INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 23, No. 2, p. 108-117, 2023
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Economic valuation and perceptions on mangrove resources: toward mangrove conservation and management in Nabago, Surigao City

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Article published on August 15, 2023

Key words: Economic valuation, Mangroves, Perception, Training needs assessment, Nabago, Ecosystem services

Abstract

Despite their abundant services, mangroves are among the most threatened ecosystems in the world. Household interviews conducted in Nabago, Surigao City determined the direct use values (DUV) and indirect use values (IUV) of mangrove products and services using market price for DUV and Replacement Cost Method for IUV. Residents may also directly contribute to the alteration of ecosystems; hence, this study included the extent of local knowledge, attitudes, and training needs concerning Nabago's mangrove resources. Mangrove aquatic biota provides an annual direct benefit of Php103,262.00/ha/year, while commercial aquaculture, PhP509,433.96/ha/year. Overall, the potential DUV of the entire mangrove ecosystem of Nabago is Php4,149,303.88/year. IUV for coastal protection, wind barrier, protection from extreme sunlight, protection from saltwater intrusion, and carbon sequestration has a total benefit value of PhP68,568,598.22/year. The total annual DUV and IUV of the mangrove ecosystem in Nabago is around Php 72.72 million, of which the IUV is 94% of the total benefit value. High awareness of the ecological functions of the mangrove ecosystem and a positive attitude toward mangrove protection implies that the locals see the intrinsic value (i.e., valuing the forest for its existence) and attach a bequest value to the mangroves to preserve these for future generations. Mangrove monitoring, conservation, management, restoration, and rehabilitation were the top training needs compared to aquaculture training. Dissemination of valuation results and economic empowerment is necessary to inform stakeholders of the value of their mangrove ecosystem and discourage possible conversion of the forests in favor of development in the area.

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Introduction

Mangrove forests are diverse ecosystems with complex relationships among animal and plant species. Mangrove forests play a vital role in terms of social, economic, and ecological functions (Mariana, 2016). Mangrove forests also serve as a buffer against strong ocean waves and help protect the shores from tidal surges by reducing the wind pressure force. These trees also prevent shoreline erosion and saltwater intrusion towards the ground, filter sediments in estuarine waters, support wildlife, and are a source of renewable forest products (Bann, 1998). Despite the many services mangrove ecosystems provide, they are among the most threatened in the world as a result of climate change and other anthropogenic activities (Ward *et al.*, 2016). It has been reported that more than 50% of mangrove ecosystems have been degraded in the last century and have been significantly transformed and devastated due to human development (Laulikitnont, 2014). Researchers, academicians, stakeholders, policymakers, government, and non-government agencies are in motion to mitigate and prevent further destruction and alteration of mangroves. Indeed, restoration is the critical priority of such agencies and people (Sharma *et al.*, 2018). Community participation is also vital since they are the ones who are in direct contact with the goods and services provided by mangrove ecosystems. As the direct recipient of the goods and services, residents may also be the immediate contributor to the alteration of the mangrove ecosystem. Indigenous Peoples and Local Communities (IPLC) generally defined as ethnic groups who are descended from and identify with the original inhabitants of a given region, are affected by the global environmental change because they often rely directly on their immediate environments and local natural resources for meeting basic livelihood needs (Pecl *et al.*, 2017).

Although mangrove ecosystems provide a variety of non-market and marketed goods and services, the whole value of mangrove products is not readily available, especially the indirect use values, and thus is often neglected in conservation and development planning (Syah *et al.*, 2019). Consequently, goods and services are compromised and may affect the community in the long term, while uses of mangrove ecosystems focus on directly marketable products, such as aquaculture. A more extensive assessment of the goods and services from mangrove ecosystems can be acquired through economic valuation approaches and hence may provide more well-versed management. This study aimed to estimate the economic value of the mangrove ecosystem in Barangay Nabago, Surigao City. The economic valuation was done by identifying the benefits and functions of mangrove forest resources through the aspect of direct benefit value.

