coast. Curr. Newsl. 7 (1), 9–10. Silliman University Marine Laboratory.

Christie, P., Armada, N., White, A., Gulayan, A., de Dios, H., 2006. Coastal environmental and fisheries profile of Danajon Bank, Bohol, Philippines. Fish. Improv. Sustain. Harvest FISH Proj. 63. Cebu, Philippines.

Coastal Conservation and Education Foundation Inc, 2013a. A Profile of Danajon Bank Philippines: a Portfolio of the Coastal Resource/Socio-economic Status and Coastal Resource Management Programs in Danajon Bank, p. 48. Cebu City, Cebu, Philippines.

Coastal Conservation and Education Foundation Inc, 2013b. Danajon Governance Framework. Coastal Conservation and Education Foundation Inc, Cebu City, Philippines, p. 29.

Department of Tourism Philippines, 2012. Tourism Statistics. Quezon City. Philippines.

Green, S.J., Alexander, R.D., Gulayan, A.M., Migrino III, C.C., Jarantilla-Paler, J., Courtney, C.A., 2002. Bohol Island: Its Coastal Environmental Profile. Bohol Environmental Management Office and Coastal Resource Management Project, p. 174. Cebu City, Philippines.

Green, S.J., Flores, J.O., Dizon-Corrales, J.Q., Martinez, R.T., Nunal, D.R., Armada, N.B., White, A.T., 2004. The fisheries of Central Visayas, Philippines: status and trends. Coastal Resource Management Project of the Department of Environment and Natural Resources and the Bureau of Fisheries and Aquatic Resources of the Department of Agriculture, Cebu City, Philippines, p. 159.

Grobe, H., Willkom, H., Wefer, G., 1985. Internal structure and origin of the double reefs of north Bohol and Olango Reef Flat (Philippines). Philipp. Sci. 22, 83–94.

de Groot, R., Brander, L., van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L., ten Brink, P., van Beukering, P., 2012. Global estimates of the value of ecosystems and their services in monetary units. Ecosyst. Serv. 1, 50–61.

Hargreaves-Allen, V., 2004. Estimating the Total Economic Value of Coral Reefs for Residents of Sampela, a Bajau Community in Wakatobi Marine National Park, Sulawesi: a Case Study. MSc Thesis. Facility of Life Sciences, Imperial College of Science, Technology and Medicine, London.

Israel, D.C., 2004. Economics and environment in the fisheries sector, p.131–137. In: Seas, Turbulent (Ed.), DA-bfar (Department of Agriculture-Bureau of Fisheries and Aquatic Resources). The Status of Philippine Marine Fisheries, Coastal Resources Management Project, Cebu City, Philippines., p. 378

Kolstad, C.D., 2000. Environmental Economics. Oxford University Press, New York, Oxford.

Kuklok, A., 2012. Assessing the Feasibility of Expanding Dive Tourism to Danajon Bank, Philippines (A thesis submitted in partial fulfillment of the requirements for the degree of Master of Marine Affairs, School of Marine and Environmental Affairs, University of Washington).

Lucas, Ethan Y., 2010. Outer Danajon Bank, Philippines: Biophysical State, Local Resource Use Patterns, and Feasible Governance Structures for a Large-scale No-take Marine Protected Area. Thesis (M.M.A.)-University of Washington, 2010.

National Statistical Coordination Board (NSCB) http://www.nscb.gov.ph/poverty/2012/highlights_fullyear.asp.

National Statistics Office (NSO), 2012. Total Population by Province, City, Municipality and Barangay: as of May 1, 2010, 2010 Census of Population and Housing. http://www.census.gov.ph/content/2010-census.

Perennou, C., Mundkur, T., Scott, D.A., Follestad, A., Kvenild, L., 1994. The Asian Waterfowl Census 1987 – 91: Distribution and Status of Asian Waterfowl. Asian Wetland Bureau (AWB), Kuala Lumpur, Malaysia, and International Waterfowl and Wetlands Research Bureau (IWRB), Slimbridge, United Kingdom. AWB Publication No. 86 and IWRB Publication No. 24, p. 372.

Pichon, M., 1977. Physiography, morphology and ecology of the double barrier reef of north Bohol (Philippines). In: Proceedings of the Third International Coral Reef Symposium, Miami, USA, pp. 261–267.

Rowe, G., Frewer, L.J., 2005. A typology of public engagement mechanisms. Sci. Technol. Hum. Values. Sci. Technol. Hum. Values 30, 251–290.

Samonte, G., Karrer, L., Orbach, M., 2010. People and Oceans. Science and Knowledge Division, Conservation International, Arlington, Virginia, USA.

Samonte-Tan, G., White, A., Tercero, M.A., Diviva, J., Tabara, E., Caballes, C., 2007. Economic valuation of coastal and marine resources: Bohol marine triangle, Philippines. Coast. Manag. 35 (2), 319–338.

Savina, G.C., White, A.T., 1986. Reef fish yields and non-reef catch of Pamilacan Island, Bohol, Philippines, p. 497–500. In: Maclean, J.L., Dizon, L.B., Hosilos, L.V. (Eds.), The First Asian Fisheries Forum. Asian Fisheries Society, Manila, Philippines.

White, A.T., Rosales, R., 2003. Community-oriented marine tourism in the Philippines: role in economic development and conservation. In: Gosling, S. (Ed.), Tourism and Development in Tropical Islands: Political Ecology Perspectives. Edward Elgar Publishing, Cheltenham, pp. 237–263.

White, A., Ross, M., Flores, M., 2009. Benefits and costs of coral reef and wetland management, Olango Island, Philippines. In: Lasmarias, N.C., Sumalde, Z.M., Tongson, E.E. (Eds.), Readings on the Economics of Climate Change and Natural Resource Management. REAP-REECS-EEDPSEA, Manila, Philippines, p. 247.