Materials and methods

Study area

Based on the 2016 Surigao City Ecological Profile, Barangay Nabago is classified as a mainland coastal barangay with a population of 1,143 individuals. It is located at 9° 44' 05.14" North and 125° 33' 50.60" East. it is bounded by Barangay Capalayan on the East and Barangay Cabonbongan on the North. The barangay has a total land area of 3.7538 km2 with an average elevation of seven (7) meters above sea level (Fig. 1).

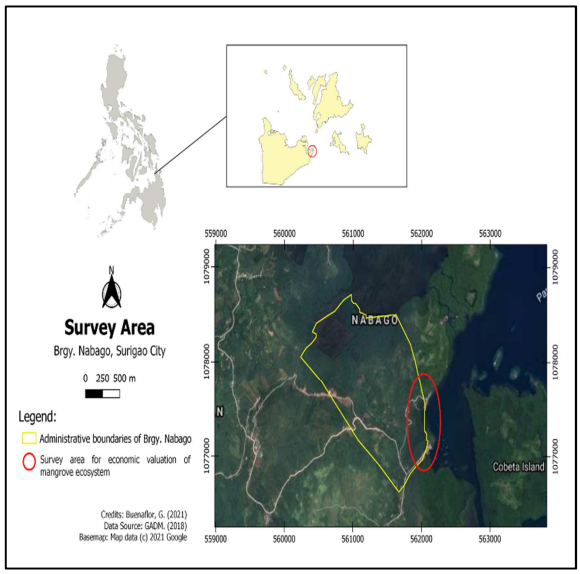

Fig. 1. Map of the study area

Data collection

The direct use values included forestry and fishery products and covered consumptive use and

productive use values. While the indirect use values are non-consumptive values which deal primarily with ecological functions of the ecosystem, which included: 1) coastal protection, 2) provision of nursery grounds, 3) carbon sequestration, and 4) protection from saltwater intrusion. Table 1 shows the list of mangrove products and ecosystem services that this study assessed the values of and the methods for valuing them.

Table 1. Valuation Techniques used for the different components of mangrove services

Component	Valuation technique
Direct Use Value (Consumable Services) Forestry products (fuelwood, timber, wild vegetables, herbs) Fishery Products (fish, shellfish)	Market Price
Indirect Use Value Coastline protection Provision of nursery grounds	Replacement Cost
Carbon sequestration Protection from saltwater intrusion	Market price

Household interviews using a structured questionnaire were conducted with the residents of Barangay Nabago in April 2021 to assess the direct use values of mangrove services. A purposive sampling method was adopted in the study (Tongco, 2007). Respondents must have a dependence on the mangrove forests (fishermen, firewood collectors, etc.). Only residents that were of legal age and have been residing in the area for at least one year qualified for the interview. This was to ensure a 95% confidence level with a 5% margin of error. The calculation of sample size was through the Raosoft online sample size calculator.

To determine the extent of local knowledge and attitudes on mangroves and to identify training needs, a household survey was conducted in the same community in August 2021.

Data Analysis

The identified services and functions of mangroves were quantified using the market price for direct use and the Replacement Cost Method for the indirect value of commodities from the mangrove ecosystem. The market price was used on products that were derived from the mangrove ecosystem and traded directly (e.g., the value of fish, shrimp, crab, etc.) (Bennett and Reynolds, 1993). Replacement Cost Method was used where there was no assigned value to the commodities or services provided by the mangrove ecosystem.

Table 2. The formula needed for valuing mangrove services.

Environmental component	Valuation technique	Formula
Direct Use Value A. Fish B. Crab C. Shrimp D. Clams E. Nipa	Market Price	DUV = A+B+C+ D+E+…
Indirect Use Value A. Coastline Protection B. Provision of nursery grounds C. Carbon sequestration D. Protection from saltwater intrusion	• Replacement Cost • Carbon sequestration international standard • Market price of potable water	IUV = A+B+C+ D+etc.

Result and discussion

Direct use values provided by mangroves in Barangay Nabago

Seven (7) goods under direct use values (DUV) obtained from the mangrove aquatic biota, and two (2) from commercial aquaculture were identified by the respondents. These goods, with their corresponding harvests and amount, are shown in Table 3.

Table 3. Weekly harvest of the DUV in the mangrove ecosystem and corresponding amount.

Goods	Unit	Total Weekly harvest	Market Price (PhP per unit)
Fish	kg	358.00	133.10
Crabs	kg	161.23	127.10
Clams	kg	128.80	140.00
Shrimps	kg	119.00	236.80
Sea Cucumber	kg	83.50	2,795.70
Seaweeds	kg	4.00	36.00
Nipa palm	sheets	310.00	500.00
Total		1,164.53	566.96

The major aquatic biota collected in the mangrove ecosystem of Nabago were fish, shellfish, seaweeds,

sea cucumber, and nipa palm. Shellfish can be categorized as crustaceans, which include crabs and shrimps, and bivalves that are mostly clams. Other bivalves such as oysters and mussels are also present in the area but not a focus of the residents to earn a living. The total weekly harvest is the average harvest in a week of the 89 households that were interviewed, which includes those consumed by these households. The collection system is by area or by Purok. One area/Purok focused on collecting clams, while the others are for sea cucumber, shrimps/crabs, nipa palm, and seaweeds. As a result, fish was shown to have the highest catch in a week while seaweed was the least harvested, although also abundant in the area. It is reasonable for the fish to top among others in terms of harvest because most of the residents fish for household consumption. Based on actual market price, sea cucumber was the most expensive, while seaweeds were the cheapest. The low market value of the seaweeds is probably the reason why the residents of Nabago do not focus much on seaweed collection despite its abundance. From the market price, a discount rate of 5% was applied as adapted from (Bennett and Reynolds, 1993). In commercial aquaculture, most of the operators were raising milkfish (*Chanos chanos*). Although some were engaged in culturing lobsters, only one responded in the survey. The harvest for commercial aquaculture is shown in Table 4.

Table 4. Average harvest of the commercial aquaculture in Barangay Nabago

Product	Growing period (months)	Market Price (Php/kilo)	Operating Cost (Php)	Harvest (pieces per area)	Area (sq.m.)
Chanos chanos	6	150.00	180,000.00	22,500	50
Nephropidae	9	3,150.00	250,000.00	150	9
Average	7.8	1,650.00	215,000.00	11,325	29.50

As gleaned in Table 4, for the average growing period of 7.8 months with average area of 29.50 square meter, the estimated harvest woul give a total amount of Php18,686,250.00 (assumption: 1kg/piece, based on interview). Based on the data gathered, it is most likely that the milkfish will provide more benefits than those engaged in aquaculture, considering that its operating cost and groeing period is much lower that than for lobsters. Further, milkfish can easily be sold in the market, while the lobsters require a regular customer or need a contract to be able to dispose it. Combining the harvest from both the local residents and commercial aquaculture, shown in Table 5 is the calculation of the direct use values of the mangrove ecosystem in Barangay Nabago.

Table 5. Calculation of the direct use values of mangrove ecosystem in Barangay Nabago

Type of benefits	Annual Market Value (Php/ha)	Total Area (has.)	Benefit value of mangrove in Barangay Nabago (Php)
Mangrove aquatic biota (fish, bivalves, crustaceans, seaweed, Nipa palm, sea cucumber)	103,262.93	1.64 has.	169,351.07
Aquaculture fishpond (Milkfish and Lobster)	509,433.96	7.81 has.	3,979,952.81
Total Potential DUV	612,696.89		4,149,303.88

As reflected in Table 5, the major aquatic biota that can be collected in the mangrove ecosystem of Nabago is fish in both residents and commercial aquaculture. The resident's harvests provided an annual direct benefit of Php103,262.00 per hectare per year to the residents of Barangay Nabago, which gives a total amount of Php169,351.07 for the entire mangrove ecosystem of Barangay Nabago. For commercial aquaculture, the total area occupied is 7.81 hectares with an estimated Php509,433.96 per hectare per year. This gives a total benefit value of Php3,979,952.81 annually. Based on the estimated calculation, the total benefits of the direct use values provided by the mangrove ecosystem of Barangay Nabago is Php612,696.89 per hectare per year.

Reference (Rizal *et al.*, 2018) shows that the direct use values for the mangrove ecosystem in Indonesia was estimated to be from Php 977.00-84,885.00 per hectare, which is way lower than the estimated amount in the Barangay Nabago. Further, there were about 26 identified productive uses in the same study, and these productive uses include mangrove wood for timber and firewood use. Since mangrove cutting for such purposes is prohibited in the Philippines, and the residents of Nabago are aware of this, such use did not come out during the survey. Further, commercial aquaculture was not considered in the calculation of the direct use values reference (Rizal *et al.*, 2018), which played a big part in the estimation of the DUV in Barangay Nabago. In another study in Indonesia, the estimated direct use value of the mangrove ecosystem was IRP 70,362,595.42 per hectare per year, which is about 246,513.01 in Philippine pesos (Perdana *et al.*, 2018). The contributing factor to the difference in the calculation of the DUV in both Timbulskolo Village, Indonesia, and Barangay Nabago is that the commercial aquaculture in the Philippines has a bigger area. The variability of the direct use values of the mangrove ecosystem, specifically on fishing, is usually influenced by the fishing boat capacity, quality of equipment, and the weather condition in the area which affects the fishing days (Lahjie *et al.*, 2019).

Indirect use values provided by mangroves in Barangay Nabago

Benefits that were not directly dereived from the mangrove ecosystems were identified as the indirect use values. In the mangrove ecosystem of Barangay Nabago, there were five (5) indirect use values as identified by the local residents, shown in Table 6. The length of the coastal protection and the protection from extreme sunlight was equivalent to the total area of mangrove ecosystem in the area which is 2.35 hectares. For the wind barrier, the length of 1,008 meters was based on the coastal area or the residential area that directly experienced protection from strong winds was accounted. For protection from saltwater intrusion, calculations were based on the average water consumption per household per day, which is about 60 liters for both commercial sources (bottled water) and from the spring provided by the local government, based on the interviews with the locals. This gives a total of 21,900 liters per household annually. As to carbon sequestration, an actual assessment of the aboveground and belowground dead carbon pool of 421.64 Mg/ha was used. Shown in Table 6 are the calculated indirect use values of the mangrove ecosystem in Barangay Nabago.

Table 6. Calculation of the indirect use values of mangrove ecosystem in Barangay Nabago.

Benefit	Market Value (Php)	Estimated measurement	Benefit value (Php/year)
Coastal protection	460,408.63	2.35 has.	1,083,617.75
Wind barrier	224.75.00	1,008 m.	226,548.00
Protection from extreme sunlight	250,000.00	2.35 has.	588,400.00
Protection from saltwater intrusion	1.25	21,900 L	2,436,375.00
Carbon sequestration	279.34	421.64 Mg/ha.	5,982,057.47
Total Potential IUV			68,568,598.22

In calculating the coastal protection value where the replacement cost method was used, the cost of construction of a seawall was considered. The standard annual cost of a seawall is USD9,065 per hectare (Barbier, 2007), which is equivalent to Php460,409.63 per hectare per year (at Php50.7897 per USD). For the wind barrier, the cost of USD4.425 /meter of a windbreak by the United Nations Environmental Programme-Climate Technology Centre & Network (UNEP-CTCN) was used as a replacement cost. The market value of a Nipa hut shed was used in calculating the value of the protection from extreme sunlight [16] thus, based on the actual market value of a Nipa hut, it costs Php250,000.00 per hectare. The salt intrusion was based on the actual market value of the water supplied to the area for both potable and domestic use. Lastly, the Carbon Sequestration Value (CSV) using benefit transfer methods adapted from reference (Eong, 1993) which is 5.5 USD/tonCO_2.

Reference (Malik *et al.*, 2015)shows that the calculated IUV of the mangrove ecosystem ranged from USD 4,016,814.00-10,244,784.00 per year, while in the present study, it is about USD1,350,049

(Php 68,568,598.22). The large variance may be attributed to the calculation of IUV for the provision of nursery ground in Reference (Pecl *et al.*, 2017), which was not included in the present study due to the unavailability of data needed for the calculation. While reference (Harini *et al.*, 2019) shows that the total amount of the IUV in the mangrove ecosystem was around Php5,102,212.95 (IDR 1,454,258,834) where only two (2) ecosystem services were considered in the calculation-coastal protection and provision of a nursery ground. The perceptible discrepancies in the valuation of the mangrove ecosystem depend on the ecosystem services that were identified during the conduct of the study. Further, in valuing the services provided by the mangrove ecosystem, outcomes will rely mostly on the socio-economic circumstances of the area and to the specific context (Vo *et al.*, 2015).

Based on the sum values of the DUV and IUV, the annual use values of the mangrove ecosystem in Barangay Nabago is around Php 72.72 million pesos (Table 7).

Table 7. Calculation of the potential values of mangrove ecosystem in Barangay Nabago

Type of benefits	Benefit value (Php/ha./year)
Total Direct Use Values	4,149,303.88
Total Indirect Use Values	68,568,598.22
Total potential value of mangrove ecosystem	72,717,902.10

The IUV has the bigger contribution which is about 94% of the total benefit value. This result conforms to the reference (Malik *et al.*, 2015) in which the DUV also resulted to have contributed 94% of the Total Economic Value (TEV) of the mangrove ecosystem. In addition, reference (Harini *et al.*, 2019) shows that IUV also contributed 81.66% of the total economic value of the services provided by the mangrove ecosystem.

Among the benefits of the IUVs, carbon sequestration has been recorded to have the highest value followed by protection from saltwater intrusion. Reference (Malik *et al.*, 2015) and (Harini *et al.*, 2019) showed that coastline protection was the biggest contributor to the total value. Both studies did not consider carbon sequestration and protection from saltwater intrusion as part of the indirect use values. When these services are excluded from this study, it will appear that coastal protection will have the highest IUV, which will conform to their studies.

Extent of local knowledge and attitudes on mangroves

Most of the respondents that were surveyed belonged to the 30-39 (32.0%) and 40-49 (29.5%) age brackets (Table 8). In terms of sex, females (56.5%) accounted for a majority of the respondents. Since the survey was done during a weekday, most males were out for work while females were left at home. The respondents were also long-term residents of Nabago, mostly living in the area for two (2) to five (5) decades. As for education, more than half (55.5%) were elementary school graduates, while a third (34.0%) were junior high school graduates. Only a small percentage (2.5%) did not have formal schooling.

Table 8. Profile of the respondents

Profile Variables	Count (n=200)	Percentage
Age (years)		
18-29	30	15.0
30-39	64	32.0
40-49	59	29.5
50-59	31	15.5
60 and above	16	8.0
Sex		
Male	87	43.5
Female	113	56.5
Years of Residency		
1-5	4	2.0
6-15	21	10.5
16-25	42	21.0
26-35	45	22.5
36-45	47	23.5
46-55	33	16.5
56 and above	8	4.0
Educational Attainment		
No formal schooling	5	2.5
Elementary	111	55.5
Junior HS	68	34.0
Senior HS	4	2.0
College	12	6.0

Generally, despite their educational background, the residents of Nabago exhibited high levels of awareness on the ecological functions of the mangrove ecosystem (Table 9).

This is notable in contrast to reference (Alimbon and Manseguiao, 2021) where the authors attributed the resident's knowledge on the benefits from mangroves to their educational attainment. In the present study, long-term residency in the area may have contributed to the residents' high level on awareness of mangrove ecosystems, as most have lived in the area for two or more decades.

Table 9. Locals awareness on mangrove ecosystems.

Statement	Mean	QD
I am aware that mangrove forests should be protected.	4.51	Fully Aware
I am aware that mangrove forest protection is necessary for the benefits of the present and future generations.	4.45	Fully Aware
I am aware that mangrove ecosystems play key roles in our environment in terms of ecosystem services.	4.45	Fully Aware
I am aware that mangrove forests are a nursery for small fishes, mollusk crabs, and shrimps.	4.42	Fully Aware
I am aware that mangrove ecosystems play vital roles in our environment in terms of vulnerability.	4.40	Fully Aware
I am aware that mangrove forests are important to human sustainability.	4.38	Fully Aware
I am aware that mangrove ecosystems play vital roles in our environment in terms of biodiversity.	4.35	Fully Aware
I am aware that mangrove ecosystems play key roles in our environment in terms of restoration practices.	4.34	Fully Aware

Note: Fully aware (4.23-5.00); Aware (3.42-4.22); Neither (2.62-3.41); Unaware (1.81-2.61); Very Unaware (1.00-1.80); QD- Qualitative Description.

Table 10. Locals attitude on mangrove ecosystems.

Statement	Mean	QD
I feel bad if access to the mangrove forest is denied.	4.56	Strongly Agree
I feel safe living in the mangrove forest.	4.49	Strongly Agree
I would like to help other forest agencies to protect the mangrove forests.	4.48	Strongly Agree
I am willing to participate in the protection of the mangrove forests.	4.45	Strongly Agree
I like to support laws that are intended to protect mangrove forests.	4.44	Strongly Agree
I agree to the government policy regarding the protection of the mangrove forests	4.43	Strongly Agree
I considered mangrove ecosystems as valuable places which need to be protected from destruction	4.40	Strongly Agree
I think the protection of mangrove forests requires everyone's effort.	4.33	Strongly Agree
I agree that living in the mangrove forest contributes to its destruction.	4.27	Strongly Agree
I think my right will be violated if I am asked to stop using the mangrove forests.	4.27	Strongly Agree
I feel a sense of responsibility for the protection of the mangrove forests.	4.19	Agree
I feel responsible for the protection of animals and other living things in the mangrove forests.	4.03	Agree
I agree to vacate the mangrove if asked to do so.	3.94	Agree
I think it is good for the mangrove to be converted to other uses e.g., human settlements, farming, and an area for depositing waste sites, etc.	3.67	Agree
It is necessary to deny people access to mangrove forests.	3.46	Agree
I think mangrove forests are areas to be used as waste sites.	2.47	Disagree

Note: Strongly Agree (4.23-5.00); Agree (3.42-4.22); Neither (2.62-3.41); Disagree (1.81-2.61); Strongly Disagree (1.00-1.80); QD- Qualitative Description

In terms of attitude (shown in Table 10), most respondents showed positive attitude toward mangrove protection. Statements on mangrove protection included those involving helping forest agencies, participating in mangrove forest protection, supporting laws and agreeing with government policies on mangrove protection, protecting mangroves from destruction, combined effort, having a sense of responsibility for mangrove protection not just for the mangrove forest but also for the animals and other organisms living in it. Generally, the respondents felt safe living in the mangrove forest; however, they also strongly agreed that living in the mangrove forest contributes to its destruction. They agreed to vacate the forest if asked to do so. Although the respondents agreed that it is necessary to deny people access to mangrove forests, they also agreed that they would feel bad if they were denied access to the mangrove forest. In terms using the mangrove forest, the respondents strongly agreed that their rights will be violated if they will be asked to stop using the mangrove forest and even agreed that mangrove forest conversion is good. To the extent that mangrove forests are used as waste sites, the respondents disagreed.

The respondents' sense of responsibility for the protection of the mangrove forest and the organisms living therein implies that the locals see the intrinsic value of the mangroves (i.e., valuing the forest for its existence). This may be due to their high level of awareness of the benefits that mangrove forests provide in terms of biodiversity, ecosystem services, restoration practices, vulnerability, and serving as a nursery ground for marine organisms. Awareness of the importance of the mangrove ecosystem concerning sustainability for future generations, positive attitude toward mangrove protection, as well as support for policies and laws related to mangrove protection, all imply that the locals attach a bequest value on the mangroves to preserve these for future generations (Ballad and Mangabat, 2021; O'Garra, 2009). On the other hand, responses to the statements on the use of the mangrove resources (e.g., living in the mangrove forest, entitlement to use the mangrove forests, conversion of the mangrove area, utilizing the mangrove forests as waste sites) indicate attitudes toward the role of natural resources in the development process (Ballad and Mangabat, 2021). This is important for resource managers to look into since, despite the high level of awareness of the benefits provided by mangrove forests, the locals are open to converting these areas for other uses. This may be due to the respondents' economic status. In the interview conducted for the economic valuation, 79% of the respondents were fishermen and 66% had a monthly income of PhP5,000 or below. Economic empowerment may be necessary to improve the socio-economic condition of the residents of Nabago so that they may be better equipped to protect the mangrove resources that the community heavily depends upon.

Training Needs on Mangrove Resources

In terms of training needs, the respondents ranked mangrove monitoring as their top priority for training, followed by mangrove conservation, management, restoration, and rehabilitation (Fig. 2). Training on aquacultures such as seaweed, sea cucumber, and crab culture was the last among their ranking. This is remarkable as the respondents see the value of the mangrove ecosystem as the source of the benefits that they enjoy, with the five training topics related to mangroves being on the top of their training priorities.

Because of the high level of awareness and sense of responsibility in protecting their mangrove resources, the respondents see that protecting the mangrove ecosystem in their Area through monitoring, conservation, management, restoration, and rehabilitation are their top training needs compared to training related to aquaculture, from which they could gain direct monetary values. Although not yet aware of the total indirect benefit value (as calculated in this study) that the mangrove ecosystem provides, the respondents may already have felt the many indirect benefits through the years.

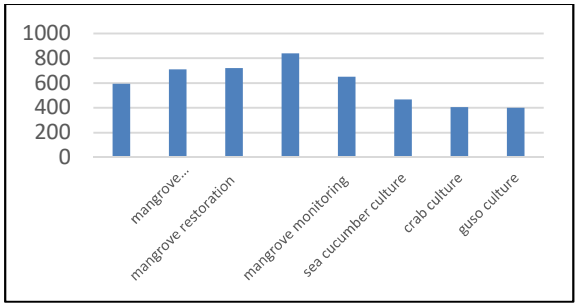

Fig. 2. Training needs ranked by importance.

Conclusion

The mangrove ecosystem of Nabago, Surigao City, has high economic value in terms of direct and indirect uses. Calculating the direct and indirect use values of ecosystems provides concrete fig. for the users of the ecosystems. High awareness of the ecological functions of the mangrove ecosystem and a positive attitude toward mangrove protection implies that the locals of Nabago value the mangrove ecosystem for its existence and would like to preserve it for future generations, as evidenced by the training needs related to mangrove monitoring, conservation, management, restoration and rehabilitation over those related to aquaculture. Perception studies and economic valuations of natural resources may be helpful in gaining insight into how communities view their natural resources. In addition, the identification of the training needs of the community is a step towards taking concrete action in addressing what it needs relative to natural resource conservation and management. The local government may use this study in formulating policies concerning the use of the mangrove ecosystem in Nabago. Dissemination of the valuation results in this study is necessary to show the importance of the community's mangrove ecosystem, thereby discouraging the possible conversion of the forests in favor of development in the Area.

Acknowledgment

The authors would like to thank both the College of Arts and Sciences and the College of Teachers Education for funding this research endeavor and to the local government unit of Barangay Nabago, Surigao City, for the consent given to them to conduct this study on their area.

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